Table of Content

1. Course Title:

The title of the program is Bachelor of Pharmacy (B. Pharm)

2. General Instructions:

Course Objective

- To produce internationally competent pharmaceutical health workforce for the development of pharmacy as a profession for fulfilling the health need of the people.
- To ensure better pharmacy practice in the hospital, pharmaceutical industries as well as in the community settings.
- To provide technically competent professionals for the promotion of rational use of drugs.
- To provide sound academic knowledge and skills to the students, that assists in the strengthening of the profession.
- To produce quality health professionals in order to provide quality health service to the general public.
- To develop leadership quality in the students for better health promotion and health programming.

Bachelor of Pharmacy Program of Purbanchal University is designed to produce competent graduates who have the abilities and skills in:

- Providing pharmaceutical care to patients
- Developing and managing medication distribution and control systems
- Managing the pharmacy in community and hospitals
- Promoting Public Health
- Providing drug information and education
- Managing and supervising the pharmaceutical manufacturing unit
- Working as a team member of Health workers in clinical setting

The curriculum emphasizes three major areas of instruction:

1. **Basic Sciences:** (Inorganic Pharmaceutical Chemistry, Organic Chemistry, Physical Chemistry, Mathematics).

II. Basic Medical Sciences: (Anatomy & Physiology, Biochemistry, Microbiology, Pathophysiology).

III. Pharmaceutical Sciences:

a. Pharmaceutical Chemistry and Instrumental Analysis: Emphasizes the application of chemical sciences to pharmacy. The courses deal with chemicals used as medicines, properties, preparation and preservation. In addition, attention is given to the processes and tests used to determine the purity and strength of a chemical or its pharmaceutical dosage form.

b. Pharmacognosy and Chemistry of Natural Product:

This course deals with the nature and sources of "natural drugs"- those obtained from plants or animals, either directly or indirectly. The aim of this course is to provide the knowledge and skill of basic principle and techniques in Pharmacognosy and to make the students familiar with the herbal drugs in different systems of medicines, phytochemistry, evaluation and standardization of crude drugs.

c. Pharmacology and Pharmacotherapeutics:

This course gives students the basic knowledge of drugs acting on various systems, pharmacotherapeutics management of some disorders and skills to carry out some selected pharmacological experiments. This course will help the students to develop the competency in pharmaceutical practice and research, in evaluating drug-interaction and drug incompatibility and providing drug information in community and clinical settings.

d. Hospital & Clinical Pharmacy and Community Pharmacy: These courses are designed to give an appreciation of the background and nature of the profession, to familiarize students with the many skilled processes used in pharmacy, to introduce the various forms of medicines, and to teach them how to dispense medication accurately and skillfully.

c. Physical Pharmacy, Pharmaceutics and Dosage form Design:

These courses will provide students the knowledge of application of physical pharmacy, formulation of different dosage forms, basic unit operations related to pharmaceutical procedures which will help students to design dosage form and work in pharmaceutical fields.

3. Course Duration:

The course duration is 4 years in 8 Semesters.

Total Credit hours: 168 Practical: 32 credits, Theory: 122 credits, Seminar-2 credits, Project Work: 6 credits and Professional internship 6 credits.

One semester	16 weeks
One credit for theory class	16 hours
One credit for practical class	48 hrs

One practical class should be carried out 3 in laboratory hrs.

One day project work	6 hours
One day professional internship	8 hours
One seminar	48 hours

Total credits of B. Pharm. Course =168 credits

Total Theory Credits	Total Practical Credits	Project works Credits	Seminar Credits	Professional Internship Credits	Grand Total Credits
122	32	6	2	6	168

4. Course Coding:

Each course is given four capital letters (PHAR) followed by three digit numbers. PHAR letter indicates pharmacy program and three digit numbers indicates year, semester and sequence of subject respectively. Term 'Lab' indicates practical of respective subject and "Sem" indicates seminar.

5. Maximum Duration of Course:

A student will get a maximum of 7 years time period to complete the degree course (B. Pharm) from the date of admission.

6. Enrolment Criteria:

To be eligible for applying the program, one must meet the following criteria

- Must have passed 12 years (10+2) of formal education or I.Sc. or equivalent or certificate level in pharmacy or Diploma in Pharmacy.
- Must have passed higher secondary physics, chemistry and mathematics OR physics, chemistry and biology with an average score 50%. In case of grading system, required criteria will be as per university entrance notice.
- From Diploma in Pharmacy: Must pass Diploma of Pharmacy with average score 60% or Certificate of Pharmacy with Average score 50%.The candidate should have registration in Nepal Pharmacy Council (NPC).
- Must pass in the entrance examination conducted by PU or from PU affiliated colleges as per PU norms.
- From other Diploma (Health) Level Background:
  a. Must pass Proficiency Certificate Level in General of Medicine (HA), Certificate in Medical Laboratory Technology (CMLT), with average score 60%. The Candidate should have registered in their respective council.
  b. The above mentioned candidate from HA and CMLT should have diploma degree equivalent to 10+2 as per NEB (former HSEB) norms.

7. Medium of Language for Teaching and Examination:

The mode of instructions of teaching and Examination are conducted in English medium.

8. Academic Schedule:

Academic schedule consists of two semesters per year namely fall semester (September- February) and spring semester (February-August).

9. Instructions:

I. Each Semester consists of a minimum of 16 weeks instructions.

II. Internal assessment of Theoretical (20%) will be based on two class tests of 10 marks in each of the theory subject during each semester and 10 marks for class performance and attendance of student in each subject.

III. Internal assessment of Practical: 60% will be based on day to day attendance, viva, laboratory **record** etc.

IV. A minimum of 80% attendance in theory and practical classes are compulsory.

V. A student has to obtain minimum 50% marks in theory paper and 60% marks in practical subjects separately to pass each subject.

10. Teaching/ Learning Methodology:

I. **Lectures:**

Theory classes will be conducted 7 hours per working days according to the routine set by the program coordinator.

II. **Practical/Demonstration:**

The students have to carry out the practical/laboratory work to learn the prescribed skills under the supervision of the respective teachers/laboratory incharges. Some practical may be demonstrated either manually or by video demonstration. The practical/demonstration would be subjected to change according to the need of the subject matter as decided by the department.

III. **Problem oriented learning/Self-directed learning:**

"Problem oriented learning" and self-directed learning shall be applied whenever appropriate, that will be helpful to set problem based questions in the examination.

IV. Project work:

In fourth year (**eighth semester**), the project assignment will be given to students (in group of maximum 3 students) which should be completed and submitted to the department before the final examination. Students shall review and search the literature, conduct research and prepare project work report under the supervision of assigned teacher. The students will have to defend their project work.

V. Industry / Academia Interaction:

Experts from the regulatory bodies (DDA), pharmaceutical industries, research/ quality control laboratory and related institutions will be invited to give insights and to share experiences in emerging areas.

VI. Visits and Observations:

Visits and Observations in different hospitals, pharmaceutical industries, drug regulatory bodies, research laboratories, and community pharmacy and drug distributors will be conducted as instructed by curriculum.

VII. Seminar Works:

In Fifth and Sixth semester, students in a group of maximum five numbers shall be given topics related on scientific publication, review article, case study etc. Students shall present their topic and the evaluation for the same will be done by internal and external examiner.

VIII. Internship/Training:

Internship/Training in hospital and community pharmacy, pharmaceutical industry, quality control laboratory etc. will be carried as per curriculum requirements.

11. Evaluation System:

Evaluation system is divided into internal evaluation and end semester final examination (external evaluation).

11.1. Internal Evaluation:

Table 1: Marks Allocation for Internal Evaluation

Theory		Practical		Seminar		Project Work/ Professional Internship	
FM	PM	FM	PM	FM	PM	FM	PM
20	10	30	18	30	18	60	36

11.2 Internal Evaluation Criteria:

A. Theory

S. N.	Particular	Percentage (%)	Marks (FM=20)
1.	Minimum Two assessments	50	10
2.	Attendance	25	5
3.	Class Performance and Discipline	25	5
Total			20

B. Practical

S. N.	Particular	Percentage (%)	Marks (FM=30)
1.	Lab Performance	40	12
2.	Record file	20	6
3.	Attendance	20	6
4.	Internal Test/Viva	20	6
Total			30

C. Seminar

S. N.	Particular	Percentage (%)	Marks (FM=30)
1.	Content	30	9
2.	Presentation and performance	50	15
3.	Interaction skill	20	6
Total			30

D. Project Work

S. N.	Particular	Percentage (%)	Marks (FM=60)
1.	Dissertation writing and Literature Review and References	20	12
2.	Research Work in Hospital/ Community/ Industrial/ Study area	40	24
3.	Scientific contents: contribution and existing subject knowledge in his/her work	10	6
4.	Result & Discussion, Conclusion writing	15	9
5.	Presentation skills & Communication	15	9
Total			60

E. Research Methodology and Proposal Design

S. N.	Particular	Percentage (%)	Marks (FM=30)
1.	Literature Survey	40	12
2.	Proposal Submission	40	12
3.	Presentation/Viva	20	6
Total			30

F. Professional Internship:

S.N.	Particular	Percentage (%)	Marks (FM=60)
1.	Log Book Record	60	36
2.	Report Submission	30	18
3.	Presentation /Viva	10	6
Total			60

11.3 End Semester Examination (External Evaluation):

Table 2: Marks Allocation for End Semester Assessment

Theory		Practical		Seminar		Project Work/ Professional Internship	
FM	PM	FM	PM	FM	PM	FM	PM
80	40	20	12	20	12	40	24

End semester examination will be conducted by Examination Management Office of Purbanchal University at the end of every semester. The procedure for examination will be as per the examination rules of University.

11.4. End Semester Evaluation Criteria:

A. Theory

End Semester examination of theoretical subject will be conducted for three hours for the total of 80 marks in written paper test. The examination question pattern is divided into four parts as shown in Annex I.

B. Practical

S. N.	Particular	Percentage (%)	Marks (FM=20)
1.	Synopsis	25	5
2.	Experiment	50	10
3.	Viva Voce	25	5
Total			20

C. Seminar

S. No.	Particular	Percentage (%)	Marks (FM=20)
1.	Content	30	9
2.	Presentation and performance	50	15
3.	Interaction Skill	20	6
Total			20

D. Project Work

S. N.	Particular	Percentage (%)	Marks (FM=40)
1.	Report Content	40	16
2.	Presentation skills & Communication	30	12
3.	Question and Answer (Viva)	30	12
Total			40

E. Research Methodology and Proposal Design

S. N.	Particular	Percentage (%)	Marks (FM=20)
1.	Proposal Submission	50	10
2.	Presentation/Viva	50	10
Total			20

F. Professional Internship

S. N.	Particular	Percentage (%)	Marks (FM=20)
1.	Report Submission	50	10
2.	Presentation /Viva	50	10
Total			20

End semester (final) examination of practical, seminar work, Research Methodology and Proposal Design and Project Work/ Professional internship evaluation will be done by internal and external examiner appointed by Purbanchal University, Examination Management Office.

12. Grading System:

The grades (marks) awarded to student in a course is based on his/her consolidated performance in internal and final examinations. The letter grade in any particular subject is an indication of a student's relative performance in that course. The pattern of grading will be as follows:

Table: 3 Letter Grading System of Purbanchal University,

Equivalent marks in %	Letter Grades	Grade Value	Remarks
90 and Above	A^+	4.00	
80 and Below 90	A	3.75	
70 and Below 80	B^+	3.50	
60 and Below 70	B	3.00	

50 and Below 60	C	2.50	
40 and Below 50	D	1.75	
Below 40	F	0.00	Fail
Not Qualified (NQ) /Absent	I		Incomplete

The student's final grade will be calculated on cumulative grade point average (CGPA). **CGPA** at the end of the degree defines the division which will as followings:

CGPA Definition	Division
3.75-Below 4.00	First with Excellence
3.50-Below 3.75	First with Distinction
3.00-Below 3.50	First Division
2.50-Below 3.00	Second Division
2.00-Below 2.50	Pass Division

13. Dismissal from the Program:

A student will be dismissed from the program if he/she fails to maintain CGPA of 2.50 and could not complete B. Pharm course within 7 years from date of admission.

14. Field Observation:

- During first semester (1day trip) and third semester (3-4 days trip) as per the syllabus requirement of Pharmacognosy-I, Pharmacognosy-II and Pharmcognosy-III, students will be visited the Herbal Garden (Botanical Garden) or a suitable medicinal garden to observe the local flora and fauna with the following objectives:

- Every student will collect herbal samples and prepare a standard herbarium medicinal plant from observed field.
- Student will submit a report that will be evaluated for respective subject.
- Visit to any Essential oil extraction plant.

- Pharmaceutical Industry Visit: During 6th or 7th Semester, students will visit National Pharmaceutical Industries as per available opportunity with the following objectives.

General objective visit:

- To observe the organization of a pharmaceutical manufacturing unit.

Specific Objectives

i) To observe and understand the Water Treatment System
ii) To observe and understand the HVAC and other utility
iii) To observe and understand the manufacturing flow of different Pharmaceutical Dosage form in the industry and
iv) To understand the Quality Control System implemented and practiced in the Industry.

Department assigned a group of 3-4 students to submit an observation visit report that will be evaluated for 50% of internal test marks of Pharmaceutical Technology II Practical or Dosage form Design Practical as per the time of the visit.

15. Professional Internship:

Six weeks and two days professional internship on Industrial or QA/QC Laboratory or Hospital or Community Pharmacy Internship is compulsory for all students for the partial fulfillment of degree of Bachelor of Pharmacy in Purbanchal University.

Detail Syllabus Outline of Bachelor of Pharmacy (Revised 2019)

First Year: First Semester

S. N.	Course Code	Subject	Credit Hour		Hrs/ Wk	Hrs/ Sem	Evaluation			
							Internal		Final	
			Th	Pr			FM	PM	FM	PM
1.	PHAR 111	Pharmaceutical Inorganic Chemistry	3	-	3	48	20	10	80	40
2.	PHAR 112	Pharmacognosy- I	3	-	3	48	20	10	80	40
3.	PHAR 113	Physical Chemistry	3	-	3	48	20	10	80	40
4.	PHAR 114	Mathematics	3	-	3	48	20	10	80	40
5.	PHAR 115	Basic Computer Applications	2	-	2	32	20	10	80	40
6.	PHAR 116	Communication Skill	2	-	2	32	20	10	80	40
7.	PHAR 111 Lab	Pharmaceutical Inorganic Chemistry Practical	-	1	3	48	30	18	20	12
8.	PHAR 112 Lab	Pharmacognosy- I Practical	-	1	3	48	30	18	20	12
9.	PHAR 113 Lab	Physical Chemistry Practical	-	1	3	48	30	18	20	12
10.	PHAR 115 Lab	Basic Computer Applications Practical	-	1	3	48	30	18	20	12
	Total Credit		**16**	**4**	**28**	**448**	**240**		**560**	
Total Credit Hours (Theory and Practical) and Full Marks			**20**				**800**			

First Year: Second Semester

S. N.	Course Code	Subject	Credit Hour		Hrs/ Wk	Hrs/ Sem	Evaluation			
			Th	Pr			Internal		Final	
							FM	PM	FM	PM
1.	PHAR 121	Pharmaceutical Organic Chemistry–I	3	-	3	48	20	10	80	40
2.	PHAR 122	Pharmacognosy-II	3	-	3	48	20	10	80	40
3.	PHAR 123	Physical Pharmacy	3	-	3	48	20	10	80	40
4.	PHAR 124	Pharmaceutical Analysis-I	3	-	3	48	20	10	80	40
5.	PHAR 125	Anatomy & Physiology-I	3	-	3	48	20	10	80	40
6.	PHAR 121 Lab	Pharmaceutical Organic Chemistry–I Practical	-	1	3	48	30	18	20	12
7.	PHAR 122 Lab	Pharmacognosy–II Practical	-	1	3	48	30	18	20	12
8.	PHAR 123 Lab	Physical Pharmacy Practical	-	1	3	48	30	18	20	12
9.	PHAR 124 Lab	Pharmaceutical Analysis-I Practical	-	1	3	48	30	18	20	12
10.	PHAR 125 Lab	Anatomy & Physiology-I Practical	-	1	3	48	30	18	20	12
	Total Credit		**15**	**5**	**30**	**480**	**250**		**500**	
Total Credit Hours (Theory and Practical) and Full Marks			**20**				**750**			

Second Year: Third Semester										
S. No	Course Code	Subject	Credit Hour		Hrs / Wk	Hrs/ Sem.	Evaluation			
							Internal		Final	
			Th.	Pr.			FM	PM	FM	PM
1.	PHAR 211	Pharmaceutical Organic Chemistry-II	3	-	3	48	20	10	80	40
2.	PHAR 212	Pharmacognosy-III	3	-	3	48	20	10	80	40
3.	PHAR 213	Pharmaceutical Analysis-II	3	-	3	48	20	10	80	40
4.	PHAR 214	Pharmaceutical Engineering-I	3	-	3	48	20	10	80	40
5.	PHAR 215	Anatomy & Physiology-II	3	-	3	48	20	10	80	40
6.	PHAR 211 Lab	Pharmaceutical Organic Chemistry-II Practical	-	1	3	48	30	18	20	12
7.	PHAR 212 Lab	Pharmacognosy-III Practical	-	1	3	48	30	18	20	12
8.	PHAR 213 Lab	Pharmaceutical Analysis-II Practical	-	1	3	48	30	18	20	12
9.	PHAR 214 Lab	Pharmaceutical Engineering-I Practical	-	1	3	48	30	18	20	12
10.	PHAR 215 Lab	Anatomy & Physiology-II Practical	-	1	3	48	30	18	20	12
	Total Credit		**15**	**5**	**30**	**480**	**250**		**500**	
Total Credit Hours (Theory and Practical) and Full Marks			**20**				**750**			

Second Year: Fourth Semester

S. N	Course Code	Subject	Credit Hour		Hrs / Wk	Hrs/ Sem.	Evaluation			
							Internal		Final	
			Th.	Pr.			FM	PM	FM	PM
1.	PHAR 221	Biochemistry	3	-	3	48	20	10	80	40
2.	PHAR 222	Chemistry of Natural Products	3	-	3	48	20	10	80	40
3.	PHAR 223	Pharmaceutical Engineering-II	3	-	3	48	20	10	80	40
4.	PHAR 224	Pharmaceutical Microbiology	3	-	3	48	20	10	80	40
5.	PHAR 225	Pharmacology-I	3	-	3	48	20	10	80	40
6.	PHAR 221 Lab	Biochemistry Practical	-	1	3	48	30	18	20	12
7.	PHAR 222 Lab	Chemistry of Natural Products Practical	-	1	3	48	30	18	20	12
8.	PHAR 223 Lab	Pharmaceutical Engineering-II Practical	-	1	3	48	30	18	20	12
9.	PHAR 224 Lab	Pharmaceutical Microbiology Practical	-	1	3	48	30	18	20	12
10.	PHAR 225 Lab	Pharmacology-I Lab	-	1	3	48	30	18	20	12
	Total Credit		**15**	**5**	**30**	**480**	**250**		**500**	
Total Credit Hours (Theory and Practical) and Full Marks			**20**				**750**			

Third Year: Fifth Semester										
S. N.	Course Code	Subject	Credit Hour		Hrs/ Wk	Hrs/ Sem.	Evaluation			
							Internal		Final	
			Th.	Pr.			FM	PM	FM	PM
1.	PHAR 311	Medicinal Chemistry- I	3	-	3	48	20	10	80	40
2.	PHAR 312	Pharmaceutical Technology- I	3	-	3	48	20	10	80	40
3.	PHAR 313	Pharmaceutical Biotechnology	3	-	3	48	20	10	80	40
4.	PHAR 314	Pharmacology –II	3	-	3	48	20	10	80	40
5.	PHAR 315	Public Health Pharmacy	3	-	3	48	20	10	80	40
6.	PHAR 316	Pathophysiology	3	-	3	48	20	10	80	40
7.	PHAR 311 Lab	Medicinal Chemistry- I Practical	-	1	3	48	30	18	20	12
8.	PHAR 312 Lab	Pharmaceutical Technology-I Practical	-	1	3	48	30	18	20	12
9.	PHAR 313 Lab	Pharmaceutical Biotechnology Practical	-	1	3	48	30	18	20	12
10.	PHAR 317 SEM	Seminar-I	-	1	3	48	30	18	20	12
	Total Credit		**18**	**4**	**30**	**480**	**240**		**560**	
Total Credit Hours (Theory and Practical) and Full Marks			**22**				**800**			

Third Year: Six Semester

S. N.	Course Code	Subject	Credit Hour		Hrs/ Wk	Hrs/ Sem.	Evaluation			
							Internal		Final	
			Th.	Pr.			FM	PM	FM	PM
1.	PHAR 321	Medicinal Chemistry- II	3	-	3	48	20	10	80	40
2.	PHAR 322	Pharmaceutical Technology- II	3	-	3	48	20	10	80	40
3.	PHAR 323	Pharmacology –III	3	-	3	48	20	10	80	40
4.	PHAR 324	Bio pharmaceutics & Pharmacokinetics	3	-	3	48	20	10	80	40
5.	PHAR 325	Biostatistics	3	-	3	48	20	10	80	40
6.	PHAR 321 Lab	Medicinal Chemistry-II Practical	-	1	3	48	30	18	20	12
7.	PHAR 322 Lab	Pharmaceutical Technology-II Practical	-	1	3	48	30	18	20	12
8.	PHAR 323 Lab	Pharmacology–III Practical	-	1	3	48	30	18	20	12
9.	PHAR 324 Lab	Biopharmaceutics & Pharmacokinetics Practical	-	1	3	48	30	18	20	12
10.	PHAR 326 SEM	Seminar-II		1	3	48	30	18	20	12
	Total Credit		**15**	**5**	**30**	**480**	**250**		**500**	
Total Credit Hours (Theory and Practical) and Full Marks			**20**				**750**			

Forth Year: Seventh Semester										
S. N.	Course Code	Subject	Credit Hour		Hrs/ Wk	Hrs/ Sem.	Evaluation			
							Internal		Final	
			Th.	Pr.			FM	PM	FM	PM
1.	PHAR 411	Dosage Form Design	3	-	3	48	20	10	80	40
2.	PHAR 412	Pharmaceutical Management	3	-	3	48	20	10	80	40
3.	PHAR 413	Pharmacotherapeutics	3	-	3	48	20	10	80	40
4.	PHAR 414	Research Methodology	3	-	3	48	20	10	80	40
5.	PHAR 415	Forensic Pharmacy	3	-	3	48	20	10	80	40
6.	PHAR 416	Dispensing and Community Pharmacy	3	-	3	48	20	10	80	40
7.	PHAR 411 Lab	Dosage Form Design Practical	-	1	3	48	30	18	20	12
8.	PHAR 414 Lab	Research Methodology and Proposal Design Practical	-	1	3	48	30	18	20	12
9.	PHAR 416 Lab	Dispensing and Community Pharmacy Practical	-	1	3	48	30	18	20	12
	Total Credit		**18**	**3**	**27**	**480**	**210**		**540**	
Total Credit Hours (Theory and Practical) and Full Marks			**21**				**750**			

Forth Year: Eighth Semester										
S. N.	Course Code	Subject	Credit Hour		Hrs/ Wk	Hrs/ Sem.	Evaluation			
							Internal		Final	
			Th.	Pr.			FM	PM	FM	PM
1.	PHAR 421	Hospital Pharmacy	3	-	3	48	20	10	80	40
2.	PHAR 422	Drug Delivery System	2	-	2	32	20	10	80	40
3.	PHAR 423	Instrumental Analysis	3	-	3	48	20	10	80	40
4.	PHAR 424	Clinical Pharmacy	2	-	2	32	20	10	80	40
5.	PHAR 421 Lab	Hospital Pharmacy Practical	-	1	3	48	30	18	20	12
6.	PHAR 422 Lab	Drug Delivery System Practical	-	1	3	48	30	18	20	12
7.	PHAR 423 Lab	Instrumental Analysis Practical	-	1	3	48	30	18	20	12
8.	PHAR 425	Project Work	-	6	3	288	60	36	40	24
Total Credit Hours (Thoery and Practial)			10	9	28	592	230		420	
9.	PHAR 426	Professional Internship	6		48	304	60	36	40	24
Grand Total Credit hours (Thoery+ Practical + Internship)			**25**			**896**	**750**			

Summary of B Pharm. Curriculum in credits and hours

Semester	I	II	III	IV	V	VI	VII	VIII	Total
Credits	20	20	20	20	22	20	21	25	**168**
Full Marks	800	750	750	750	800	750	750	750	**6100**
Total hrs	448	480	480	480	480	480	480	896	**4224**

FIRST SEMESTER

PHAR 111 Inorganic Pharmaceutical Chemistry [48 Hours]

Unit 1: Sources of impurities in pharmaceuticals, Test of Purity, Importance of limit test and general principles of limit tests for chloride, sulphate, Heavy metals (lead, arsenic) and iron. (3 hrs)

Unit 2: Acid, Base, Buffers and Water (10 hrs)

Introduction, Different concepts of acid and base, Importance of acids and bases in Pharmacy, storage condition. Official acids: Phosphoric acid (Conc/dil), HCl (Conc/dil), Boric acid. Official Bases: NaOH, KOH, $Ca(OH)_2$, dil. and strong NH_3, Na_2CO_3, Acidosis and Alkalosis. (3 hrs)

Buffer: Definition, types of buffer, properties, pH of buffer and calculation of pH (Handerson Hasselbalch equation), Mechanism of buffer action, buffer capacity, criteria for buffer selection, Role of buffers in pharmacy, some examples of buffer system, physiological acid-base balance, buffer system in body and their role (3 hrs)

Official buffer: Standard buffer system, pharmaceutical buffer system, composition of standard buffer: (Hydrochloric acid buffer, acid phthalate buffer, neutralized phthalate buffer, phosphate buffer, alkaline buffer) (1 hr)

Water: Importance, types of water (Potable water, Purified water, Water for Injection/ Sterile), Water Purification Method (Distillation, Ion Exchange Method & Reverse Osmosis Method), Monographic study of purified water, water for injection according to latest pharmacopoeia. (3 hrs)

Unit 3: Gastrointestinal Agents (6 hrs)

Antacids: Definition, criteria for selection, classification, non-systemic (Aluminum hydroxide, calcium carbonate, magnesium oxide, magnesium carbonate and magnesium trisilicate), systemic (sodium bicarbonate); combination preparations (types & significances) (3 hrs)

Protective & adsorbent: Definition, characteristics, Bismuth sub carbonate, Kaolin (1hr)

Acidifying agents or Acidifiers: Definition, types of acidifiers, dilute hydrochloric acid (1hr)

Cathartics (Purgatives): Definition, classification of purgatives, mechanism of action of each purgatives, magnesium sulphate, sodium potassium tatarate, sodium phosphate (1hr)

Unit 4: Intracellular, Extracellular Electrolytes and Cations & Anions (4 hrs)

Intracellular, Extracellular Electrolytes:

Role of physiogical ions (sodium, potassium, magnesium, sulphate, bicarbonate, phosphate) & acid base balance, electrolytes used in acid-base therapy (potassium citrate, sodium acetate and Ammonium Chloride), Electrolyte used in replaceme. therapy (NaCl, KCl, composition of ORS, Ringer lactate solution) (3 hrs)

Cations & Anions: (1 hr)

Definition, Biological roles or importance of cations (Sodium, Potassium, Calcium) & anions (Chloride, Bicarbonate, Phosphate)

Unit 5: Essential Trace Elements: (4 hrs)

Definition of transition elements; Iron & haemantenics; Functions of iron in the body, Causes of deficiency of iron. Focus on Compounds: Ferrous Fumarate; Ferrous Gluconate and Ferrous sulphate) Mineral Supplements (Cu, Zn, Cr, Mn, Sb, S, I).- Introduction, Role and deficiency.

Unit 6: Topical Agents: (4 hrs)

Protective; - Definition, Classification, Focus on talcum, Zinc oxide, Calamine

Local anti-infective: Definition, Classification, Focus on H_2O_2, $KMnO_4$, Iodine, Povidone iodine; Advantage of Povidone iodine over iodine.

Astringents: Definition, Mechanism of action, Focus on Alum, $ZnSO_4$, $AgNO_3$,

Unit 7: Gases & Vapors: (3 hrs)

Definition, role of gases in our body, focus on Oxygen, CO_2

Inorganic anesthetics: Definition, Nitrous oxide

Respiratory Stimulant: Definition, Ammonia solution, spirit of ammonia

Unit 8: Dental Product (3 hrs)

Introduction and types of dental products with examples; Dentifrices: Calcium Carbonate and Dicalcium phosphate. Dental caries/dental plaque, Anti-caries agent: Role of fluoride as anticaries agent, consequences of fluoride overdosing, Sodium Fluoride and Stannous fluoride.

Unit 9: Complexing & Chelating Agents used in Therapy: (3 hrs)

Concept of complexation & chelation, properties of chelating agent, importance of chelation; Heavy metal poisoning and their antagonist (Activated Charcoal, Disodium edetate, desferroaxamine mesylate, D-penicillamine, dimercaprol).

Unit 10: Miscellaneous Agents: (5 hrs)

i. Antidotes in Poising:(Introduction, heavy metals, and their antagonist, Cyanide poisoning) (1 hr)

ii. Antioxidant and preservatives: Introduction, criteria, mechanism of action, detail study of new official compounds. (1 hr)

iii. Pharmaceutical aids: Filter aids, adsorbents, dilutes, excipients, suspending agents, colorants (1 hr)

iv. Miscellaneous agents: Sclerosing agents, expectorants emetics and sedatives (2 hrs)

Unit 11: Inorganic Radio Pharmaceuticals: (3 hrs)

Definition, Isotopes, Radioactive decay particles, Units of radio activity & half life of radio elements, Precaution to be taken while handling & storage of radio isotopes, Application, Radio pharmaceutical preparation & clinical uses of Cobalt- 57 & 60, Gold–198, Iodine-125 & 131, Radio opaque contrast media ($BaSO_4$); types, ideal properties of radio opaque contrast media.

PHAR 111 Lab:Inorganic Pharmaceutical Chemistry-I Practical [48 Hours]

- Identification tests for pharmacopoeal inorganic pharmaceuticals and qualitative tests for cations & anions should be covered. At least four inorganic drugs should be prepared in the laboratory.
- Limit test for Chloride, sulphate and iron should be done according to current pharmacopoeia.
- Monographic study of Purified water according to latest pharmacopoia.

Books and other resources recommended Latest edition

1. Practical pharmaceutical chemistry by A.H. Beckett and J.B. Stenlake
2. British Pharmacopoeia, Indian Pharmacopoeia
3. Text book of pharmaceutical chemistry by Bently and Driver
4. Inorganic pharmaceutical chemistry by G.R. Chatwal
5. Inorganic pharmaceutical and medicinal chemistry by Block, Roche, Soine and Wilson.

PHAR 112: Pharmacognosy-I [48 Hours]

Unit–1: Introduction (8 hrs)

Definition, Historical back ground, present status and future scope of Pharmacognosy. Vegetation occurring in various climatic zones of Nepal, method of plant collection, preparation of herbarium and their storage including traditional and complementary system of medicine.(Ayurvedic, homeopathic, traditional Chinese, siddha system, Unani system and Amachi system).

Unit–2: Cultivation, Collection, Processing and Storage of Crude Drugs (10 hrs)

Methods of propagation, Factors influencing the cultivation of medicinal plants.Types of soil and fertilizers of common use. Pest management and natural pest control agents. Polyhouses and greenhouses.Plant hormones and their application, polyploidy and hybridization with the special references to medicinal plants.

Unit–3: Plant Description (8 hrs)

Key characters, family description of one member each from the following: Rutaceae, Umbelliferae, Labiatae, Solanaceae, Liliaceae, Myrtaceae and Rubiaceae.

Unit–4: Study of Herbal Resources (14 hrs)

Classification of crude drugs (Alphabetical, morphological, taxonomical, chemical, pharmacological and chemotaxonomical with principle, merits and demerits and examples). Study of different plant tissue system. Organized crude drugs- General morphological and anatomical study of subterranean organs, leaf, bark, wood, fruits and seeds. Unorganized crude drugs- general identifying characters.

Macroscopical and microscopical characters, varieties, cultivation, collection, principal, constituents, chemical nature, tests for identification, adulterants, substitutes and uses of the following drugs. Leaves: Eucalyptus. Flowers: Saffron. Fruit: Fennel. Powder: Lycopodium. Barks: Cinchona. Seeds: Ispaghula. Woods: Sandal

Unit–5: Commercial Production and Quality Control of Crud Drugs (8 hrs)

Commercial production of crude drugs, Adulteration of crude drugs an their detection by organoleptic, microscopic, physical, chemical an biological methods of evaluation. WHO guide lines of th standardization of Herbal raw materials and finished products.

PHAR 112 Lab: Pharmacognosy-I Practical [48 Hours]

Proposed Practical Topics

1. Morphological characteristics of plant families in theory.
2. Microscopic measurements of cells contents: starch grains, calcium oxalate crystals and phloem fibers.
3. Determination of leaf constants such as stomatal index, stomatal number, vein islet number, vein termination number and palisade ratio.
4. Preparation of Herbarium sheet.
5. Identification of crude drugs mentioned in theory.

Experiments list out:

1. Study of covering and glandular trichomes.
2. Study of stomata (diacytic, paracytic, animocytic, anisocytic stomata).
3. To determine leaf constants of given leaf using Camera Lucida (Stomatal number, Stomatal index, Palisade ratio, Vein islet number, Veinlet termination number).
4. To measure dimension of cell inclusions such as starch grains, calcium oxalate crystals using micrometry.
5. Study of chemomicroscopy using various staining reagents.
6. Study of powder microscopy of given crude drugs.
7. Demonstrate skill of preparation & labeling of herbarium specimen & explain its significance
8. Visit to medicinal plant garden, herbarium and plant tissue culture lab.

Books and other resources recommended Latest Editions

1. Atal, CK and Kappor, BM.Cultivation and Utilization of Medicinal Plants.
2. Trease, CE and Evans, WC. Textbook of Pharmacognosy.11th to 14th Editions. Tindal L. U.K.
3. Tyler, VC Brady, LR and Robers JE.Pharmacognosy.8th Edition, Lea & Febeger, Philadelphia.
4. Wallis, T E. Textbook of Pharmacognosy, 5th Edition, J & A ,Churchill Limited,U.K.
5. Kokate, CK Purohit, AP. And Gokhale, SB.Pharmacognosy.
6. Introduction to Alkaloids, A Biogentic Approach, Willy, New York.
7. Vinod D. Rangari, Pharmacognosy and Phytochemistry, Career publication, Nashik.
8. Kaufmann, Natural Products from Plants, CRS Press, New York.
9. Nakanishi K., Chemistry of Natural Products, Kodausha Book Publishing Company, Osaka (Japan).
10. Harborne, J.B., Phytochemical Methods, Chaparan& Hall, London.
11. Sim, S.K., Medicinal Plant Guidelines, University of Toronto Press.
12. Sim, S.K., Medicinal Plant Alkaloids, University of Toronto press.
13. Cordell, G.A., The Alkaloids - Chemistry and Pharmacognosy, Academic Press, London.
14. Raphael, Ikan, Natural products, A Laboratory Guide, Academic Press, INC.
15. Agarwal, O.P., Chemistry of Organic Natural Products, Krishna Prakashan Media (P) Ltd., Meerut, India.
16. Kalia, A.N., Textbook of Industrial Pharmacognosy.
17. Jarald, E.E., Jarald, S.E., Textbook of Pharmacognosy and Phytochemistry.
18. Bruneton Jean, Pharmacognosy and Phytochemistry of Medicinal Plants.
19. Kaufmann, Natural Products from Plants, CRC Press, New York.

PHAR 113 Physical Chemistry [48 Hours]

Unit–1: Gaseous State (4 hrs)

Introduction, gas laws, kinetic theory of gaseous, derivation of kineti gas equation, deduction of gas laws, deviation from ideal behavior Vander Waal equation of state for real gases, significances of Vande Waal constant a and b, critical phenomena and vander Waal constan value of a and b.

Unit–2: Liquid State (6 hrs)

Introduction, vapor pressure and boiling point, surface tension, determination of surface tension by drop formation method, viscosity and its determination by ostwald's viscometer, effect of temperature on viscosity, additive and constitutive properties, parachor and reochor, refractive index, optical rotation, dipole moments.

Unit–3: Solutions (10 hrs)

Mole concept, concentration terms, ideal and real solutions, Henry's law, colligative properties, ideal solution(non volatile solute), lowering of vapor pressure, Raoult's law, determination of molecular weight from vapor pressure lowering, ideal solution and deviation from Raoult's law, ideal solution of two volatile components, elevation of boiling point, determination of molecular weight from freezing point depression, osmotic pressure, distribution coefficient, application and limitations of distribution law, phase rule, statements, terms involved in phase rule, derivation of phase rule, single component system(water system). Conductance (specific conductance, equivalent conductance, molar conductance, cell constant), measurement of conductance, variation of conductance with dilution, Faraday's law of electrolysis, Debye -Huckel Theory.

Unit–4: Adsorption (3 hrs)

Adsorption and absorption, Freundlich adsorption isotherm, Langmuir adsorption isotherms, application of adsorption.

Unit–5: Thermodynamics (9 hrs)

Introduction, importance, limitation, terms/ terminology, state function , extensive and intensive properties, thermodynamic process and system, internal energy, work done(reversible and irreversible). First law of thermodynamics, enthalpy, enthalpy change, temperature dependence of enthalpy change, Hess's law of constant heat summation, application and calculations; heat of vaporization, heat of fusion, heat of formation, heat of combustion, heat of neutralization, heat capacities and relation between Cp and Cv; criteria of spontaneous process, entropy, second law of thermodynamics, free energy, relation between free energy and equilibrium constant, relation between free energy and useful work. Third law of thermodynamics.

Unit–6: Photochemistry (3 hrs)

Consequences of light absorption, Lambert-Beer's law, Laws of photochemistry, Quantum efficiency.

Unit–7: Chemical Kinetics (9 hrs)

Introduction, rate of reaction, factor influences the rate of reaction, rate law equation, rate constant, order and molecularity of reaction, integrated rate equation for zero order, first order and second order(single and different types of reaction) and half life period, activation energy, temperature dependence of Arrhenius equation, opposing reaction(first order opposed by first order), parallel reaction, collision theory of bimolecular reaction (no derivation), unimolecular reaction, steady state approximation, catalysis, characteristics of catalysis, homogeneous catalysis, heterogeneous catalysis, acid base catalysis, enzyme catalysis, Michaelis Menten equation.

Unit–8: Quantum Mechanics (4 hrs)

Postulates of Quantum Mechanics, Operator (Linear, Laplacian, Hamiltonian operator), and Schrodinger's wave equation.

PHAR 113 Lab: Physical Chemistry Practical [48 Hours]

1. To determine molar mass by Rast method and cryoscopic method.
2. To determine refractive index of given liquids and find out the contribution of carbon', hydrogen and oxygen in molar refraaction of a compound.
3. To determine molar mass of volatile liquids by Victor-Meyer method.
4. To determine the specific rotation of sucrose at various concentrations and determine the intrinsic rotation.
5. To determine the heat of solution, heat of hydration and heat of neutralization.
6. To determine the cell constant, verify Ostwald dilution law and perform conductometric titration,
7. To determine rate constant of simple reaction.

Books and other resources recommended Latest edition

1. Essential of physical chemistry-B.S. Bahl
2. Meyer's University Chemistry
3. Physical pharmacy and pharmaceutical sciences by Alferd Martin

PHAR 114 Mathematics [48 Hours]

Unit-1: Differentiation (12 hrs)

Limits of functions, indeterminate forms, theorem on limits of algebraic, trigonometric, exponential & logarithmic functions; continuity of a function; graphs of discontinuity function; definition of differential coefficient, differentiation of standard functions, including function of a function (Chain rule). Differentiation of implicit functions, logarithmic differentiation, parametric differentiation, successive differentiation.

Unit-2: Integrals and Applications of the integrals (12 hrs)

Integration as inverse of differentiation, indefinite integrals of standard forms, integration by parts, substitution and partial fractions, formal evaluation of definite integrals.The definite integral as an area under the given curve, Area between two curves. (Beta & Gamma function only definition)

Unit-3: Calculus (6 hrs)

Notation of limit and continuity of a function, derivatives of composite, implicit, parametric, inverse circular, hyperbolic functions, logarithemic differentiation, derivative of a function with reference to another function, application of differentiation, partial differentiation, computation of the first and second order partial derivatives.

Unit-4: Differential equations (12 hrs)

Revision of integral calculus, definition and formation of differential equations, equations of first order and first degree, variable separable, homogeneous and linear differential equations and equations reducible to such types, linear differential equations of order greater than one with constant coefficients, applications of differential equations, complementary function and particular integral, simultaneous linear differential equations, pharmaceutical applications.

Unit-5: Laplace transforms (6 hrs)

Definition, transforms of elementary functions, properties of linearity and shifting, inverse Laplace transforms, transforms of derivatives, solution of ordinary and simultaneous differential equations.

Books and other resources recommended (Latest edition)

1. A Textbook of Mathematics for XI-XTI Students, NCERT Publications, Vol. I-IV
2. Grewal B S, Higher Engineering for Mathernatics, Khanna Publishers, New Delhi.
3. Schaum, Differential Equations, McGraw-Hill Singapore
4. Prasad Gorakh Text book on differential calculus, Pothishala Pvt. Ltd., Allahabad.
5. Narayan Shanti, Differential calculus, Shyamlal Charitable Trust, New Delhi.
6. Prasad Gorakh Text book on integral calculus, Pothishala Pvt. Ltd., Allahabad.
7. Das B.C. &Mukharjee B.N.: Integral Calculus UN. Dhur& Sons Pvt. Ltd. India.
8. Pant G.D. &Shrestha G.S, Integral Calculus and Differential Equation, SunilaPrakasan, Bhotahity, Kathmandu, Nepal.

PHAR 115 - Basic Computer Applications [32 Hours]

Unit- 1: Basic Concept (10 hrs)

History of computers, simple model of computer and working parts of the computer, CPU, memory, input/output devices, computer languages and their hierarchal machine language, assembly language, high level language, comparison of high level and low level languages especially C, C++, PASCAL

Unit-2:Operating Systems and Commuter networks-Topology (4hrs)

Introduction to types of operating systems, UNIX, MS-DOS, etc. RAM, ROM, Virtual Memory. Introduction to Computer Networks, Email and Internet.

Unit-3: Database Management (7 hrs)

Spread sheets (like MS-EXCEL, ACCESS), concepts and objectives of database, nd database management system, Types of DBMS, advantages and disadvantages of the database management system and examples of DBMS packages (like DBASE III), HINARI, Software development life-cycle

Unit- 4: Flow Chart and Algorithm Development (5 hrs)

Definition and properties of the algorithm, Flow chart symbols and their uses, Examples of efficient algorithm and flow-chart, conversion of algorithm/flow-chart to high-level languages.

Unit-5: Software (4 hrs)

Introduction, SPSS, EPI Info, Chem Win, Chem 4D and Chem Draw

Unit-6: Computer Security System (2 hrs)

Antivirus and others

PHAR 115 Lab: Basic Computer Applications Practical [48 Hours]

Day 1- Define Folder, Files, Icons, My computer, Introduction to Desktop, Creating, Renaming, moving, Deleting folders, Saving Text, Image, Bitmap to the folder and Changing Wallpaper

(Task: Create your own name folder in D:\student\ and mak your own name written picture and set as desktop background).

Day 2- What is Name of Computer? Network File Sharing, Hard-dis Error Checking, Virus Scanning, Using internet for fil attachment and Lock the Taskbar, Screensaver, Hide Desktop Customize Desktop (Task: Create a text file which contain information about your computer's RAM, Processor and shar with your friend in network).

Day 3- PowerPoint Introduction, Creating 1st PowerPoint, Animation Transition, Background, Layout, bullet & numbering and Inserting media, Show (Task:Create a presentation of your own favorite topic and at least 5 slides).

Day 4-Creating table and chart in PowerPoint, setting animation timing inserting shapes to slide and editing picture shape (Task: Prepare a table and design a chart as per data provided).

Day 5- Starting MS-Word, Introduction,creating new file, save, open edit, copy, paste, find and replace, page setup-margin, inserting header and footer, Inserting page break and page number and alignment(Task: prepare application letter for applying to a given post).

Day 6- Indent Text, Setting tabs, margin using ruler, formatting text- B,I, U,bullet and numbered lists, font size and character spacing (Task: Prepare your own CV).

Day 7-Insert symbols, Header and Footer, Delete header and Footer, Formatting using show/hide button, text boxes- border / color and columns break (Task:prepare newspaper with image inserted)

Day 8 - Working with tables, Entering text in the table, creating chart, change text direction in table and inserting and deleting table, rows, resizing table and adding borders and shading (Task: make a table of SLC mark sheet and make a chart of data).

Day 9 - Working with shapes, word art drawing objects, drawing toolbar and working with picture and its alignment (Task: Design traffic

signals and cover page of report. For advance: section break and page numbering)

Day10- Working with Excel, creating sheets, renaming sheets, understanding rows and column, inserting rows and column and simple formula (Task: Prepare personal information as well as monthly budget)

Day 11-15 Working with multiple worksheets, inserting and deleting worksheets, complex formula, merging cells, text and cell alignment, use of function, page setup and chart (Computer lab: Day Working with some common DOS Command) Demonstration and identification of hardware

Books and other resources recommended (Latest edition)

1. Basic computer programming- V.K Jain, pusthak mahal, Delhi
2. Programming in basic by E.Balagurusami,tatamcgrawhill
3. Programming in basic-Gottfried,tata mcgrawhill
4. ABC of windows 98-BPB Publications , New Delhi
5. Working in microsoft office-Ronmansfield
6. Commercial application development using ORACLE developer 2000 by Iran bay ross,BPB Publications, New Delhi
7. Computer fundamentals with pharmacy applications by N.K.Tiwari published by pharma book syndicate.

PHAR 116- Communication Skills [32 Hours

Unit- 1: Communication (4 hrs)

- Definition of communication; Importance of communication
- Major forms of communication
  - Internal operational communication
  - External operational communication
  - Personal communication
- Dimension of communication
  - Downward communication
  - Upward communication
  - Horizontal communication
- Types of communication
  - Verbal communication
    - Oral communication
    - Written communication
  - Nonverbal communication
    - Body language
    - Sign language
    - Para language
    - Haptics/Touch language
    - Time language
- Barriers to effective communication
- Tips to improve communication
- Time management skills (Communication)
- Communication by email
- Reading/ Speaking / Listening skills

Unit-2: Note Taking Practice from Authentic Textual Materials including the use of Audio Visuals (2 hrs)

- Aims of note taking; Taking notes from texts, Taking notes from lectures (Branching notes, Listing and numbering)
- *Practical work: taking notes*

Unit-3: Writing Article and Summaries (4 hrs)

Definition of articles; Format of writing articles; Definition of summary

The five "**R**" techniques of writing summary (Read, Reduce, Record, Review and Rewrite)

Practical work: writing articles and summaries

Unit 4: Minutes (5 hrs)

Definition of minute; Parts of a minute (Beginning or introduction, Attendance

Special attendance, Agenda, Decisions, Closing signature)

Practical work: preparing minutes

Unit -5: Writing Proposals (3 hrs)

Definition of proposal

Parts of a proposal; Difference between proposal and report

Practical work: preparing proposals.

Unit -6: Report writing (5 hrs)

Definition of research report; Qualities of a good report

Parts of a research report

Preliminary

- Title page
- Letter of authorization
- Acknowledgement
- Abstract
- List of contents
- List of tables
- List of figures
- List of abbreviations

Body part

- Introduction
- Objectives
- Significance
- Limitations

Methodology
Source of data
Data collection tools
Data analysis
Findings
Conclusions
Recommendations
End part
References/Bibliography
Appendix
Practical work: preparing reports

Unit-7: Seminar (4 hrs)

Definition of seminar
Types of discussion groups
Conducting seminars
Practical work: conducting a seminar

Unit-8: Business correspondence (5 hrs)

Definition of letter
Parts of business letters
Formats of business letters
Full block format
Modified format
Semi blocks or indented form
Types of business letters
Enquiry letters
Quotation letters
Order letters
Complaint letters
Replies to complaints
Acceptance for adjustments
Refusal for adjustments
Job application and resume

Memorandum

Definition of memorandum

Parts of a memo

Subject line

Introduction

Discussion

Conclusion

Practical work: writing business letters, job application letters, memos and preparing resume.

Books and other resources recommended (Latest edition)

1. Business communication skill, Asha Kaul
2. Technical Writing, Gearson and Gearson

SECOND SEMESTER

PHAR 121 Organic Chemistry–I [48 Hour

Unit-1: Structure and Properties (12 hrs)

Atomic structure, Atomic orbital, Molecular orbital theory, wa equation, Molecular orbital, Bonding and Anti-bonding orbital, Covale bond, Hybrid orbital, Intermolecular forces, Bond dissociation energ Polarity of bonds, Polarity of molecules, structure and physic properties, Intermolecular forces, Acids and bases.

Unit-2: Stereochemistry (8 hrs)

Isomerism and nomenclature and associated physicochemical propertie optical activity, stereoisomerism, specification of configuratio Reactions involving stereoisomers, chirality, and chiral reagen conformations.

Unit- 3: Structure, Nomenclature, Preparations and Reactions of- (28 hrs)

Alkanes, Alkenes, Alkynes; Cycloalkane's, Dienes, Benzen Polynuclear aromatic compounds, Arenes, Alkyl halides, Alcohol Ethers, Epoxides, Amines, Phenols, Aldehydes and ketones, Carboxyli acids, Functional derivatives of carboxylic acids, Reactive intermediate - carbocations, carbanions, carbenes, nitrene and nitreniurn ions.

PHAR 121 Lab: Organic Chemistry–I Practical [48 Hours]

I. Introduction to Equipment & Glassware, Recrystallization method, details of M.P., B.P. and distillation

II. Preparation of organic compounds (each involving a specific organic reaction covered in theory)

1. N-Acetylation: Preparation of Acetanilide from Aniline
2. O-Acetylation: Preparation of Aspirin from Salicylic acid
3. Nuclear Bromination: Preparation of p-Bromoacetanilide from Acetanilide
4. Hydrolysis: Preparation of p-Bromoaniline from p-Bromoacetanilide

5. Nuclear Nitration: Preparation of m-Dinitrobenzene from nitrobenzene
6. Oxidation: Preparation of Benzoic acid from: Benzyl chloride
7. Esterification: Preparation of n-Butylacetate from n-Butylalcohol
8. Naphthyl methyl ether β Etherification: Preparation of -Naphthol.
9. Halogenation: Preparation of Iodoform from Oxidation of Acetoneα
10. Extensive Nuclear Substitution: Preparation of Tribromophenol or Bromination, Tribromoaniline from Phenol or Aniline

Books and other resources recommended Latest edition

1. Vogel's Textbook of Practical Organic Chemistry (5th Edition)
2. Modern Organic Synthesis: An introduction. George S. Zweifel and Michael H. Nantz
3. Problems in Organic Synthesis by Hasan Palandoken
4. Workbook for Organic Synthesis: Strategy and Control
5. Organic Synthesis, 3rd Edition by Professor Michael B. Smith
6. Organic chemistry by Morrison and Boyd
7. Organic chemistry by B.S. Bahl

PHAR 122 Pharmacognosy-II [48 Hours]

Unit-1: Natural Source of Drugs (3 hrs)

Plant, Animal and Microorganism as a source of drugs. Traditional healer's practices in Nepal. Role of Medicinal & aromatic plants in National Economy.

Unit-2: Tissue culture (4 hrs)

General procedure involved in plant tissue culture as a source of herbal ingredients. Plant tissue culture in production of phytopharmaceuticals, biochemical conversion, clonal propagation and production of immobilized plant cells.

Unit-3: Systematic Pharmacognostic Study of the Following Drugs (23 hrs)

Definition, general occurrence and distribution, classification, properties, screening tests of following phytochemicals:

Resins: Canabis, Turmeric, Ginger.

Tannins: Gambir, Black catechu.

Volatile oil: Mentha, Coriander, Cinnamon, Lemon grass, Citronella, Clovepalmarosa

Alkaloid containing drugs: Belladona, Opium, Catharanthus, Ephedra, Colchicum, Datura-Kurchi

Glycoside containing drugs: Digitalis, Liquorice, Aloe, Senna, Asparagus, Almond, Vanilla.

Unit-4: Phytochemistry (5 hrs)

General methods associated with the phytochemical investigation of herbal drugs- Authentication of plant materials, various methods of extraction, general ideas of isolation (in example of Atropine) and, purification of the chemical constituents and characterization of isolated compounds.

Unit-5: Carbohydrates and Derived Products (4 hrs)

Definition, classification, properties, general test and isolation of carbohydrates. Systematic pharmacognostic study of Agar, Honey and Tragacanth.

Unit-6: Lipids (4 hrs)

Definition, classification, properties, general chemical test and analytical parameters of lipids. Systematic pharmacognostic study of castor oil, cod liver oil, linseed oil and yellow bees wax.

Unit-7: Pharmaceutical aids (3 hrs)

Study of pharmaceutical aids like talc, diatomite, kaolin, bentonite and gelatin.

Unit-8: Plant Allergens (2 hrs)

Introduction, classification of allergens; Fungi and mould causing allergy.

PHAR 122 Lab Pharmacognosy–II Practical [48 Hours]

1. Identification of crude drugs mentioned in theory.
2. Study of Talc and gelatin pharmaceutical aids.
3. Microscopic studies of seven-selected crude drugs and their powders mentioned under the category of carbohydrate, Lipid and Resin in theory and their chemical tests,
4. Identification of crude drugs listed in theory.
5. Standardization of some traditional drug formulations.

Experiments list outs:

1. To perform macroscopical and microscopical study of given crude drugs mentioned course. (At least five)
2. Extraction of given crude drugs by Soxhlet extraction
3. Extraction and estimation of volatile oils by Clevenger's method (Hydrodistillation method)
4. Extraction of oleoresin from Ginger and Curcuma.
5. Preparation of extracts of by successive solvent extraction method to record the percentage yield.
6. Phytochemical screening of various classes of compounds
7. Preparation of detailed monograph of at least one medicinal plant covering Taxonomy, Phytochemistry and Pharmacological investigation with its use in traditional system of medicine.

8. Gross identification/Spotting of drugs containing volatile oil, resin, tannin and fixed oil (5 drugs each).

Books and other resources recommended (Latest edition)

1. Pharmacognosy, Phytochemistry, Medicinal Plants by Jean Bruneton
2. Natural Products a laboratory guide by Raphael Ikan.
3. Textbook of Industrial Pharmacognosy, A. N. Kalia, C. B. S. Publisher, New Delhi
4. Pharmacognosy by C.K. Kokate
5. Pharmacognosy by Trease& Evans
6. Pharmacognosy & Phytochemistry by Vinod Rangari
7. Pharmacognosy &Pharmacobiotechnology by Ashutoshkar
8. Pharmacognosy and Pharmacobiotechnology by Robert Siperoet. et al.
9. Peach - Tracey - Modern Methods of Plant Analysis.
10. Harborne - Phytochemical Methods.

PHAR 123 Physical Pharmacy [48 Hours]

Unit-1: Matter, Properties of Matter (4 hrs)

State of matter, change in the state of matter, latent heats and vapor pressure, sublimation-critical point, Eutectic mixtures, gases, aerosols-inhalers, relative humidity, liquid. Complexes, liquid crystals, glassy state, solids-crystalline, amorphous and polymorphism.

Unit-2: Micromeretics and Powder Rheology (7 hrs)

Particle size and distribution, average particle size, number and weight distribution, particle number, methods for determining particle volume, optical microscopy, sieving, sedimentation, measurement, particle shape, specific surface, methods for determining surface area, air permeability, adsorption, derived properties of powders, porosity, packing arrangement, densities, bulkiness & flow properties.

Unit- 3: Surface and Interfacial Phenomenon (7 hrs)

Liquid interface, surface and interfacial tensions, surface free energy, measurement of surface and interfacial tensions, spreading coefficient, adsorption at liquid interfaces, surface active agents, HLB classification, solubilization, detergency, adsorption at solid interfaces, solid-gas and solid-liquid interfaces, complex films, electrical properties of interface.

Unit- 4: Viscosity and Rheology (5 hrs)

Newtonian systems, Law of flow, kinematics viscosity, effect of temperature, non-Newtonian systems, pseudoplastic, dilatant, plastic, thixotropy, thixotropy in formulation, determination of viscosity, capillary, falling ball, rotational viscometers.

Unit- 5: Dispersion Systems (10 hrs)

Colloidal Dispersions: Definition, types, properties of colloids, protective colloids, applications of colloids in pharmacy; Suspensions and Emulsions: Interfacial properties of suspended particles, settling in suspensions, theory of sedimentation, effect of Brownian movement, sedimentation of flocculated particles, sedimentation parameters, wetting of particles, controlled flocculation, flocculation in structured vehicles, rheological considerations; Emulsions-types, theories, physical stability.

Unit-6: Complexation (3 hrs)

Classification of complexes, methods of preparation and analysi applications.

Unit-7: Kinetics and Drug Stability (6 hrs)

General considerations& concepts, half-life determination, Influence temperature, light, solvent, catalytic species and other factor Accelerated stability study, expiration dating.

Unit-8: Buffers (3 hrs)

Buffer equations and buffer capacity in general, buffers pharmaceutical systems, preparation, stability, buffered isoton solutions, measurements of tonicity, calculations and methods adjusting isotonicity.

Unit-9: Nanotechnology (3 hrs)

Importance of Nanotechnology-History of Nanotechnology. Classificatio based on the dimensionality- nanoparticles, nanoclusters-nanotube nanowires and nanodots. Application in Drug Delivery (Therapeuti applications).

PHAR 123 Lab: Physical Pharmacy Practical [48 Hours]

1. Determination of latent heat, vapor pressure, critical point.
2. Studies on polymorphs, their identification and properties.
3. Determination of particle size, particle size distribution and surfac area using various methods of particle size analysis.
4. Determination of derived properties of powders like density, porosity compressibility, angle of repose etc.
5. Determination of surface/interfacial tension, HLB value and critica micellar concentration of surfactants.
6. Study of rheological properties of various types of systems using different Viscometers.
7. Studies of different types of colloids and their properties.
8. Preparation of various types of suspensions and determination o their sedimentation parameters.

9. Preparation and stability studies of emulsions.
10. Studies on different types of complexes and determination of their stability constants.
11. Determination of half-life, rate constant and order of reaction.
12. To study the influence of various factors on the rate of reaction.
13. Accelerated stability testing, shelf-life determination and expiration dating of pharmaceuticals.
14. Preparation of pharmaceutical buffers and determination of buffer capacity.
15. Experiments involving tonicity adjustments.

Books and other resources recommended (Latest edition)

1. Martin: Physical Pharmacy, K.M.B. Varghese Co. Bombay.
2. A.T. Florence and D. Attwood W: Physiochemical principles of Pharmacy.
3. Shotton and Ridgeway: Physical Pharmaceutics.
4. Remingtons Pharmaceutical Sciences, Mark Publishing Co.
5. H.S. Beans, A.H. Beckett and J.E. Carless: Advances in Pharmaceutical Sciences,Vol.I IV.
6. S.P.Agarwal, Rajesh Khanna: Physical Pharmacy, CBS Publishers, New Delhi.
7. Tutorial pharmacy by Cooper and Gunns
8. Physical Pharmacuetics by CVS Subhramanyan
9. Pradeep.T "A textbook of Nanoscience and Nanotechnology", Tata McGraw–Hill education private ltd, 2012.
10. Niemeyer .C.M. Mirkin C. A "Nanobiotechnology: Concepts, Applications and Perspectives", Wiley–VCH, 2004.
11. Neelina H. Malsch (Ed.), Biomedical Nanotechnology, CRC Press (2005)

PHAR 124 Pharmaceutical Analysis-I [48 Hours

Unit-1: Fundamental of Analysis (8 hrs)

Significance of quantitative analysis in quality control, differe techniques of analysis, preliminaries and definitions, significant figure selection of sample, precision and accuracy, repeatability an reproducibility , fundamentals of volumetric analysis, methods expressing concentration, primary and secondary standards.

Unit-2: Acid Base Titration (10 hrs)

Acid base concepts, role of solvent, relative strengths of acids and base ionization, law of mass action, common ion effects, ionic product water, pH, Hydrolysis of salts, Henderson-Hessel Balch equation, Buffe solutions, Neutralization curves, Acid Base indicators, theory indicators, choice of indicatiors, mixed indicator, polyprotic systen polyamine and amino acid systems, amino acid titration, applications i assay of H_3PO_4, NaOH etc.

Unit-3: Oxidation Reduction Titration (10 hrs)

Concepts of oxidation , reduction and oxidation number, Redo reactions, Strength and equivalent weight of oxidizing and reducin agents, balancing of redox reaction(ion electron method or oxidatio number method), theory of redox titrations, redox indicators, ce representations, measurement of electrode potential, Oxidation reduction curves, Iodimetry and Iodometry, titrations involving ceri sulphatel, potassium iodate, potassium bromate, potassium permanganat

Unit-4: Precipitation Titration (9 hrs)

Precipitation reactions, solubility products, effect of acids, temperatur and solvent upon the solubility of precipitate, argentometric titration and titrations involving ammonium or potassium thiocyanate & mercuri nitrate, precipitation indicators, Mohr's method, Volhard's method an Fajan's method.

Unit-5: Gravimetric Analysis (11 hrs)

Precipitation techniques: supersaturation, co-precipitation, post precipitaiton. Colloidal state, digestion and washing of the precipitate, filtration and ignition. Filter paper and crucibles used for precipitate separation, thermogravimetric curves(pyrolysis curves), specific examples like barium sulphate, aluminium as aluminium oxide, calcium as calcium oxalate and magnesium as magnesium pyrophosphate, organic precipitants.

PHAR 124 Lab: Pharmaceutical Analysis-I Practical

[48 Hours]

Experiments relevant to theoretical topics covered should be done.

Books and other resources recommended (Latest edition)

1. Text Books of qualitative chemical analysis - (Vogel's)
2. Quantitative analysis - (R.A. Day, Jr.A.L. Underwood)
3. Pharmaceutical drug analysis (Ashutoshkar)

PHAR 125 Anatomy and Physiology-I

[48 Hours]

Unit-1: Introduction (2 hrs)

Scope of anatomy and physiology and basic terminology used these subjects. Anatomical planes, anatomical positions

Unit-2: Cell Membrane and Their Function (4 hrs)

Structure of cell, its components and their functions, body fluids, membrane physiology through cell membrane, cell metabolism, membrane potential and neurotransmission.

Unit-3: Human Tissues and Their Function (4 hrs)

Elementary Tissues of the Human Body: Epithelial, connective, muscular and nervous tissues, their sub-types and their characteristics.

Unit-4: Osseous System (6 hrs)

Structure, composition and functions of skeleton, classification of joints, terminologies of movements of joints. Types of bone and its feature, parts of long bone. Disorders of bones and joints.

Unit-5: Skeletal Muscle (5 hrs)

Skeletal Muscles: Gross anatomy; NeuroMuscular Junction) physiology of muscle contraction, physiological properties of skeletal muscles.

Unit-6: Haemopoietic System (6 hrs)

Composition and functions of blood and its elements, their disorders, blood groups and their significance, mechanism of coagulation, disorders of platelets and coagulation. Erythropoesis, coagulative factors.

Unit-7: Lymph and Lymphatic System (5 hrs)

Composition, formulation and circulation of lymph; basic physiology and functions of spleen. Important group of lymph nodes (auxiliary, inguinal and others)

Unit- 8: Cardiovascular System (8 hrs)

Basic anatomy of the heart, Physiology of heart, blood vessels and circulation. Basic understanding of Cardiac cycle, heart sounds and understanding of cardiac cycle, heart sounds and electrocardiogram. Blood pressure and its regulation.

Unit-9: Digestive System (8 hrs)

Gross anatomy of the gastro-intestinal tract, functions of its different parts including those of salivary gland, liver, pancreas and gall bladder, various gastrointestinal secretions, composition and their role in the absorption and digestion of food. Gastro intestinal movement. Basic concept of peritoneum. Disorders of digestive system-constipation, diarrhoea and vomiting.

PHAR 125 Lab: Anatomy and Physiology- I Practical

[48 Hours]

1. Study of human skeleton.
2. Study of different systems with the help of charts and models.
3. Microscopic study of different tissues.
4. Estimation of hemoglobin in blood, blood grouping, Determination of bleeding time, clotting time; R.B.C. Count, Total leucocytes count, D.L.C. and E.S.R.
5. Recording of body temperature, pulse rate and blood pressure, basic understanding of Electrocardiogram-PQRST waves and their significance.

Books and other resources recommended (Latest edition)

1. Sujit K. Chaudhuri: Concise Medical Physiology.
2. C.C. Chatterjee: Human Physiology.
3. Kathleen J.W. Wilson Ross and Wilson: Anatomy and Physiology in Health and Illness
4. T.W.A. Glenister and Jean R.W. Ross: Anatomy and Physiology for Nurses
5. Arthur C. Guyton: Textbook of Medical Physiology.
6. Cyril A. Keele, Erie Neil, Norman Joels and Samson Wrights: Applied Physiology

THIRD SEMESTER

PHAR 211 Organic Chemistry-II [48 Hours]

Unit-1: Nucleophilic Aromatic Substitution (10 hrs)

Introduction to Nucleophilic Substitution in aromatic compound. Comparison of Nucleophilic aromatic substitution in aromatic & aliphatic substrate. Mechanism of nucleophilic aromatic substitution: Bimolecular aromatic Nucleophilic substitution (SN Ar mechanism) Reactivity & orientation in SN Ar reaction in aromatic substrate and Benzyne mechanism & its evidences

Unit-2: Unsaturated Carbonyl Compounds (5 hrs)

Introduction to unsaturated carbonyl compounds. Preparation of unsaturated carbonyl compounds by Aldol condensation, Perkin reaction, from α-halo acids. Reactions:-Electrophilic addition, Nucleophilic addition, Michael reaction and Diel's Alder reaction

Unit-3: Neighboring Group Effect (3 hrs)

Effect of neighboring group in nucleophilic substitution.Stereochemistry of product. Explain anchimeric assistance with examples.

Unit-4: Catalysis by Transition Metal Complexes (2 hrs)

Role of transition metal complex in organic reaction. Role of Wilkinson Catalyst in homogenous hydrogenation of alkenes & its stereochemistry. Role of octacarbonyldicobalt in oxo process.

Unit-5: Stereo Selective & Stereo Specific Reaction (2 hrs)

Introduction to stereo selective & stereo specific reaction.Difference between stereo selective & stereo specific showing suitable examples.

Unit-6: Heterocyclic Compounds (12 hrs)

Introduction to heterocyclic compounds. Preparation and properties of following heterocyclic compounds- Five membered ring: pyrrole, furan & thiophane. Six membered ring: pyridine (Basicity, Substitution reaction) Higher membered ring: Indole (2, 3-Benzopyrrole), Quinoline 2,3–Benzopyridine and Isoquinoline.

Unit-7: Carbohydrate (4 hrs)

Classification of Carbohydrate. Glucose: Mutarotation, various structure. Classification, Sources & Structure of (Fructose, Sucrose, Maltose and starch).Amylose, Amylopection, Cellulose. Chain lengthening reaction of aldoses.

Unit-8: Lipids (4 hrs)

Occurrance & composition of fats. Saponification of fats. Detergents. Hydrogenation of oils .Phosphoglycerite and Phospholipids.

Unit-9: Proteins & Nucleic acids (3 hrs)

Structure of Amino acids. Amino acid as dipolar ions. Isoelectric point of amino acid.Preparation & peptide linkage. Protein and its classification. Structure of protein.

Unit -10 Uses and preparation of some new organic reagents used in drug synthesis: (3 hrs)

Salicylic acid, cinnamic acid, quinoline, ethylacetoacetate, acetic anhydride, pyridine, benzaldehyde, acetophenone, dimethylaniline, tosyl chloride, diphenyl, succinic anhydride.

PHAR 211 Lab: Pharmaceutical Organic Chemistry-II Practical [48 Hours]

Synthesis and test of the following compounds (Minimum 8-10 experiments)

1. m-Dinitrobenzene from nitrobenzene,
2. p-Nitroacetanilide from Acetanilide ,
3. p-Bromoacetanilide from Acetanilide,
4. Oxazolone from Benzoylglycine,
5. Acetanilide from Aniline,
6. p-Benzanilide from benzophenone oxime (Beckmann's rearrangement),
7. Benzil from benzoin,
8. Fluorescein from phthalic anhydride,

9. Eosin from fluorescein,
10. O-Chlorobenzoic acid from anthranilic acid (Sand mayer reaction),
11. m-Dinitrobenzene from nitrobenzene,
12. 2, 5-Dioxopiperazine from Glycine.
13. Diazonium Coupling Reaction of p-Nitrobenzenediazonium sulfate and N, N-Dimethylaniline: Synthesis of p-(4-nitrobenzeneazo)-N,N-dimethylaniline.
14. Systematic analysis of organic binary mixtures (Determination of Acid value of fixed oils, Determination of Acid value of fixed oils,
15. Determination of Saponification value of a fixed oil,
16. Determination of Acetyl value of a fixed oil.
17. Stereochemical Study of Organic Compounds via Models and R and S configuration of optical isomers.

Books and other resources recommended (Latest edition)

1. Vogel's Textbook of Practical Organic Chemistry (5th Edition)
2. Modern Organic Synthesis: An introduction. George S. Zweifel and Michael H. Nantz
3. Problems in Organic Synthesis by Hasan Palandoken
4. Workbook for Organic Synthesis: Strategy and Control
5. Organic Synthesis, 3rd Edition by Professor Michael B. Smith

PHAR 212 Pharmacognosy-III [48 Hours]

Unit-1: Evaluation of Herbal Drugs and Formulation (20 hrs)

1.1. Development of analytical techniques for the estimation of markers present in the Herbal and classical formulations.

1.2. Evaluation of Herbal drugs and formulations by Biological methods. General animal models for screening of Herbal drugs and formulations.

1.3. Toxicological evaluations of herbal drugs and formulations. Methods and materials for Acute, sub acute and chronic toxicity studies. Teratogenicity, mutagenicity and carcinogenicity studies.WHO and other regulatory requirements for toxicological evaluations.

1.4. WHO, Nepalese and Indian regulatoryrequirements of Clinical trials for herbal formulations.

1.5. Department of Drug Administration, (DDA) Nepal and Indian requirements (Schedule T) and other regulatory requirements for the manufacturing of Herbal and Ayurvedic products.

1.6. Comparative study of Ayurvedic pharmacopeia of India and W.H.O guidelines for herbal medicinal products.

Unit-2: Global Trading of Herbs and Herbal Constituents. (10 hrs)

Utilization and production of phytoconstituents such as Taxus resin, quinine, morphine, Reserpine, Sennosides, Digitalis glycosides, Diosgenin and Atropine. Herb collection centers around Nepal.

Worldwide trade in medicinal plants and derived products with special refrence to diosgenin,taxol,digitalis, tropane alkaloids containing plants, papain, cinchona, ipecac, liquorice, ginseng, aloe, valerian, Rauwolfia and plants containing laxatives.

Unit–3: Study of Traditional Drugs (11 hrs)

Common Vernacular name, Biological sources, morphology, chemical nature of chief constituents, pharmacology, categories and common uses and toxicological activity of marketed formulations of following indigenous drugs: Amla, Kantkari, Satavari, Tylophora, Bhilwa, Kalijiri, Vach, Harro, Barro, Punarnava, Chitrak, Apamarg, Gokhru, Shankhpushpi, Brahmi, Methi, Lehsoun, Palash, Guggul, Gymnema, Shilajit, Tulsi, Nagarmotha, Majith, Malkanguni, Asuro and Neem.

Unit- 4: Alternative System of Therapy (5 hrs)

Introduction and principals of Ayurvedic, Unani, Sidha and Homeopathic system of medicine. Introduction to Ayurvedic dosages form: preparations and standardization of Ayurvedic preparations such as Aristas, Asvas, Gutika, Tailas, Churnas, Lehyas and Bhasmas.

Unit-5: Current Trends (2 hrs)

Biologically active compounds from marine organism and their uses.

PHAR 212 Lab: Pharmacognosy-III Practical [48Hours]

1. Extraction and Isolation of some important phyto constituent mentioned in the theory.
2. Extractions of volatile oil and their chromatographic profile.
3. Chromatographic studies of some important phytoconstituent.
4. Preparation of different ayurvedic formulation
5. Powder analysis of drug
6. Determination of total ash content, water soluble ash, acid insoluble ash, sulfated ash.
7. Determination of water and alcohol soluble extractive values.
8. Quality evaluation of fixed oil and volatile oil.
9. Determination of heavy metals (Lead and Arsenic).
10. Determination of pesticide residues.
11. Formulation of PanchavidhaKasayaKalpana
12. Formulation and quality control of Ayurvedic formulations mentioned in theory.
13. Study of analytical profiles of a medicinal plant with special emphasis on its marker compounds.

Books and other resources recommended (Latest edition)

1. Indiand pharmacopoea, Indian Herbal Pharmacopoea.
2. Ayurvedic Formulary of India.
3. Screening methods of Pharmacology By Robert turner
4. WHO guide lines for the quality control of Herbal plant materials
5. The Practical evaluation of Phytopharmaceuticals by Brain & Turner.
6. Thin layer chromatography by Egon stahl.
7. Drug Discovery & Evaluation by H.Gerhard Vogel

8. British Herbal Pharmacopeia
9. Quality Standards of Indian Medicinal Plants Vol-I, ICMR, New Delhi
10. Scheuer, P.J., Marine Natural Products. Academic Press, London.
11. Swain, T. Chemical Plant Taxonomy Academic Press, London.
12. Reinetert, J & Bajaj, Y.P.S. Applied and Fundamental aspects of plants cell, tissue and organ culture Berlin.
13. Atal C.K. and Kapoor, B.M. cultivation and utilization of medicinal plants. R.R.L. Jammu.
14. Barz, W., Reinhard, E. and Zerk, M.H. plant tissue culture and its Biotechnological application.Springer, Berlin.
15. Chadha, K.L. and Gupta, R. advance in horticulture vol. II medicinal and aromatic plants. Malhotrapublishing house, New Delhi.
16. Export potential of selected medicinal plants; prepared by basic chemicals, pharmaceuticals andcosmetic export promotion council, Mumbai and other reports.
17. Trease, G.E. and Evasn W.C. Pharmacognosy. Baillier, Tindall, Eastbourne, U.K.
18. Kokate, C.K., Purohit, A.P. and Gokhale, Pharmacognosy, Nirali Prakashan, Pune.
19. Tyler, V.C., Brady, L.R., and Robers, Pharmacognosy, Lea and Febiger, Philadelphia.
20. Kalia, A.N. Textbook of Industrial Pharmacognosy, CBS Publishers and Distributors, New Delhi.
21. Vyas and Dixit, Biotechnology, CBS Publishers New Delhi
22. Dewick, P.M, (2002) Medicinal Natural Products (II edition), John Wiley and Sons, Chichester.
23. Pharmacognosy, Phytochemistry, Medicinal Plants by Jean Bruneton
24. Natural Products a laboratory guide by Raphael Ikan.
25. Textbook of Industrial Pharmacognosy, A. N. Kalia, C. B. S. Publisher, New Delhi
26. Pharmacognosy & Phytochemistry by Vinod Rangari
27. Pharmacognosy &Pharmacobiotechnology by Ashutoshkar
28. Peach - Tracey - Modern Methods of Plant Analysis.
29. Harborne - Phytochemical Methods.

PHAR 213 Pharmaceutical Analysis- II [48 Hours]

Unit-1: Non-aqueous Titration (4 hrs)

Principle of non-aqueous titration; aprotic, protogenic, protophillic and amphiprotic solvents; effect of temperature in non-aqueous titration; indicators in non-aqueous titration; end point detection by potentiometry, titration of alkali metal salts of organic acid, amines and amine salts of organic acid, halogen acid salts of bases and acidic substances, preparation & standardization of standard perchloric acid & methoxide solution, applications in assay of metronidazole, chloroquine phosphate, chlorpromazine HCl.

Unit-2: Complexometric Titration (6 hrs)

Theory of complexometric titration; chelating and sequestering agents; effect of pH on complex formation; stability of complexes- stability constant, factors affecting stability constant, absolute & effective stability constant; types of complexometric titrations; end point detection using physical methods (spectrophotometric detection, potentiometric titration, amperometric titration, high frequency titration) and pH indicators; pH indicators, methods of increasing titrant selectivity-pH adjustment, use of selective indicators, use of selective precipitants & use of masking and demasking agents; disodium edetate titrations; application in determination of hardness of water, applications in assay of calcium gluconate.

Unit-3: Miscellaneous Methods of Analysis (2 hrs)

Diazotisation titrations, Kjeldahl method of nitrogen estimation, Karl-Fischer titration,

Unit-4: Extraction procedures including separation of drugs from excipients (4 hrs)

Nernst law, extraction efficiency & selectivity, factors influencing solvent extractions-effect of temperature, inert solutes, pH, ion pair formation & synergestic extraction, separation of drugs from excipients in pharmaceutical preparations- chloroquine phosphate tablets, codeine tablets.

Unit-5: Chromatography (20 hrs)

Introduction, classification of chromatographic techniques, modes of separation, distribution coefficient, retention volume, dead volume, retention time, dead time, selectivity factor, capacity factor, resolution, chromatographic theories- plate theory & rate theory, Sources of band broadening- eddy diffusion, longitudinal diffusion & non equilibrium mass transfer, van Deemter equation.

TLC: Principle, Advantages of TLC over paper chromatography; steps in TLC- selection of coating material, preparation of TLC plate, activation of plate, purification of plate, sample application, selection of mobile phase, development of plate, detection of components; Problems in TLC:Over-large Spots, Uneven Advance of Solvent Front and Streaking, applications of TLC.

HPTLC: Comparison of HPTLC & TLC; HPLC & HPTLC; Principle, Instrumentation- Sample applicator, Development Chamber, Scanner; Applications.

HPLC: Principle, Instrumentation: Solvent reservoir & degassing system, Solvent programming, Pumps- reciprocating pump, syringe pump, constant pressure pumps, Sample injection system, Columns, Bonded phase, Column switching, Detectors- bulk & solute property detectors, Photometric detectors, fluorescence detectors, refractive index detectors, electrochemical detectors; Elution methods: Gradient, Isocratic & Stepwise elution; Internal Standard; Peak asymmetry, peak tailing & peak fronting; Ghost peaks, System suitability test, Pharmaceutical applications of HPLC.

GC: Principle, Instrumentation-carrier gas supply & flow regulators, sample injection system, detectors (ECD, FID, DTC, thermionic emission detector); Temperature programming, Headspace analysis, pharmaceutical applications of GC; limitations of GC.

GC-MS: in phytoconstituents analysis

LC-MS: Principle, Instrumentation, sample injection system, pharmaceutical applications for BA, BE.

Column Chromatography: Principle, Applications, Ion Exchange Chromatography, Principle, Cation exchanger, Anion exchanger, Ion exchange capacity; Suppressor column, Pharmaceutical applications of IEC, Size Exclusion Chromatography,Principle; Gel Permeation & Gel Filteration chromatography; Packing Material for column and Solvent; Detector, Applications of SEC.

Unit-6: Potentiometry (4 hrs)

Short description of the following: Reference electrodes (SHE, SCE, Silver-silver chloride electrode) and indicator electrodes (metal electrodes-first, second, third & inert electrodes; membrane indicator electrodes-glass electrode including its advantages & disadvantages); potentiometric titrations-advantages, apparatus & methods of end point detection -graphical, differential and Gran's plot; applications.

Unit-7: Conductometry (3 hrs)

Ohm's law, specific, molar & equivalent conductance, measurement of conductivity, cell constant, conductometric titrations: acid-base titrations (SA vs.SB, SA vs. WB, WA vs.SB, WA vs.WB, mixture of acids with strong base), applications of conductometry in precipitation titrations, redox titration, complexometric titration; advantages of conductometric titrations.

Unit-8: Coulometry (2 hrs)

Current efficiency, principle of coulometry, types of coulometric titration, coulometric titrations, advantages & application of coulometric titration including application in Karl Fischer titration.

Unit-9: Polarography (2 hrs)

Introduce polarography. Describe its application in pharmaceutical analysis.

Unit-10: Amperometry (1 hr)

Introduce Amperometry. Describe its application in pharmaceutical analysis.

PHAR 213 Lab Pharmaceutical Analysis-II Practical [48 Hours]

Experiments relevant to theoretical topics covered should be done

Books and other resources recommended (Latest edition)

1. Principles of Instrumental Analysis by Skoog, Holler, Nieman, 5th Ed.Saunders College Publishing
2. A Text book of Pharmaceutical Analysis by Kenneth A. Connors, 3rd Ed. John Wiley & Sons
3. Instrumental Methods of Chemical Analysis by Galin W. Ewing, 5th Edition, N.C. Graw-hill International Edition
4. Instrumental Methods of Analysis by Willard, Merritt, Dean, Settle, CBS Publishers, 7th Edition
5. Spectrometric Identification of Organic Compounds by Silverstein, Dassler, Morril, 5th Ed. John Willey & Sons inc.
6. Pharmaceutical Analysis: Modern Methods by James Monson, Marcel Dekker inc.
7. Practical Pharmaceutical Chemistry-I & II by A. H. Backett & Jacket Stanlake, 4th Ed.. CBS Publishers
8. Indian, British & United State Pharmacopoeia.
9. P D Sethi Quantitative Analysis of Drugs in Pharmaceutical formulations.
10. Bochmman & Hassan, Pharmaceutical Analysis, edited by: Higuchi.

PHAR 214 Pharmaceutical Engineering-I [48 Hours]

Unit-1: Introduction to Unit Operation (2 hrs)

Law of conversion of mzatter, Law of conversion of energy, introduction to Gas Laws, Dalton's law of partial pressure.

Unit-2: Fluid Flow (10 hrs)

Fluid Flow: Properties of fluid, Viscosity, Compressibility and Surface tension, static and dynamic flow, fluid in motion, Bernoulli's theorem, Flow measurement and flow meters, Laminar and Turbulent flow, Liquids in flow pipe, Significance of Reynolds' flow, Reynolds's experiment and Reynolds number, flow of fluid through packed bed, pumps-positive displacement pumps, centrifugal impeller pump, Measurement of rate of flow of liquids- measuring devices (Manometer, Orifice meter, venturimeter, Rota meter).

Liquid handling (transportation of fluids)- valves, pumps and pump impeller.

Unit- 3: Handling of solids (2 hrs)

Sliding and flow of powder, Method for free flowing powder and granules, methods for coheshive powders Bins, Vacuum and conveyor.

Unit- 4: Handling of steam and gas (2 hrs)

Cylinder, steam traps, valves and pipes and pipe handling system.

Unit- 5: Filtration and clarification (7 hrs)

Mechanism (straining, impingement, entanglement, attractive force) , types of filtration , difference between surface and depth filtration and Theory of filtration (Poiseulle's equation, Darcy's equation, Kozeny's-Carman Equation), factors influencing filtration, filter media including materials (rigid media, flexible media) and filter aids, handling of filter aids, and filtration equipments (Gravity filters, Vacuum filters, Pressure filters and the centrifuge filters)

Unit- 6: Centrifugation (3 hrs)

Theory and application, classification of centrifuge (sedimentation, filtration) and equipment (perforated basket centrifuge, non-perforated basket centrifuge, short cycle batch centrifuge, continuous horizontal centrifuge, Super centrifuge, conical disc centrifuge).

Unit- 7: Crystallization (6 hrs)

Theory and application, characteristics of crystals (geometry, habit, crystal lattice, crystal systems), pharmaceutical solids (crystalline, amorphous,), polymorphs and isomorphs, crystal hydrate and caking of crystals. Crystal hydrates and crystal solvates, Production of very fine crystals, Production of large crystals. Crystallizers (Agitated batch crystallizer, Swenson Walker Crystallizer, Krystal Crystallizer, vacuum

Unit- 8: Heating, Ventilation and Air conditioning (HVAC) (8 hrs)

Definition of Humidity, Absolute humidity, Relative humidity, specific humidity, humidity chart and its utility, dry bulb and wet bulb thermometers. Dew point, methods of dehumidification, Types of dehumediers, Approaches to dehumidification, heat exchangers. HVAC terms, Application of HVAC in pharmaceutical unit – Air handling units (AHU), Factors that contribute to quality of pharmaceutical products. The manufacturing environment is critical for product quality, Role of AHU for the reduction of cross contamination, laminar and turbulent air flow. Refrigeration: Principle, Refrigeration cycle and condensers.

Unit- 9: Material of construction (5 hrs)

Factors affecting selection of material of construction(physical, chemical and economical); Ferrous metal (including stainless steel – 202, 304, 316 and 316 L), Alloys, nonferrous metal (aluminum, aluminum alloy, copper lead, Tin), Non-metals (inorganic- glass Types: soda lime, borosilicate glass, Pyrex, quartz, neutral, fiber glass with special reference to glass for pharmaceutical use.) organic (rubber natural and synthetic(silicon rubber) special reference to pharmaceutical use) and plastic (polymers)-Type of plastic: Cellulose based plastic, Polystyrene and PVC, Nylon, Rubber, and their uses in Pharmacy. Common plastic and special purpose plastic.

Unit-10: Industrial Hazards and Safety Precautions (3 hrs)

Hazards (mechanical, chemical, electrical, environmental, fire, noise abatement), dust explosion personal protective equipment (masks,

gloves, respirators, spectacles, suits). Biological Hazard Protection, manmade hazards and Technological hazards; Fire and types of fire extinguisher.

PHAR 214 Lab: Pharmaceutical Engineering-I Practical

[48Hours]

1. Determination of water flow by a water pump.
2. Study of factors affecting filtration using filter media and/or aids.
3. Demonstration of centrifugation.
4. Study of crystallization behavior of Ibuprofen, Salicylic acid and sodium carbonate.
5. Observation of HVAC.
6. Determination of humidity using dry and wet bulb thermometer Learning the skill of using thermometers and psychometric charts.
7. Observation of different construction materials focus to utensils equipments and machines.
8. Demonstration of different personal safety equipment.

Books and other resources recommended latest edition

1. Pharmaceutical Engineering –principles and practices by CVS Subrahamanyam, J T Setty, S Suresh and V K Devi. Vallabh Prakashan Delhi.
2. Pharmaceutical Engineering by K Sambamurthy–New age international publisher.
3. Theory and Practice of industrial Pharmacy by Lacman and Lieberman.
4. Unit Operation by Anthony J Hiki
5. Pharmaceutical Process scale-up: by Michel Levin- Marcel Dekker.
6. Pharmaceutical production facilities; design and application by Cole G- 2nd edition Taylor Francis, 1998.
7. Pharmaceutical Process Engineering-Anthony J Hickey, Marcel Dekker 2001.

PHAR 215 Anatomy & Physiology-II [48 Hours]

Unit-1: Respiratory System (8 hrs)

Anatomy of respiratory organs & its functions, respiration, mechanism and regulation of respiration, respiratory volumes and vital capacity.Acid base balance and brief description of respiratory system. Bronchopulmonary segments, nervous control of respiration, Basic concept about hypoxia, anoxia, hyperventilation. Cough and sneezing reflex

Unit-2: Central Nervous System (8 hrs)

Functions of different parts of brain and spinal cord. Neurohurnoral transmission in the central nervous system, reflex action, specialized functions of the brain, Cranial nerves and their functions. C.S.F and it's route of transmission; Pyramidal tracts. Physiology of pain.

Unit-3: Autonomic Nervous System (8 hrs)

Physiology and functions of the autonomic nervous system. Mechanism of neurohurmoral transmission in the A.N.S.

Unit-4: Urinary System (5 hrs)

Various parts, structures and functions of the kidney and urinary tract.Physiology of urine formation and acid-base balance.

Unit-5: Reproductive System (5 hrs)

Male and female reproductive systems and their hormones, physiology of menstruation, spermatogenesis & oogenesis and fertilization. Pregnancy its maintenance and parturition.

Unit-6: Endocrine System (5 hrs)

Basic anatomy and physiology of Pituitary, Thyroid,
Parathyroid. Adrenals, Pancreas, Testes and ovary, their hormones and functions.

Unit-7: Sense Organs (5 hrs)

Basic anatomy and physiology of the eye (vision), ear (hearing), taste buds, nose (smell) and skin (superficial receptors).

Unit-8: Body Temperature Regulation (4 hrs)

Structure and function of skin, heat production and dissipation, nervous factors involved in body temperature regulation.

PHAR 215 Lab Anatomy & Physiology-II Practical [48 hours]

1. Study of different systems with the help of charts and models.
2. Microscopic studies of different tissues.
3. Simple experiments involved in the analysis of normal and abnorma urine: Collection of specimen, appearance, and determination of pH Sugars, proteins, urea and creatinine.
4. Physiological experiments on nerve-muscle preparations.
5. Determination of vital capacity, experiments on spirometry.

Books and other resources recommended (Latest edition)

1. Sujit K. Chaudhuri: Concise Medical Physiology.
2. C.C. Chatterjee: Human Physiology.
3. Kathleen J.W. Wilson Ross and Wilson: Anatomy and Physiology in Health and Illness
4. T.W.A. Glenister and Jean R.W. Ross: Anatomy and Physiology for Nurses
5. Arthur C. Guyton: Textbook of Medical Physiology.
6. Cyril A. Keele, Erie Neil, Norman Joels and Samson Wrights Applied Physiology

FOURTH SEMESTER

PHAR 221 Biochemistry [48 Hours]

Unit-1: (2 hr)
Biochemical organization of the cell and transport process across cell membrane.

Unit-2: (2 hrs)
The concept of free energy, bioenergetics, production of ATP and its biological significance.

Unit-3: Enzymes: (4 hrs)
Nomenclature, enzyme kinetics and its mechanism of action, mechanism of inhibition, enzymes and iso-enzymes in clinical diagnosis.

Unit -4: Carbohydrate Metabolism: (6 hrs)
Conversion of polysaccharide to glucose-1-phosphate, Glycolysis and fermentation and their regulation, gluconeogenesis and glycogenolysis, Metabolism of galactose and galactosemia, role of sugar nucleotides in biosynthesis, and Pentosephosphate pathway.

Unit-5: The Citric Acid Cycle: (4 hrs)
Significance, reactions and energetic of the cycle, Amphibolic role of the cycle.

Unit-6: Lipids Metabolism: (6 hrs)
Oxidation of fatty acids, β-oxidation & energetic, α-oxidation, ω-oxidation, Biosynthesis of ketone bodies and their utilization, Biosynthesis of saturated and unsaturated fatty acids, Control of lipid

Unit-7: Biological Oxidation: (6 hrs)
Enzymes and co-enzymes involved in oxidation, reduction & its control, respiratory chain, its role in energy capture and its control, Inhibitors of respiratory chain and oxidative phosphorylation, Mechanism of oxidative phosphorylation.

Unit-8: Metabolism of Ammonia and Nitrogen Containing Monomers: (6 hrs)
Nitrogen balance, Biosynthesis of amino acids, Catabolism of amino acids, Conversion of amino acids. Formation of bile pigments, hyperbilirubinemia, Purine biosynthesis, Purine nucleotide interconversion.

Unit-9: Biosynthesis of Nucleic Acids: (6 hrs)

Waston–Crick model of DNA, Brief introduction of genetic organization of the mammalian genome, alteration and rearrangements of genetic material. Biosynthesis of DNA and RNA.

Unit-10: Genetic Code and Protein Synthesis: (6 hrs)

Genetic code, Components of protein synthesis, and Inhibition of protein, synthesis. Brief account of genetic engineering and polymerase chain reactions. Regulation of gene expression.

PHAR 221 Lab: Biochemistry Practical [48 Hours]

1. Preparation of standard buffers (citrate, phosphate and carbonate) and measurement of pH.
2. Titration curve for amino acids.
3. Separation of amino acids by two dimensional paper chromatography and gel electrophoresis.
4. Separation of lipids by TLC.
5. Separation of serum proteins by electrophoresis on cellulose acetate.
6. Quantitative estimation of amino acids.
7. Quantitative estimation of proteins.
8. Determination of glucose by means of the enzyme glucose oxidase.
9. Enzymatic hydrolysis of glycogen by alpha- and beta- amylases.
10. Isolation and determination of RNA and DNA.
11. Effect of temperature on the activity of alpha-amylase.
12. Estimation of SGOT, SGPT, Alkaline phosphotase and Bilirubin in the serum.

Books and other resources recommended (Latest edition)

1. Conn, E.E. and Stump, P.K. Outlines of Biochemistry. John Wiley & Sons, New York.
2. Jayaraman, J. Laboratory Manual in Biochemistry. Wiley Eastern Ltd., New Delhi
3. Lehninger, A.L. Biochemistry, Worth Publisher, Inc.
4. Plumer, D.T. An Introduction to Practical Biochemistry.Tata McGraw Hill, New Delhi.
5. Harper's Biochemistry, Lange Publishing Group.

6. Harrow, B and Mazur, A. Textbook of Biochemistry. W.B. Saunders Co., Philadelphia.
7. Lehninger, A.L. Principles of Biochemistry. CBS Publishers.
8. Martin, D.W., Mayos, P.A. and Redwell, V.M. Harper's Biochemistry. Lange Medical Publications.
9. Mussay, R.K., Granner, D.K., Mayos, P.A. and Redwell, V.M. Harper's Biochemistry. Prentice-Hall International.
10. Ramarao Textbook of Biochemistry UBSPD.
11. Stryer, L. Biochemistry. W.H. Freeman & Co., San Fransisco.

PHAR 222 Chemistry of Natural Products [48 Hours]

Unit-1: Introduction (6 hrs)

Introduction to natural product chemistry, primary & secondary metabolites & fundamental metabolic pathways–the acetate, shikimate, mevalonate, and deoxyxylulose phosphate pathways.

Unit-2: Application of Chromatographic & Spectroscopic Techniques. (4 hrs)

Unit-3: Terpenoids (8 hrs)

Chemistry and pharmacological activity of medicinally important monoterpenes (limonene, menthol), sesquiterpenes (zingiberene), diterpenes (taxol, forskolin, phorbol, steviol) and triterpenoids (fusidic acid), biogenetic relationship among monoternenes.

Unit-4: Carotenoids (4 hrs)

Chemistry & pharmacological activity of alpha-carotene, beta-carotene, Vitamin A & medicinally important xanthophylls-capsorubin & capsanthin.

Unit-5: Glycoside (6 hrs)

Chemistry, biosynthesis (those marked with *only) & pharmacological activity of digitoxin*, digoxin*, hecogenin, sennosides and sarsapogenin.

Unit-6: Alkaloids (12 hrs)

Chemistry, biogenesis (those marked with *only) and pharmacological activity of atropine* and hyoscine#, quinine#, reserpine#, morphine*, papaverine#, ephedrine*, ergot, and vinca alkaloids.

Biogenesis not required

Unit-7: Lignans (8 hrs)

Chemistry and pharmacological activity of medicinally important lignans (lignans of *Podophyllum spps, Piper cubeba & Linum usitatissimum)*; flavanoids (flavanoids of *Ginkgo biloba*-Kaempferol, Quercetin, Myricetin; *Liquorice*-Liquirtin, Liquirtigenin*)* and quassanoids (Quassia wood).

PHAR 222 Lab Chemistry of Natural Products Practical

[48 Hours]

1. Laboratory experiments on isolation, separation, and purification of various groups of chemical constituents of pharmaceutical significance.
2. Exercises on paper and thin layer chromatographic evaluations of herbal drug constituents.
3. Extraction of total alkaloids.
4. Extraction and isolation of Caffeine from tea dust.
5. Extraction and isolation of piperine from black pepper.
6. Isolation of Glycyrrhizin from Liquorice.
7. Extraction and isolation of Curcumin from Curcumin longa.
8. Extraction and isolation of Hesperidin from Orange peel.
9. Extraction and isolation of Calcium Sennosides from senna leaves.
10. Extraction and isolation of Nicotine as Nicotine picrate from Tobaco leaves.
11. Extraction and isolation of Lycopene from Tomato.
12. Separation of β-carotene and Chlorophyll of spinach using Column chromatography.
13. Estimation of total flavonoid content in given extract.
14. Estimation of total polyphenoliccontent in given extract.

Books and other resource recomended (Latest editions)

1. Paul M Dewick Medicinal Natural Products-A Biosynthetic Approach 3rd Edition.
2. Trieber, Quantitative TLC & industrial Application.
3. Vepoorte Swendson–Chromatography of alkaloids.
4. V K Srivastava – Introduction to Chromatography – Theory and Practice.
5. Harbone – Phytochemical Methods of Chemical Analysis.
6. Ara Dermarderosia – The Review of Natural Products.
7. H F Liskens and J F Jacksons- Modern Method of Plant Analysis-HPLC in Plant Science.

8. Medicinal Natural Products: A Biosynthetic Approach. Paul M Derwick.
9. Chemistry of Natural Products: Sujata V. Bhat, B.A. Nagasampagi, Meenakshi Siva kumar.
10. Natural Products Chemistry: Sources, Separations, and Structures. Raymond Cooper George Nicola. CRC press.
11. Chemistry of Natural Products: A Unified Approach: N R Krishnaswamy.
12. Classics in Spectroscopy: Isolation and Structure Elucidation of Natural Products: Stefen Berger.
13. Comprehensive Bioactive Natural Products, Volume 6: Extraction, Isolation & Characterization. VK Gupta, SC Taneja and BD Gupta.
14. Natural Products Isolation Methods and Protocol 3rd ed. by Sarker Satyajit D, Nahar Lutfun.
15. Techniques for extraction and isolation of natural products: a comprehensive review. PMID: 29692864
16. Laboratory Handbook for the Fractionation of Natural Extracts, First Edition, 1998 Houghton PJ and Amala Raman Chapman & Hall, London

PHAR 223 Pharmaceutical Engineering-II [48 Hours]

Unit 1: Heat Transfer: (7 hrs)

Sources of heat (steam and electricity, Mechanism of heat transfer (conduction, convection and radiation), Conduction: Fourier's law, Conduction through Single Metal Wall, Compound resistances in series, heat flow through a cylinder; Convection: Temperature gradient in forced circulation; Radiation: Black body, Grey Body Fourier Law (heat flow through a metal wall and through a cylinder); equipment (heat exchangers and interchangers); Heat exchangers: tubular heater, multi pass heater; Heat interchangers: Baffles, liquid to liquid interchanger, double pipe heat interchanger, Numerical on heat transfer

Unit 2: Evaporation: (4 hrs)

Introduction, factors affecting evaporation, evaporators:- tube evaporators (horizontal and vertical), film evaporators (Rising film and falling film), Forced Circulation Evaporator, multiple effect evaporators.

Unit 3: Drying: (6 hrs)

Definition, pharmaceutical application of drying, theory of drying (drying equation), terms used in drying process (bound water, unbound water, equilibrium moisture content, measurement of EMC, free moisture content, loss on drying, percentage moisture content, drying rate), behaviors of solids during drying (drying rate curves) , Classification and types of dryers, dryers used in pharmaceutical industries:- Tray Dryer, Spray Dryer, Fluidized Bed Dryer, Vacuum Dryer, Freeze Dryer and drum dryer, Numerical on drying

Unit 4: Distillation: (7 hrs)

Definition, application, theory of distillation (Raoult's law, Dalton's law, phase diagrams, volatility), general equipment for distillation (still, condenser, receiver), Distillation methods (simple distillation, flash distillation, fractional distillation,principle of working of fractionating column, packed column & plate column (bubble cap plates), azeotropic and Extractive distillation, steam distillation, distillation under reduced pressure, rectification), molecular distillation, destructive distillation, compression distillation, calculation of theoretical plates (Mc. cabe-thiele method), Equipment, production of WFI in pharmaceutical industries.

Unit 5: Size Reduction and size separation: (5 hrs)

Definition, pharmaceutical application of size reduction, factors affecting size reduction/selection of size reduction equipment, laws of size reduction (Rittinger's Law, Kick's Law and Bond theory), mechanism of size reduction (cutting, compression, impact and attrition), Size reduction equipment (cutter mill, roller mill, hammer mill, edge and end runner mill, ball mill, fluid energy mill and colloid mill)

Size Separation: (4 hrs)

Introduction, Official standards for powders (powder grades according to IP/BP), sieve analysis using sieve shaker (Sieve size BSS standards) equipment for size separation (Sieving and Screening equipment: shaking screens, cyclone separator, air separator and bag filter)

Unit 6: Mixing: (6 hrs)

Theory of mixing, applications, mechanism of **mixing in solids**, degree of mixing (Perfect mixing, Alternative to mixing (Random & ordered Mixing)) and statistical evaluation, factors influencing mixing, equipment for solid mixing (double cone blender, Ribbon blender, sigma blade blender, planetary mixer, barrel type continuous mixer, zigzag continuous blender);

Mixing of liquids:- mechanism, mixing vessels(baffles) and devices (propeller, turbines, paddles), flow pattern during mixing, vortex formation and its prevention, equipments for continuous mixing (air jet mixers and jet mixer) ;

Mixing of immiscible liquids- emulsification (equipment: -Silverson Mixer, colloid mill and ultrasonic emulsifier). Mixing of semi-solids (equipment:- Triple roller mill).

Unit 7: Automated Process Control Systems (5 hrs)

Definition, history, advantage and disadvantage, Automation tools, automated manufacturing, introduction to PID controller, control panel and PLC. CAM- introduction, origin, advantage and disadvantage, Introduction and list of Computer added techniques and devices, five basic Technologies that adopted for CAM, introduce Computer Integrated Manufacturing Open System Architecture and Manufacturing process management

Unit 8: Reactors and fundamentals of reactors design for chemical reactions: (4 hrs)

Chemical reactors- introduction and type, important process variables of chemical reactors, aspects of the CSTR, Plug Flow Reactor, Semi-batch reactor, Catalytic reactor, microreactor and Upflow Anaerobic Sludge Blanket (UASB) Reactors.

PHAR 223 Lab Pharmaceutical Engineering-II Practical.

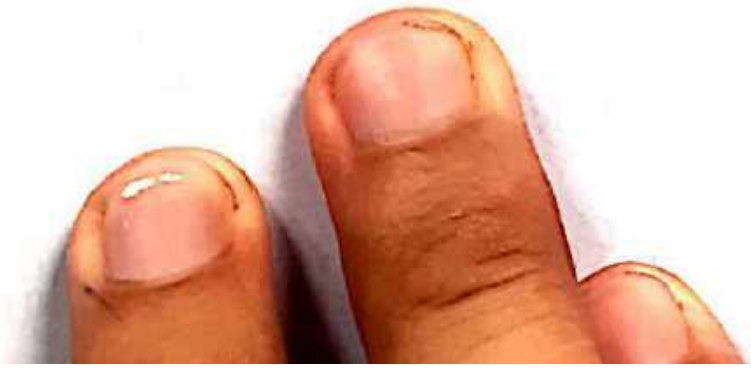
[48 Hours]

1. Determination of overall heat transfer coefficient
2. Determination of rate of evaporation.
3. Two experiments on distillation.
4. Determination of drying rate and verification of drying curve.
5. Experiments on milling of solid
6. Experiments on sieve analysis.
7. Demonstration of mixing of solids
8. Demonstration of mixing of miscible liquids and study of vortex formation during liquid mixing.
9. Demonstration of mixing of immiscible liquids
10. Demonstration of APCS.
11. Elementary Knowledge of Engineering Drawing - Concept of orthographic and isometric views of elevation and third angle projection. Notation and abbreviation used in engineering drawing.
12. Basic Engineering Drawing Practice - Bolts, nuts, riveted fronts, screws, worn screws as per specification.

Books and other resource recomended (Latest Editions)

1. Pharmaceutical Engineering–principles and practices by CVS Subrahamanyam, J T Setty, S Suresh and V K Devi. Vallabh Prakashan Delhi.
2. Pharmaceutical Engineering by K Sambamurthy–new age international publisher.
3. Theory and Practice of industrial Pharmacy by Lachman and Lieberman.
4. Unit Operation by Anthony J Hiki

5. Pharmaceutical Process scale-up: by Michel Levin- Marcel Dekker.
6. Pharmaceutical production facilities; design and application by Cole G. 2nd edition Taylor Francis, 1998.



PHAR 224 Pharmaceutical Microbiology [48 Hours]

Unit-1: Introduction (3 hrs)

History, branches of microbiology and importance of pharmaceutical microbiology. Contribution of Antony Van Leeuwenhoek, Robert Koch, Louis Pasteur and Alexander Fleming.

Unit-2: Structure of Bacterial Cell (9 hrs)

Microscopy–Principle and description of light microscopes and electron microscope. Structure of procaryotic and eucaryotic cells and their comparison. Theory of staining, simple, Gram's, acid fast, negative, flagella and spore staining methods. Classification of microbes and their taxonomy.Actinomycetes, bacteria, rickettsia, spirochetes and viruses. Nutrition, culture media, cultivation, isolation of bacteria, actinomycetes, fungi, viruses. Microbial genetics and mutation.

Unit-3: Control of Microbial Growth (7 hrs)

Disinfection, factors influencing disinfectants, dynamics of disinfection, disinfectants and antiseptics and their evaluation. Sterilization, different methods of sterilization, validation of sterilization methods & equipments.Introduction to microbiology of water.Bacteriological examination for assessment of the quality of water. Microbial limit tests for E. coli and Pseudomonas.

Unit-4: Sterility Testing of all Pharmaceutical Products (9 hrs)

General methodology, Media for use in sterility testing, growth promotion test for media, diluents, solvents and wash solution for use in sterility testing, Method of membrane filtration, Method of direct transfer, Negative control test, Positive control test, interpretation of results, Sterility testing environment, Pyrogen- sources and method of testing, Limulus amebocyte lysate (LAL) Test, introduction to aseptic technique and bioburden determination.

Unit-5: Immunity (10 hrs)

Immunity: Definition of antigen and antibody, types of antigens and antibodies, classification of immunoglobulin, types of immunity.

Antigen-antibody reactions (agglutination, precipitation, neutralizat and complement fixation).Types of Hyper sensitivity reactions. Definition of infection, non-specific defense mechanisms, bacte toxins, virulence and virulence factors and attenuation.

Unit-6: Microbial Assays of Antibiotics, Vitamins &Amino Acids

(10 hrs)

Principles and Methods involved in Assay of Antibiotics, Vitami Amino acids & Bio-Sensors in Analysis.

PHAR 224 Lab Pharmaceutical Microbiology Practical

[48 Hou

Experiments devised to prepare various types of culture media, s culturing of common aerobic and anaerobic bacteria, fungus and yea various staining methods, various methods of isolation and identificati of microbes, sterilization techniques and their validation, evaluation antiseptics and disinfectants, testing the sterility of pharmaceuti products as per pharmacopoeial requirements, microbial assay antibiotics and vitamins.

Proposed List of experiments:

1. Preparation of nutrient broth;
2. Preparation of nutrient agar;
3. Inoculation of bacteria;
4. Isolation of pure cultures;
5. Simple staining;
6. Gram's staining;
7. Motility of bacteria;
8. Spore staining;
9. Oligodynamic action of copper;
10. Liquefaction of gelatin;
11. Starch hydrolysis;
12. Nitrate reduction;
13. H_2S production
14. Phenol coefficient;
15. Chick Martin coefficient;
16. Viable count;

17. Fermentation of carbohydrates;
18. Microbiology of water;
19. Microbiology of milk;
20. Antibiotic sensitivity test;
21. Morphology of yeast, fungi and actinomycetes.
22. Sterility testing

Books and other resource recomended (Latest editions)

1. Microbiology by Pelczar, M.J. Reid, R.D. and Chan, E.S. Tata McGraw Hill Publishing Co. Ltd.;
2. Medical microbiology edited by Robert Cruick Shank. ELBS edition;
3. Pharmaceutical microbiology by Harrish M. Baillere, Tindal and Co., London;
4. 1 Heritage, J Introductory Microbiology.
5. Nester, Anderson, Roberts, Pearsall, Microbiology, McGraw-Hill.
6. Hugo,W B Pharmaceutical Microbiology.
7. Tortora, Gerard Text Book of Microbiology.
8. E.A Rawlins, Betley's Text Book of Pharmaceutics, Latest edition.
9. Garg,F C Experimental Microbiology
10. Gaud, R.S Practical Microbiology
11. Recommendations for Sterility Testing- http://www.picscheme.org
12. USP Sterility Testing USP <71>
13. TGA guidelines for sterility testing of therapeutic goods.
14. Denyer SP et al.: Filtration Sterilization: In Principles and Practice of Disinfection, Preservation and Sterilization (ed. Russell AD et al.) Blackwell Scientific Publications, Oxford (UK), Latest edition.
15. Hugo WB and Russell AD: Pharmaceutical Microbiology, PG Publishing Pvt. Ltd., Singapore, 3rd edn, Latest edition.
16. Indian Pharmacopoeia: Published by the Controller of Publications, Delhi, Vol. II, 1996 and 2007.
17. Remington: The Science and Practice of Pharmacy, Lippincott Williams & Wilkins, New York, Vol.–1, 21st. edn, 2006.
18. Interference with the LAL Test and How to Address It, LAL Update, October 2005.

PHAR 225 - Pharmacology-I [48 Hour

Part-1: General Pharmacology (22 hours)

Unit-1: Introduction to Pharmacology (3 hrs)

Terms used in Pharmacology, Drug nomenclature, sources of dru Classification of different dosage forms with examples, factors governi choice of route of drug administration, Advantages and disadvantages various routes of drug administration, pharmacogenetics with suitab examples.

Unit-2: Pharmacokinetics (6 hrs)

Absorption:

Introduction to biological membranes, Drug transport processe (including Passive diffusion, Filtration, Specialized transport, Facilitate diffusion and Pinocytosis).

Factors affecting absorption, Bioavailability

Distribution:

Apparent volume of distribution (V_d), Significance of high and low V_d Conditions altering V_d, Redistribution, penetration into brain an cerebrospinal fluid, Passage across placenta, Plasma protein binding an its significance, examples of few clinically important displacemen interactions.

Metabolism (Biotransformation):

Definition of first pass metabolism and its attributes, sites an consequences of drug metabolism, Types with examples (Phase I an Phase II reaction), enzyme inhibition and its consequences.

Excretion:

Routes (renal and non-renal) of excretion of drugs with few examples Plasma half-life and its importance, Clearance Loading dose an Maintenance dose

Unit-3: Pharmacodynamics (6 hrs)

Introduction, Principles of drug action, Mechanism of drug action Action through enzymes

Action through re receptor model, natu Transducer mechan intrinsic ion chann gene expression), re Dose-response rela Drug potency and effects of drugs.

Tolerance and de

Definition of toler of developmen Pharmacodynami dependence and withdrawal react

Adverse drug re

Definition and t its types

Unit-4: Discove

Drug discovery and techniques

Part-2: Pharı

Unit-5: Neuro

Explain the g in neurotransı detail of Parasympathe

Unit-6: Para

Classificatio Acetylcholin Atropine, Sc

Action through receptors, Receptor occupation theory, Two-state receptor model, nature of receptors, Receptor sub-types.
Transducer mechanisms (G-protein coupled receptors, Receptors with intrinsic ion channels, Enzyme linked receptors, receptors regulating gene expression), regulation of receptors, Functions of receptors,
Dose-response relationship (dose response curve), therapeutic index, Drug potency and efficacy, Selectivity, Risk-benefit ratio, combined effects of drugs.

Tolerance and dependence: (2 hrs)

Definition of tolerance and its types (Natural and Acquired), Mechanism of development of tolerance (Pharmacokinetic Tolerance, Pharmacodynamics Tolerance, Cross tolerance, Tachyphylaxis), Drug dependence and its types, Drug abuse, addiction and habituation, Drug withdrawal reactions.

Adverse drug reaction: (2 hrs)

Definition and types of ADR, Predisposing factors, Hypersensitivity and its types

Unit-4: Discovery and development of new drugs (3 hrs)

Drug discovery and development, Concept and purpose of bioassay, type and techniques of bioassay assessment, clinical trial and its phases

Part-2: Pharmacology of Peripheral Nervous System (12 hours)

Unit-5: Neurohumoral transmission

Explain the general steps of neurohumoral transmission, steps involved in neurotransmission of cholinergic and adrenergic transmission, explain detail of their receptors, Differences between Sympathetic, Parasympathetic Nervous system.

Unit-6: Parasympathomimetics and Parasympatholytics:

Classification, Mechanism of action, Side-effects, Contraindications of Acetylcholine, Pilocarpine, Physostigmine, Neostigmine, Pralidoxime. Atropine, Scopolamine, Hyoscine, Donepzil

Unit-7: Sympathomimetics and Sympatholytics:

Adrenaline, Norepinephrine, Isoprenaline, Dopamine, Dobutamin Salbutamol (Albuterol), Salmeterol, Terbutaline, Terazosin, Tamsulosi Propranolol, Timolol, Atenolol and Metoprolol.

Drug acting on autonomic ganglia: Nicotine and Hexamethonium

Unit-8: Neuromuscular blocker and Local anaesthetic:

Tubocurarine, Pancuronium, Succinylcholine (depolarizing), Tizanidin Topical anesthesia (surface)

Local anesthetics:

Definition, Classification, Mechanism of action, uses and adverse effec of imp local anesthetics- Procaine, lidocaine, bupivacaine

Part-3: Pharmacology of the Central Nervous System (14 hours)

Neurohumoral transmission in the CNS:

Classification, Steps in neurohumoral transmission (Glutamate, GABA)

Unit-9: General anesthetics

Stages of General Anesthesia, Types and ideal characteristics Preanaesthetic medication- rationale with examples, Mechanism o action, indication, ADRs, C/I, Doses of commonly used GA (Halothane, Isoflurane, Nitrous oxide, Ketamine)

Therapeutic gases: Definition, List and their uses

CNS Stimulants: Amphetamine.

Unit-10: Alcohol and Disulfiram

Effect of alcohol in CNS, kidney and Liver. Use of Disulfiram fo alcohol withdrawal, recommended dose, Precautions, Side-effects Potential interaction.

Unit-11: Anxiolytics, Sedative and hypnotics

Classification, Comparison of Barbiturate, Benzodiazepam and Newe non-benzodiazepines, Mechanism of action, therapeutic uses, side effects and contraindications of Benzodiazepam and Barbiturate (Alprazolam, Diazepam,lorazepam, chlordiazepoxide. Phenobarbital: Phenobarbitons).

Unit-12: Drugs used as

Anti-psychotics: Haloperidol, Clozapine.

Anti-depressants: Fluoxetine, Duloxetine, Bupropion, Amitriptylline, Imipramine, Nortriptyline,

Mood Stabilizers: Valproate semi-sodium, Lithium salts.

Anti-epileptic drugs: Types of epilepsy, Classification of drugs, Mechanism of action, indications, adverse effects and contraindications of Phenytoin, Carbamazepine, Oxcarbazepine, and Topiramide

Anti-Parkinsonian drugs: Levodopa, Carbidopa, Selegiline.

PHAR 225 Lab Pharmacology-I Practical [48 Hours]

1. Introduction to experimental pharmacology.
2. Preparation of different solutions for experiments.
3. Drug dilution, use of molar and W/V solutions in experimental pharmacology.
4. Common laboratory animals and anesthetics used in animal studies.
5. Commonly used instruments in experimental pharmacology.
6. Some common and standard techniques. Bleeding and intravenous injection, intragastric administration procedure for rendering animal's unconscious, stunning or redents, pithing of frogs, chemical anesthesia.
7. Experiments on intact preparation :
8. Study of different route of administration of drugs in mice/rats.
9. To study the effect of hepatic microsomal enzyme inhibitors and introduction of the Pentobarbitone sleeping time in mice.
10. Evaluation of local anesthetics.
11. To study the effect of autonomic drugs on rabbit eye.
12. To study the effect of various agonists and antagonists and their characterization using isolated preparation like frogs rectus abdominus muscle and isolated ileum preparation of rat, guinea pig

Books and other resource recomended (Latest editions)

1. C.R.Craig and R.E.Stitzel: Modem Pharmacology
2. Theodore W.Rall, Alan S.Nies and Palmer Taylor: Goodman Gilman's : The Pharmacological Basisof Therapeutics by Alfred Goodman Gilman.
3. D.R.Laurence and P.N.Bennett: Clinical Pharmacology.
4. K.D.Tripathi: Essentials of Medical Pharmacology.
5. R.S.Satoskar and S.D.Bhandarkar: Pharmacology and Pharmacotherapeutics.
6. F.S.K. Barar: Essentials of Pharmacotherapeuties.
7. H.P.Rang and M.M.Dale: Pharmacology.
8. James Crossland: Lewis's Pharmacology, revised.
9. Pharmacological experiments on isolated ›reparations by Edinburgh University Pharmacology Staff, 1968.
10. Robert A.Turner and Peter Hebbom: Screening methods in Pharmacology, Vol.1 edited
11. S.K.Kulkarni: Handbook of experimental Pharmacology
12. M.N.Ghosh: Fundamentals of experimental pharmacology
13. Ian Kitchen: Text book of invitro Pharmacology
14. U.K.Sheth, N.K.Dadkar, UshaG.Kamat: Selected topics in Experimental Pharmacology
15. K. K. Pillai: Experimental Pharmacology, CBS, Delhi.

FIFTH SEMESTER

PHAR 311 Medicinal Chemistry-I [48 Hours]

Unit-1: Physicochemical parameters, transducer mechanism, biotransformation & prodrug (10 hrs)

1.1 Solubility, Partition coefficient, pKa & degree of ionization, Isomerism (Geometrical, Optical) & bioactivity, Bioisosterism (classical/non classical)

1.2 Types of Drug-receptor interaction, transduction mechanism (G-protein coupled receptor, ligand gated ion receptor, tyrosine kinase receptor, intracellular receptor)

1.3 Biotransformation (phase I and Phase II - conjugation)

1.4 Pro-drug

Unit- 2: Principles of Drug Design (Theoretical Aspects) (8 hrs)

2.1Quantitative Structure Activity Relationship: Introduction, QSAR Parameters (Hydrophobic substitution constant, electronic substitution constant, steric parameters), Hansch equation, Craig plot, Topliss scheme & Free-Wilson approach

2.2 Introduction to molecular modeling in drug design, Introduction to Computer aided drug designing (CADD) and their applications.

Study of the following classes of compounds including their chemical classification, structure and nomenclature, physicochemical properties, mechanism of action, structure activity relationship (SAR),uses and outline of synthesis (of compounds with star).

Unit-3: Cholinergic receptors and Drug Affecting Cholinergic Neurotransmission (5 hrs)

3.1 Cholinomimetics: Cholinergic receptors, Acetylcholine–biosynthesis and release, SAR, Classification of Cholinomimetics, Structure, Synthesis, property and use of Methacholine, Neostigmine, Physostigmine, Pyridostigmine, Donepezil, Organophosphate Poisoning and reactivation of phosphorylated Cholinestarase.

3.2 Anticholinergics: Natural Belladonna alkaloids (Atropine sulphate), Semi synthetic alkaloids (Ipratropium bromide), Synthetic substitutes–Tropicamide, Dicyclomine, Trihexyphenidyl HCl and Pirenzepine. Drotaverine as antispasmodic.

Unit-4: Adrenergic receptors and drug Affecting Adrenergic Neurotransmission (4 hrs)

4.1 Adrenomimetics- Adrenoreceptors, Dopamine, Adrenaline, Phenylephrine, Terbutaline, Salmeterol, Isoproterenol, Resorcinol, Metaproterenol, Albuterol (Salbutamol), Phenylephrine, indirect acting (Amphetamine, L-(+)-Pseudoephedrine,), adrenergics with mixed mechanism of action (Ephedrine, phenylpropanolamine). Nasal Decongestant – Phenylpropanolamine, Phenylepherine, Oxymetazoline, Xylometazoline.

4.2 Antiadrenergics: α-Adrenergic blockers (ergometrine, Prazosin, Terazosin and Tamsulosin). β-Adrenergic blockers:Propranolol*, Atenolol.

Unit-5: Antihistaminic and Antiulcer (2 hrs)

5.1 H_1 receptors antagonist –Diphenhydramine, Tripelennamine, Methapyrilene, Chlorcyclizine, Promethazine, Terfenadine; Astemizole; Loratadine, Triprolidine, Cetirizine, Chlorpheniramine Maleate; Cyproheptadine Hydrochloride.

5.2 H_2 receptors antagonist- structure, Cimetidine, Ranitidine and Famotidine.

5.3 Proton Pump Inhibitors; structure, Omeprazole, Pantoprazole and Esmoprazole.Sucralfate and Bismuth salts.

Unit-6: Non-steroidal anti-inflammatory Agents and Neuromuscular blockers: (3 hrs)

6.1. Salicylate, Arylacetic acids, Propionic acids, Fenamic Acid, Pyrazoles and Enolic acid, Aspirin, Mefenamic acid, Indomethacin, Ibuprofen, Ketoprofen, Diclofenac, Naproxen, Piroxicam, Ketorolac, Paracetamol, Mefenamic acid, Phenylbutazone.

6.2. Skeletal Muscle relaxants: Tubocurarine chloride, Succinylcholine, Pancuronium, Baclofen, Danthroline, Tizanidine and Chlorzoxazone.

Unit-7: Oxytocics and Prostaglandin (2 hrs)

Structure, property and uses of - Oxytocin, Ritodrine, Isoxsuprine. Prostaglandins F2, Prostaglandin E2, Prostaglandin E1, Carboprost, Misoprostol, Bimatoprost.

Unit-8: Steroids (4 hrs)

Cortisone, Hydrocortisone, Beclomethasone, Budesonide, Prednisolone, Methylprednisolone, Triamcinolone, Dexamethasone, Fluticasone and Mometasone. Estrogens (Estradiol, Diethylstilbistrol), Progesterone, Testesterone,

Unit-9: CVS Drugs (6 hrs)

9.1 Cardiac glycosides (Digoxin), Glyceryl nitrate, Propranolol.

9.2 Antihypertensive agents: Reserpine, Prazosin, Terazosin, Clonidine, Hydralazine, Sodium Nitroprusside, Minoxidil, Captopril, Enalapril, Losartan, Amlodepine

9.3 Diuretics: Acetazolamide, Hydrochlorothiazide, Frusemide, Spironolactone and Mannintol.

9.4 Anticoagulants: Heparin and Warfarin.

9.5 Antiplatelate drugs: Aspirin, Dipyridamol, Streptokinase.

Unit-10: Local anti-infective agents (2 hrs)

Ethyl Alcohol, isopropyl alcohol, formaldehyde,: phenols, cresol, hydrogen peroxide, povidine iodine, halozone, Chlorhexidine gluconate, Gentian violet, Nitrofurazone, Merbromin. Salicylic acid and benzoic acid.

Unit-11: Sulphonamides (2 hrs)

General structure of sulphonamides, and MOA, Classification and SAR, Sulphamethoxazole and trimethoprim combination (MOA and uses), Sulphadimethoxin, Sulfacetamide and silver sulphadiazine.

Syntesis of the following drug molecules: Pyridostigmine, Tropicamide, Dicyclomine, Adrenaline, Albuterol (Salbutamol), Chlorpheniramine Maleate, Paracetamol, Prednisolone, Hydrochlorothiazide and Sulphomethoxazole.

PHAR 311 Lab Medicinal Chemistry-II Practical [48 Hours]

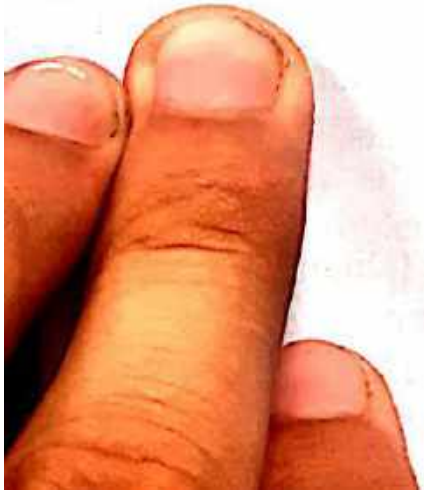
Synthesis & pharmacopoeial analysis of some medicinal compounds:

- Hexamine
- Dibenzalacetone
- Barbituric acid from Diethyl Malonate
- Benzoic acid from Benzyl chloride
- Benzimidazole from o-phenylenediamine (Phillip's Reaction)
- Acetanilide from acetophenone
- P-amino benzoic acid (PABA) from P-nitrobenzoic acid
- Benzocaine from para- nitro benzoic acid
- Benzyl alcohol by Cannizoro's reaction
- Benzoylglycine from Benzaldehyde
- Benzoyl Alanine from Benzoyl Chloride.

Books and other resource recomended (Latest editions)

1. Block JH, Beale JM, editor. Wilson and gisvold's textbook of organic medicinal and pharmaceutical chemistry. 11th ed. Baltimore: Lippincott Williams & Wilkins; 2004.
2. Lemke TL, Williams DA, editor. Foye's principles of medicinal chemistry. 6th ed. New Delhi: Wolters Kluwer and Lippincott Williams & Wilkins; 2008.
3. Kadam Dr. SS et al. – Principles of Medicinal Chemistry Vol. I and II. Nirali Prakashan, India.
4. Abraham DJ, editor. Burger's Medicinal Chemistry and Drug Discovery, 6th ed. Vol 1-6. New Jersey: John Wiley & Sons; 2007.
5. Hansch C, editor. Hansch's comprehensive medicinal chemistry, Delhi: Rajkamal Electronic Press; 2005.
6. Ariens EJ, editor. Drug design vol. I-X. Noida: Academic Press; 2009.
7. Roth HJ, Kleemann A. Pharmaceutical Chemistry. Vol-I. Drug synthesis. New York: Ellis Horwood Limited; 1988.
8. Lednicer D, Mitscher LA, The organic chemistry of drug synthesis, Volume-1-6. New York: A wiley-interscience publication; 2005.

9. Remington: The science and practice of pharmacy. 21st ed., vol. I & II, Lippincatt Willams & Wilkings, New Delhi, 2005.
10. Smith & Williams. Introduction to principles of drug design- Harwood academic press.



PHAR 312 Pharmaceutical Technology-I [48 Hours]

Unit-1. Liquid Dosage Forms (14 hrs)

Liquid dosage forms and route of administration, advantages and disadvantages of liquid dosage forms.

Solutions: Types of solutions, Formulation components of solution (Solvents, Buffers, Viscosicity enhancers and density modifiers, Antioxidants and Reducing agents, preservatives, Flavors and Fragrance, Isotonicity modifiers, Sweetetning agents, colours), General method of solution manufacturing, evaluation parameters of solution.

Suspension:

Ideal properties of pharmaceutical suspension, Types, Theorical asepects of suspension design (wetting, particle size control, particle-particle interacton and behaviour, sedimentation, crystal habit), flocculated and deflocculated suspension, Method of floccules formation, controlled flocculation, structured vehicle formulation, Formulation componets of suspension (Wetting agents, suspending and thickening agents, Dispersing agents, flocculating agents, preservatives, sweeterner, flavours and colours).Manufacruting process, Quality control and pharmacopeial tests.

Recent advances in suspension formulation – Sustain released suspension, Nanosuspension, Taste mask of oral suspension

Emulsion: Type, test for identification of emulsion type, emulsifying agents, stability of emulsion, preservation of emulsion, method of preparation, quality control including pharmacopeial tests.

Unit-2: Semisolid Dosage Forms (6 hrs)

Ideal properties of semisolid dosage forms, Types (Ointment, Cream, Gels- hydrogel, organo gel, oleo gel, stimuli responsive hydrogel, poultices, suppositories and passerines, Transdermal patch). Precutaneous absorption, Factors affecting precutaneous absorption, Physiological and pathological condition of skin, formulation of semisolids, Bases types and gelling agents, method of manufacturing (ointments, creams, gels and paste). Permeation enhancement (Physical and chemical permeation pharmacopeial tests.

Unit-3: Suppositories (3
Type, uses, Type of b
affecting drug absorptio
suppository base, con
manufacturing, , quality

Unit-4: Pharmaceutical
Advantage and disadv
Manufacturing method
compressed gas fillin
pharmacopeial tests.

Unit-5: Ophthalmic Pr
Challenges of ocular
formulation considerat
ophthalmic dosage forn
volume, Osmotic press
(solution, suspension,
system (viscosity enh
gelling system), Int
(Nanoparticles, liposo
delivery approach (Pr
inserts and contact len

Unit-6: Cosmetology
Definition (general a
wise and body site
common skin problen
Discuss formulation
control tests of follov
Hair Care Products
Shampoos, Hair cond
bleaches and Dyes.

and chemical permeation enhancers) and quality controls including pharmacopeial tests.

Unit-3: Suppositories (3 hrs)

Type, uses, Type of bases, Other supporsitory adjuvants, Factor affecting drug absorption from rectal and vaginal suppositories, ideal suppository base, concept of displacement value, Methods of manufacturing, , quality control including pharmacopeial tests.

Unit-4: Pharmaceutical Aerosols (3 hrs)

Advantage and disadvantages, Describe all component of aerosol, Manufacturing methods, filling (Cold filling, Pressure filling, compressed gas filling), stability testing, Quality control and pharmacopeial tests.

Unit-5: Ophthalmic Preparations (8 hrs)

Challenges of ocular drug delivery, pharmacokinetic consideration, formulation consideration, Physiochemical properties of drug used in ophthalmic dosage form, Buffer capacity, pH and isotonicity, instillation volume, Osmotic pressure, formulation approach, Classical dosage forms (solution, suspension, ointments). Introduction to polymeric delivery system (viscosity enhancing polymers, Mucoadhesive polymer in situ gelling system), Introduction to colloidal drug delivery system (Nanoparticles, liposome, niosomes, microparticles), Introduction to delivery approach (Prodrug, penetration enhancers, cyclodextrins, ocular inserts and contact lenses).

Unit-6: Cosmetology (14 hrs)

Definition (general and medical cosmetics), Types of cosmetics, Organ wise and body site wise cosmetics, Introduction to skin types and common skin problems, Hair- types, hair growth cycle.
Discuss formulation components and manufacturing process and quality control tests of following products:

Hair Care Products:

Shampoos, Hair conditioners, Hair setting lotions, Hair creams, Hair bleaches and Dyes.

Skin Care Products:
Skin cleansers, moisturizers, tonners, sun screens (also mention UVA UVB, drugs That Sensitize the Skin to Sunlight) and anti-dandru shampoo,

Color Cosmetics
Lipsticks and Lacquers

Dental Products
Mouth wash, Tooth powder, Tooth paste and medicated toothpaste such as Anti-caries and desensitizing agents

Personal Hygiene Products
Soaps, shaving crams and aftershave preparations.

PHAR 312 Lab Pharmaceutical Technology-I Practical

[48 Hours]

1. Preparation, evaluation and packaging of liquid orals like solutions suspensions and emulsions, ointments, suppositories, aerosols, eye drops, eye ointments etc.
2. Formulation of various types of cosmetics preparations as mentioned in theory.

Books and other resource recomended (Latest editions)

1. Aulton, M.E. Pharmaceutics- The Science of Dosage Form Design. ELBS/Churchill Livingstone.
2. Lachman, L., Lieberman, H.A., and Kanig, J.L. The Theory & Practice of Industrial Pharmacy.Lea & Febiger, Philadelphia.
3. Sagarin & Balsam, M.S. Cosmetic Science & Technology. Vol. 1-3 2nd ed. John Wiley.
4. Poucher's Cosmeticology.
5. Ansel, H.C. Introduction to Pharmaceutical Dosage Forms. V.M. Verghese & Co., Mumbai.
6. Banker, G.S. and Rhode, C.T. Modern Pharmaceutics. Marcel Dekker.
7. Carter, S.J. Cooper & Gunn's Tutorial Pharmacy. CBS Publishers, Delhi.
8. Jellinek, J.S. Formulation and Function of Cosmetics. John Wiley & Sons.

9. Kac Chensney, J.C. Packaging of Cosmetics and Toiletries. Newness Butter Worth, London.
10. Pharmaceutical Dosage Forms and Drug Delivery Systems. Lea and Febiger, Philadelphia.
11. Rawlins, E.A. Bentley's Textbook of Pharmaceutics. ELBS.

PHAR 313 Pharmaceutical Biotechnology [48 Hours

Unit 1: Immunology and Immunological Preparations (10 hrs)

Principles, antigens and haptens, immune system, cellular humora immunity, immunological tolerance, antigen-antibody reactions and thei applications. Active and passive immunization; Vaccines-types, thei preparation, standardization and storage.

Unit 2: Genetic Recombination (9 hrs)

Transformation, conjugation, transduction, protoplast fusion and gene cloning and their applications. Development of hybridoma fo monoclonal antibodies. Study of drugs produced by biotechnology such as Activase, Humulin, Humatrope, and HB.

Unit 3: Antibiotics (15 hrs)

Historical development of antibiotics. Antimicrobial spectrum and methods used for their standardization. Screening of soil for organisms producing antibiotics, fermentetor, its design, and control of different parameters.Isolation of mutants, factors influencing rate of mutation. Design of fermentation process.Isolation of fermentation products with special reference to penicillin, streptomycin tetracycline and vitamin B_{12}.

Unit 4: Microbial Transformation (7 hrs)

Introduction, types of reactions mediated by microorganisms, design of biotransformation processes, selection of organisms, biotransformation process and its improvements with special reference to steroids.

Unit 5: Enzyme Immobilization (7 hrs)

Techniques of immobilization, factors affecting enzyme kinetics. Study of enzymes such as hyaluronidase, penicillinase, streptokinase and streptodomase, amylases and proteases etc. Immobilization of bacteria and plant cells.

PHAR 313 Lab Pharmaceutical Biotechnology Practical

[48 Hours]

1. Isolation of antibiotic producing microorganism from soil.
2. Enzyme immobilization by Ca-alginate method.
3. Determination of minimum inhibitory concentration of the given antibiotic. Antibiotic assay by cup plate method.
4. Collection, Processing, Storage and fractionation of blood.
5. Standardization of Cultures.
6. Microbiological assay of Antibiotics / Vitamins.
7. Production of alcohol by fermentation techniques.
8. Comparison of efficacy of immobilized cells.
9. Isolation of mutants by gradient plate technique.
10. Preparation of bacterial vaccine.
11. Extraction of DNA.
12. Separation techniques: Various types of Gel Electrophoresis, Centrifugation.

Sample Experiments

Expt. 1: Immobilization by gel entrapment

i. Acrylamide, ii. Bis-acrylamide, iii. TEMED (N,N,N,N'-tetramethylenediamine)

Expt. 2: Protein estimation by Lowry Method

Sodium carbonate, Sodium hydroxide, Sodium potassium tartrate, Copper sulphate, Folin-Phenol and Bovine Serum Albumin

Expt. 3: Estimation of glucose by DNS method

i. 3,5 Dinitrosalicylic acid, ii. Sodium hydroxide, iii. Phenol, iv. Rochelle salt (Sodium Potassium tartrate), v. Sodium meta-bisulphate, vi. Phenolphthalein, vii. 0.5 M HCl and viii. Glucose

Other experiments related to the topics covered in theory.

Books and other resource recomended (Latest editions)

1. Wulf Crueger and Anneliese Crueger, Biotechnology, 2nd Ed, Publ-Panima publication co-operation, New Delhi.

2. P. F. Stanbury & A. Whitaker, Principles of fermentation technology, Pergamon Press
3. B.P. Nagori & Roshan Issari, Foundations in Pharmaceutical Biotechnology
4. Sambamurthy. K, Text Book of Pharmaceutical Biotechnology.
5. S. S. Kori, Pharmaceutical biotechnology.
6. Prescott and Dunne, "Industrial Microbiology" MC Caraw Hill Bool Company
7. K. Kielsliched "Biotechnology" Vol 6, Verlegchemic, Switzerland.
8. PF Standury & A. Whitaker, "Principles of fermentation Technology" Pergamon Press, Oxford
9. OP Ward" Fermentation Technology, Principles, Processes products" Open University press, Milton Keynes, UK.
10. A. M. Campbelli, Monoclinical antibody technology.
11. A. Wiseman, Handbook of enzyme biotechnology.
12. J. D. Watson, Recombinant DNA technology.
13. Smith and Hood, Molecular biology and biotechnology.
14. Brahamankar & Jaiswal– Biotechnology, SP Publication

PHAR 314 Pharmacology-II [48 Hours]

Unit-1: Pharmacology of Cardiovascular System (20 hrs)

1.1. CHF:

Congestive heart failure and its types, Classification of drugs, MOA, Indication, Dosage, ADRs, Contraindication and Drug interactions of: Digitalis.

Present status of Digitalis in CHF

1.2. Antihypertensive drugs:

Antihypertensive agents: Classification, Mechanism of action, adverse effects, Therapeutic Uses, Contraindication and Drug interaction of:

- Renin and angiotensin:ACE Inhibitors & Angiotensin Receptor Blockers/Anatgonists
- Calcium-channel blockers: Dihydropyridine& non dihydropyridine group
- Vasodilators: Hydralazine and Na nitroprusside
- Beta blockers (atenolol, metoprolol, esmolol, carvedilol,Nebivolol)
- α–adrenergic blockers: Terazosin, Prazosin, Tamsulosin.
- Centrally acting: Methyl-dopa, clonidine

1.3. Antianginal:

Types of angina, Classification of drugs, MOA, Indication, Dosage, ADRs, Contraindication and Drug interactions of:

- Nitroglycerine, Acebutolol, Sotalol, Trimetazidine
- Antianginal activity of Ca^{++} antagonist, ACE Inhbitors, AT antagonist, Beta blockers
- Rational of combination therapy

1.4. Antiarrhythmic drugs:

Classification of drugs, MOA, Indication, Dosage, ADRs, Contraindication and Drug interactions of: Quinidine, Procainamide, Propranolol, Amiodaron, Dronedarone, Ibutilide, and Magnesium Sulphate.

1.5. Antihyperlipedemic drugs:

Classification, MOA, Indication, Dosage, ADRs, Contraindication and Drug interactions of:-

- Statins: Simvastatin, Atrovastatin, Rosuvastatin, Lovastatin
- Fibrates: Clofibrate, Gemfibrozil Fenofibrate.
- Niacin
- Bile acid sequestrants resins (colestipol, cholestyramine)
- Omega fatty acids

Unit-2: Drugs used in Shock (2 hrs)

Classifications of Shock, Signs and Symptoms, ABC management, Adrenaline, Dopamine, Dexamethasone and Sodium bicarbonate injection, Management of Septic Shock.

Unit-3: Drugs acting on the Hematopoietic System (5 hrs)

- MOA, Indication, Dosage, ADRs, Contraindication and Drug interactions of following drugs:
  - Iron (Therapy with Parenteral Iron),Folic acid and Vitamin B_{12},
  - Erythropoietin
- Mechanism of blood coagulation, fibrinolysis

  Classification, MOA, Indication, Dosage, ADRs, Contraindication and Drug interactions of :
  - Anticoagulatants
    - Parental anticoagulants: Heparin, Monitoring, Protamine sulphate, Bivalirudin
    - Oral anticoagulants: Warfarin, Monitoring Anticoagulant Therapy: The INR (International Normalized Ratio).
    - Phenprocoumon, Acenocoumoral, Dabigatran, rivaroxaban, andedoxaban.
    - Fribinolytics:Streptokinase, Urokinase
  - Antiplaleletdrug:Abciximab, Aspirin, Dipyridamol, Ticlopedine, Clopidogrel
  - Fibrinolytic inhibitors: Aminocaproic Acid, Traneximic acid and Aprotinin, role of Vitamin K.

Unit-4: Drugs acting on the urinary system (6 hrs)

4.1 Diuretics (Classification, MOA, Indication, Dosage, ADRs, Contraindication and Drug interactions of Acetazolamide, Hydrochlorothiazide, Frusemide, Spironolactone, Mannitol).

4.2 Antidiuretics: List of drugs their indications, Adverse Effects and Contraindications. Drugs for Diabetes insipidus

Unit-5: Autacoids and Autacoids Antagonists (5 hrs)

5.1 Role of Histamine, Prostaglandins, 5HT

5.2 Classification, MOA, Indication, Dosage, ADRs, Contraindication and Drug interactions of Diphenhydramine, Pheniramine, Chlorpheniramine, Cetirizine, Promethazine, Cyproheptadine, Terfenadine, loratadine, and fexofenadine, .

5.3 Drugs for migraine

5.4 $5HT_3$ antagonist (Ondansetron)

Unit-6: Drugs acting on the Respiratory System (5 hrs)

6.1 Anti-asthmatic drugs (Classification, MOA, Indication, Dosage, ADRs, Contraindication and Drug interactions of

- Salbutamol, Salmeterol, Formoterol,
- Theophylline,Etophylline
- Streoids (Fluticasone, Budesonide)

6.2 Mast cell stabilizer (Chromoglycate), leukotriene inhibitors (zafirleukast and monteleukast)

6.3 Anti-tussives and expectorants (Codeine, Noscapine. Dextromethorphan, Promethazine, Triprolidine, Terpine hydrate, Bromhexine, Ammonium Chloride, Ambroxol, Levodropropizine).

6.4 Respiratory stimulants (Doxapram, Caffeine citrate injection).

Unit- 7: Narcotic analgesics, NSAIDs and Anti-gout drugs: (5 hrs)

7.1 Classification, Mechanism of action, Side-effects, Contraindications, Precautions and doses of commonly used drugs:

7.2 Narcotic analgesics and antagonists: Morphine, Methadone, codeine, Fentanyl, Pethidine, Naloxone

7.3 NSAIDs and Anti-gout drugs: Aspirin, Ibuprofen, Paracetamol, Indomethacin, Nimesulide, Diclofenac, colecoxib Naproxen, Allopurinol, Colchicine and Febuxostat, Probenecid, Sulfinpyrazone.

Books and other resource recomended (Latest editions)

1. Goodman & Gillman's: The Pharmacological basis of Therapeutics. 11th Edn. (2006)
2. Pharmacology by Rang and Dale
3. Pharmacology and Pharmacotherapeutic by Satoshkar and Bhandarkar.
4. Essentials of Pharmacotherapeutic by F.S.K.Barar.
5. Lewis Pharmacology by Crosslan.
6. Textbook of Pharmacology by Bowman and Rand.
7. Martindale: The Complete Drug Reference, 36th edition.
8. Basic & Clinical Pharmacology tenth edition, 2007 edited by Bertram G. Katzung, MD, PhD
9. Lippincott's Illustrated Reviews: Pharmacology, 4th Edition, Copyright Â©2009 Lippincott Williams & Wilkins

PHAR 316 Public Health Pharmacy [48 Hours]

Unit-1: Introduction (2 hrs)

Overview of Public Health & Pharmacy. Concept of health, disease, prevention and factors influence in health. Concepts of health and disease: Disease causing agents and prevention of disease.

Unit-2: Epidemiology and Pharmacoepidemiology (14 hrs)

Definition, scope, concept and use of epidemiology disease transmission and control defense mechanism, immunity, immunization and occupational disease. Descriptive Studies (Case report, Case series and Ecological studies), Analytical Studies (Case control studies, Cohort studies), Experimental Studies (True experimental studies, Quasi experimental studies). Methods of quantifying drug interactions/ADR and adherence to drug therapy in pharmacoepidemiology. Spontaneous reporting, Global drug surveillance and role of pharmacists. Discuss different methods of quantifying adherence to drug therapy. Methods of quantifying drug interaction using principles of epidemiology, more specifically the Rothman principle of causation and the Rothman Synergy index. Discuss different methods of quantifying adherence to drug therapy.

Unit-3: Pharmacoeconomic Methodologies (8 hrs)

Describe the Nepalese health care system with respect to: public and private sectors, persons and organizations that provide health services. Describe how characteristics of the Nepalese health care system influence prescribing, dispensing, and use of prescription medications, non-prescription medications, and complementary/alternative medicines. Describe the effect of self medication to public health.
Cost Benefit Analysis (CBA), Cost Effectiveness Analysis (CEA), Cost Minimization Analysis (CMA), Cost Utility Analysis (CUA).

Unit-4: Health Promotion & Disease Prevention (8 hrs)

Principles, scope, planning and Method (individual, Group and Mass methods) of health education in Pharmacy. Describe stakeholders in and partnerships with public/private health professional and community groups that participate at the system, community, state, national and/or international levels to promote public health and safety. Planning of

health education program (Rational use, Use of contraceptives, health hazards of insecticides and pesticides).

Unit-5: Primary Health Care (10 hrs)

Introduction, elements, Principles (explain 5 majors principles), Implementation of PHC (in terms of WHO and government of Nepal). History of health care delivery system in Nepal. Health care delivery system in Nepal and health care management models.

Promotion of pharmacy related issues of health maintenance and disease prevention and treatment to the lay public and to health professionals.

Describe population level strategies for disease prevention, detection, wellness, promotion and for resolving identified public health problems in the context of pharmacy practice.

Role of pharmacist in PHC, Theory the approach to the health (biological system, psychological system, spiritual system, socio-cultural system). First aid treatment of poisoning, shock, snake bite, burns, fracture and drowning. Diarrhea, vomiting and dehydration, fluid replacement therapy.

Unit-6: Environmental Pollution (3 hrs)

A brief description on environment, pollution, pollutant, waste, type of waste and waste from pharmaceutical activities, Classification of pharmaceutical waste. Safe disposal method of pharmaceutical wastes, WHO guidelines for the disposal of pharmaceutical waste

Unit-7: Health Insurance: (3 hrs)

Basic concept of Health insurance, Types of health insurance-private, community, social

Terminologies used in health insurance- premium, co-payment, deductibles, coinsurance,

Exclusions, maximum limit, capitation, limited coverage, adverse selection,

Medical underwriting, moral hazard (demand /supply side)

Familiarize with current health insurance act of Nepal.

Books and other resource recomended (Latest editions)

1. Levin BL, Hurd PD, Hanson A. Introduction to Public Health in Pharmacy. Sudbury, MA: Jones and Bartlett, 2008.
2. The Future of the Public's Health in the 21st Century. Washington, D.C: National, Academies Press; 2003: 97, 417.
3. Bush PJ, Johnson KW. Where is the public health pharmacist? Am J of Pharm Edu.1979; 43:249-253.
4. Berger ML, Bingefors K, Hedblom EC et.al. International society for pharmacoecomonics and outcomes research. Health Care Cost, Quality and Outcomes. 2003.
5. Pharmacoeconomics and Outcomes: Applications for Patient Care, American College of Clinical Pharmacy, Kansas City; 1997.
6. Beaglehole R, Bonita R, Kjellstrom T. Basic Epidemiology. World Health Organization, Geneva, 1993.
7. MacMahon B, Trichopoulos D. Epidemiology: Principles and Methods. 2nd Edition. Boston: Little, Brown, 1996.
8. Rothman KJ. Epidemiology: an Introduction. Oxford University Press, 2002

PHAR 317 Pathophysiology [48 Hours]

Unit-1: Basic Concepts of Pathophysiology-Cell injury, death and adaptation. (6 hrs)

Introduction, homeostasis, feedback system, occurrence of Cellular adaptations occurring in atrophy, hypertrophy, hyperplasia, dysplasia, and metaplasia.

Mechanism of cellular injury from hypoxia, free radicals, chemicals, unintentional and intentional injuries, infectious agents, immunologic and inflammatory responses, and genetic factors. Cellular accumulations occurring in response to injury and the subsequent manifestations of cellular damage.

Cell Death, Major types of cellular necrosis and compare necrosis to apoptosis. Compare the different theories of aging.

Unit-2: Acute and Chronic Inflammation (5 hrs)

Acute inflammation: vascular changes, leukocyte cellular events, chemical mediators of inflammation, outcomes of acute inflammation. Chronic inflammation. Role of lymphatic and lymph nodes in inflammation. Morphologic patterns in acute and chronic inflammation. Systemic effects of inflammation.

Unit-3: Cell Regeneration, Fibrosis, and Wound Healing (4 hrs)

Regeneration and Repair, Control of cell growth and differentiation at sites of injury. Intracellular matrix and cell-matrix. Pathologic aspects of repair. Wound healing, Overview of the inflammatory-reparative response.

Unit- 4: Disorders of Immune System (3 hrs)

Cells of the immune system. Cytokines. Histocompatibility genes and complement system. Immune mechanisms of tissue injury. Autoimmune diseases. Immunodeficiency diseases.

Unit- 5: Neoplasia (4 hrs)

Characteristics of benign and malignant neoplasms. Epidemiology of neoplasia. Carcinogenesis-the molecular basis of cancer. Biology of tumor growth .Etiology of cancer-carcinogenic agents.

Host defense against tumors-tumor immunity. Clinical features of neoplasia.

Unit- 6: Hemodynamic Disorders, Thrombosis and Shock (5 hrs)

Edema, hyperemia and congestion. Hemorrhage. Hemostasis and thrombosis. Embolism, infarction, shock. Congestive heart failure. Ischemic heart disease. Hypertensive heart disease and Shock.

Unit-7: Etiology, Pathophysiological Features and Symptoms of the following Diseases. (21 hrs)

Asthma, Chronic obstructive pulmonary diseases, Peptic ulcer. Chronic glomerulonephritis. Diarrheal diseases. Jaundice and cholestasis. Diabetes mellitus. Graves's disease. Diffuse nontoxic goiter and multinodular goiter. Osteomyelitis. Rheumatic and infectious arthritis. Fibromyalgia, Myasthenia gravis. Epilepsy, Degenerative disorders (Alzheimer's disease, Parkinsonism disease), sexually transmitted diseases, tuberculosis, and anemias.

Books and other resource recomended (Latest editions)

1. Sue E. Huether and Kathryn L. McCance. Understanding Pathophysiology. Mosby. Latest Edition
2. Clayton, F. Parkinson. Study Guide and Workbook for Understanding Pathophysiology. Mosby. Latest Edition
3. Corwin E. Handbook of Pathophysiology 2nd edition, Lippincott, 2000 or most recent edition
4. Hogan, M & Hill, K Pathophysiology, Review & Rationales 2004 Prentice Hall publishing.
5. Muralitharan Nair and Ian Peate (2009) Fundamentals of Applied Pathophysiology: An Essential Guide for Nursing Students.
6. Kathryn L. McCance and Sue E. Huether (2009)-Pathophysiology: The Biologic Basis for Disease in Adults and Children.
7. Carol Mattson Porth and Glenn Matfin-Essentials of Pathophysiology: Concepts of Altered Health States (International Edition 2010).
8. Barbara E. Gould and Ruthanna Dyer (2010)-Pathophysiology for the Health Professions.
9. Robert A. Weinberg- The Biology of Cancer. Taylor & Francis-2006.

PHAR 317 SEM: Seminar-I [48 Hours]

- Students in a group of maximum five numbers shall be given topics related on scientific publication, review article, case study etc.
- Each group should present at least three topics for seminar work and internal examiner shall evaluate it.
- Among these topics, one topic shall be presented in final exam and evaluation will be done by external examiner.

SIXTH SEMESTER

PHAR 321 Medicinal Chemistry-II [48 Hours]

Study of the following classes of compounds including their chemical classification, structure and nomenclature, physicochemical properties, mechanism of action, structure activity relationship (SAR), outline synthesis (of compounds with star)

Unit- 1: Drugs Acting on CNS (20 hrs)

1.1. General anesthetics (2 hrs)

Classification of General anesthetics, Inhalation anesthetics: Ideal properties of volatile anesthetics, Nitrous oxide*, Halothane*, and Sevoflurane. Current intravenous anesthetic agents (non-opioid) Advantage, disadvantage and properties of Thiopental sodium, Thiamylal, Propofol, Ketamine and Midazolam. Pre-anesthetic medication and Current intravenous reversal agents.

1.2. Local Anesthetics (2 hrs)

Procaine, Lignocaine* and Bupivacaine.Local anesthetics for eye surgery, eutectic mixture and its use, addition of vasoconstrictors in local anesthetic.

1.3. Sedative, Anxiolytics and Hypnotics (4 hrs)

Barbiturates: Alprazolam, Diazepam*, Nitrazepam and Lorazepam. Barbiturates verses Benzodiazepines as hypnotic and sedatives. Miscellaneous: Zolpidem and Zaleplon.

1.4. Neuroleptics (Antipsychotics) (2 hrs)

Haloperidol*, Chlorpromazine, Olanzapine, Quetiapine and Aripiprazole.

1.5. Anticonvulsants (2 hrs)

Phenobarbitone, Carbamazepine, Phenytoin, Clonazepam.

1.6. Antidepressants: (2 hrs)

MAO inhibitors, Tricyclic Antidepressants and Selective Serotonin Reuptake Inhibitors. Nortryptyline, Amoxepine, Fluoxetine, Citalopram,

Sertraline, Amitryptiline, Imipramine, Doxepin, Bupropion, Lithium Carbonate.

1.7. Opiod Analgesics: (2 hrs)

Morphine, Codeine, Diacetyl morphine, Buprenorphine, Meperidine, Fentanyl, Pentazocine, Tramadol (structure and properties) and narcotic antagonists: Naloxone. Antitussive agents: Noscapine, Dextromethorphan, Terpin Hydrate.

1.8. Antiparkinsonics: (2 hrs)

Levdopa, Carbidopa and Amantidine only), Antichlonergics: Benzhexol (Trihexyphenidyl), Catechol–O-methyl transferase inhibitors-Entacapone. Cholinesterase inhibitors–Rivastigmine. Dopa decarboxylase inhibitors–Carbidopa. Dopamine precursor–Levdopa, Dopamine agonist–Amantadine

1.9. CNS stimulants: (2 hrs)

Xanthine Derivatives: caffeine, theophylline, aminophylline and etofylline., Analeptics: Nikethamide, Doxapram and Bemegride. Miscellaneous Central Nervous System Stilmulants. Mazindol

Unit-2: Antimicrobials (28 hrs)

2.1. Penicillin (4 hrs)

B-Lactam antibiotics: Classification, Structure and nomenclature of penicillin's, MOA, classification and sources, General preparation of semi synthetic penicillin, SAR, Penicillin G* and its properties, Acid resistance (Penicillin v and ampicillin) β-Lactamase resistance (oxacillin, cloxacillin and flucloxacillin), Broad spectrum (ampicillin, amoxicillin* and carbenicillin). Combination with Prodrugs (pivampicillin) β-Lactamase inhibitors (sulbactam, clavulanic acid and imipenem) and MOA, Latent penicillin (penicillin G procaine and benzathine penicillin).

2.2: Cephalosporin &Carbamapenams (2 hrs)

Cephalosporin structure and nomenclature, Cephalosporin C. 1st Generation (cephalexin and cephadroxil), 2nd Generation (cefaclor), 3rd Generation (Cepodoxime, cefotaxime and cefixime), 4th Generation

(cefepime), Cephamycin (cefoxitin). Carbamapenams: Imipenam & Meropenam

2.3. Tetracycline and Chloramphenicol (2 hrs)

Tétracycline, Demeclocycline, Oxytetracycline, Doxycycline, Minocycline. Structure, property and SAR of the Tetracycline. Structure, property, synthesis and SAR Chloramphenicol.

2.4. Aminoglycosides, Macrolides & Lincomycins (2 hrs)

Aminoglycosides: Members, Mode of Action and uses of Aminoglycoside. SAR of Streptomycin. Macrolides-Members, Structure, Mode of action and uses. Lincomycins: Lincomycin.

2.5. Quinolones (2 hrs)

Classification, Structure, SAR and MOA of Fluoroquinolones. Structure and uses of Nalidixic acid, Norfloxacin, Ciprofloxacin* and Ofloxacin*

2.6. Antituberculars and Antileprotics (3 hrs)

Tuberculosis and classification of anti T.B. drugs, INH* and its SAR, Ethambutol* and its SAR, Rifampin. Ethionamide, Pyrezinamide* aminosaicylic acid, cycloserine and other 2nd line antitubercular drugs; Dapsone* and Clofazimine

2.7. Chemotherapy of Malaria (2 hrs)

Classification of antimalarial drugs in relation to plasmodium life cycle, properties and SAR of chloroquine, Mefloquine, Primaquine and Quinacrine.Artemisinin and derivatives.

2.8. Antifungal agents: (2 hrs)

Miconazole, Ketoconazole, Amphotericin B, Nystatin, Griseofulvin.

2.9. Antiprotozoal agents: (2 hrs)

Metronidazole, Tinidazole, Secnidazole. Diloxanide furoate,

2.10. Anthelmintics: (2 hrs)

Classification, Piperazine, Diethyl carbamazine, Pyrantel pamoate, Mebendazole, Niclosamide, Praziquantel, Albendazole*

2.11: Antiviral agents: (2 hrs)

Amantidine hydrochloride, Idoxuridine, Acyclovir, Lamivudine, Zidovidine and other Anti-HIV drugs.

2.12. Antineoplastic agents (3 hrs)

Alkylating agents: cyclophosphamide, chlorambucil, busulphan, uracil mustard; Antimetabolites: mercaptopurine, flurouracil, methotrexate, azothioprine; Antibiotics: Doxorubicin, Mitomycin; Tubulin Inhibitors: Etoposide, Vincristine, Vinblastine, Taxol and Docitaxel. Miscellaneous: Cisplatin. Hormones: Mitotane, Tamoxifen.Immunotherapy: Interferon.

Cover the synthetic scheme of the following drug molecules: Lignocaine, Diazepam, Haloperidol, Phenobarbitone, Amitryptyline, amoxicillin, Ofloxacin, INH, Albendazole.

PHAR 321 Lab Medicinal Chemistry-II Practical [48 Hours]

Synthesis & Pharmacopoeial analysis of some medicinal compounds:

- Benzyl from benjoin
- Benzanilide from aniline
- Salicylic acid from methyl salicylate
- Methyl salicylate from Salicylic acid
- Phenytion from Benzoin or Benzil
- Paracetomol from para- nitro phenol or para-aminophenol
- 1,4- Di hydro pyridine from ethyl aceto acetate
- Quinazolinone from anthranilic acid via benzoxazinone
- Sulfanilamide from acetanilide
- Isoniazid from γ-picoline
- Benzocaine from para- nitro benzoic acid
- Methyl orange and methyl red
- Benzoic acid from toluene
- Acetophenone from Benzene

Books and other resource recomended (Latest editions)

1. Block JH, Beale JM, editor. Wilson and gisvold's textbook of organic medicinal and pharmaceutical chemistry. 11th ed. Baltimore: Lippincott Williams & Wilkins; 2004.

2. Lemke TL, Williams DA, editor. Foye's principles of medicinal chemistry. 6th ed. New Delhi: Wolters Kluwer and Lippincott Williams & Wilkins; 2008.
3. Kadam Dr. SS et al.–Principles of Medicinal Chemistry Vol. I and II. Nirali Prakashan, India.
4. Abraham DJ, editor. Burger's Medicinal Chemistry and Drug Discovery, 6th ed. Vol 1-6. New Jersey: John Wiley & Sons; 2007.
5. Hansch C, editor. Hansch's comprehensive medicinal chemistry, Delhi: Rajkamal Electronic Press; 2005.
6. Ariens EJ, editor. Drug design vol. I-X. Noida: Academic Press; 2009.
7. Roth HJ, Kleemann A. Pharmaceutical Chemistry. Vol-I. Drug synthesis. New
8. Lednicer D, Mitscher LA, The organic chemistry of drug synthesis, Volume-1-6. New York: A wiley-interscience publication; 2005.
9. Remington: The science and practice of pharmacy. 21st ed., vol. I & II, Lippincatt Willams & Wilkings, New Delhi, 2005.
10. Smith & Williams. Introduction to principles of drug design-Harwood academic press.

PHAR 322 Pharmaceutical Technology-II [48 Hours]

Unit-1: Tablets (15 hrs)

General Concept: Advantages & disadvantages, Types of Tablets, Formulation of Tablets: Excipients: Diluents with common examples, Binders with common examples , Dis-integrants with common examples: mechanism of tablet disintegration, Factors affecting disintegration, super-disintegrants, Anti-frictional Agents with common examples, Miscellaneous Excipients, **Operations involved in tablet manufacturing:** Dispensing, sieving, blending, granulation, drying, Lubrication, compression, coating

Tablets Manufacturing methods: Wet Granulation : Objective of granulation, Mechanism of wet granulation (Pendular State, Funicular State, Capillary State, Droplet or Suspension State), Dry Granulation (slugging & roll compaction), Direct compression : ideal DC excipients requirements,

Compression Machines or **tablet press**: List of Components or parts of tablet compression machines, General information of parts & MOC of punches & dies, Brief knowledge of Standard tooling of compression machines (D, DB, B, BB tooling), General Tablet press cycle (Filling zone, compression zone, Ejection Zone), general concept of Single station & multi station rotary compression machine, knowledge of shape & dimension of tablets & punches (concavity, break line, embossing), Tablet processing problems & remedies: capping, lamination, cracking, chipping, sticking, picking, binding, mottling, double impression;

Tablet Coating: Objectives, components of coating, Tablet properties, Coating Process: Coating

Distribution: spray application system High pressure airless system, Low pressure air atomized system, Coating equipment, Parameters of coating process, Facility and ancillary equipment; Types of tablet coating: Sugar coating ; Film Coating : process variables, Pan variables, Process air variables, Spray variables, General Coating suspension Composition; Enteric coating : objectives, common enteric polymers;, Film defects:

causes & remedies; Quality Control test for coated tablets (General Appearance, Size & shape, Organoleptic Properties, Assay, Content Uniformity test, Mechanical strength, Friability, Hardness or crushing strength, Disintegration, Dissolution).

Unit-2: Capsules (6 hrs)

Advantages and disadvantages of capsule dosage form, material for production of hard gelatin capsules, Manufacture of hard gelatin capsule, size of capsules, method of capsule filling (manual & semiautomatic), basic formulation (excipients), soft gelatin, Advantages and disadvantages of soft gel, capsule shell formulation and capsule content: Bloom strength, Viscosity & iron content, base absorption and minim per gm, Manufacturing of soft gels: Plate process & Rotary die process, factors in soft capsules, quality control, stability testing and storage of capsule dosage forms.

Unit-3: Microencapsulation (6 hrs)

Advantages and disadvantages, Pharmaceutical Application, Fundamental consideration: Nature of core & coating materials, Stability & release characteristic of coated materials, Microencapsulation method; Examples illustrating improved stabilization: Stabilization of Vitamin A Palmitate Oil; Stabilization of incompatible aspirin mixture; Microencapsulation Techniques: Pan Coating, Air suspension, Multiorifice-Centrifugal Process, Solvent evaporation, Spray drying and spray congealing, Coacervation Phase separation; General mechanism of drug release from microencapsulated product Polymerization.

Unit-4: Parenteral Products (9 hrs)

Preformulation factors, routes of administration, water for injection, pyrogenicity, non-aqueous vehicles, isotonicity and methods of its adjustment. Formulation details, containers and closures and selection. Pre-filling treatment, washing of containers and closures, preparation of solution and suspensions, filling and closing of ampoules, vials, infusion fluids, lyophilization & preparation of sterile powders, equipment for large scale manufacture and evaluation of parenteral products. Aseptic

Techniques:-source of contamination and methods of prevention, design of aseptic area, laminar flow bench services and maintenance. Sterility testing of Pharmaceuticals.

Unit-5: Pharmaceutical Packaging: (12 hrs)

Classification of Packaging; **Glass containers**: props, advantages & disadvantage, composition & manufacturing of glass, Types of glass,

Plastic Containers: properties, advantages & disadvantages, list of plastic polymers, Drug Plastic interaction (Permeation, Leaching, Sorption, Chemical reaction, Modification of the materials properties), Environmental issues, resin identification codes;

Collapsible Tubes: Metal, Foils (PVC, PVdC, Aluminum);

Closures: Threaded screw cap, Crown cap, Pilfer proof closure, Lug cap, Roll On Closure (ROPP);

Liners: Closure Liner, Homogenous liner, Heterogeneous liner, Torque testing of caps, Rubber stoppers,

Tamper resistant packaging: Blister package, Strip package, Alu-Alu pack, bubble pack, shrink pack, Foil, paper or plastic pouch, Bottle seals, Breakable caps, Sealed tubes (Collapsible Tubes), Sealed Box (Printed carton duplex), Induction seal.

Brief concept of Packaging equipment: (Blister packing machines, Strip packing machine, Alu-Alu packing machine, Shrink Packing machine, Induction Sealing Machine, Strapping Machine)

PHAR 322 Lab Pharmaceutical Technology-II Practical

[48 Hours]

1. Experiments to illustrate preparation, stabilization, physical and biological evaluation of pharmaceutical products like powders, capsules, tablets, parenterals, micro-capsules, sterile water for injection, Calcium gluconate injection, Sodium chloride injection, Formulation, isotonicity, packaging and quality control of the following LVPs as per British Pharmacopoeia. Also explain industrial

scale manufacturing processes, Contact lens solution, Sodium chloride and Dextrose infusion

2. Micro encapsulation (using one solid and one liquid drug) by coacervation and polymer incompatibility, evaluation of microcapsules.
3. Evaluation of materials used in pharmaceutical packaging.

Books and other resources recommended (Latest edition)

1. Lachman, L. Lieberman, H.A. Kanig, J.L. The Theory & Practice of Industrial Pharmacy. Lea & Febiger, Phialdelphia.
2. Turco, S & King, R.E. Sterile Dosage Forms. Lea & Febiger, Philadelphia
3. Remington's the science and practice of Pharmacy mack Publishing Co. Easton, PA.
4. Lieberman, H.A. Lachman, L. Sachwartz, J.B. Pharmaceutical Dosage Forms: Tablets Vols 1-3 Marcel Dekker, N.Y.
5. Lieberman, H.A. Rieger, M.M.& Banker, G.S. Pharmaceutical Dosage Forms: Disperse Systems. Vol 1-2 Marcel Dekker, N.Y.
6. Ridgway, K. Hard Capsules The Pharmaceutical Press, London.
7. Ansel, H.C. Introduction to Pharmaceutical Dosage Forms KM Verghese.
8. J. Swarbrick, J. Boylan; Encyclopedia of Pharmaceutical technology, 2nd ed, Marcel Dekker, 2002.
9. Aulton, M.E. Pharmaceutics- The Science of Dosage form Design ELBS.
10. Avis, K.E. Lachman, L. & Lieberman, H.A. "Pharmaceutical Dosage Forms: Parenteral Medications" Vols. I & II Marcel Decker.
11. I. R. Berry; R.A. Nash; Pharmaceutical Process Validation; 2nd ed, Marcel Dekker, 1993.

PHAR 323 Pharmacology-III [48 Hours]

Unit-1: Drugs Acting on GIT (6 hrs)

(Classification, MOA, Indication, Dosage, ADRs, Contraindication and Drug interactions)

1.1 Anti-ulcer drugs
- H_2 receptor Antagonists(Cimetidine, Ranitidine, Famotidine
- Proton Pump Inhibitors (omeprazole, pantoprazole, rabeprazole, lansoprazole, esomeprazole)
- Antacids
- Mucosal protectives- Misoprostol, Sucralfate, Colloidal bismuth subcitrate (CBS)
- Treatment of *H. pylori* ulcer /infection

1.2 Laxatives
- Lactulose, Bisacodyl, Lubiprostone, Ispaghula, liquid paraffin

1.3 Emetics (Ipecac syrup, Apomorphine)
Anti-emetics: Ondansetron, Granisetron, Dolasetron, Domperidone, Promethazine, Metoclopromide, Itopride

1.4 Antispasmodics (Dicyclomine, Drotaverine, and Hyoscine Butylbromide)

1.5 Antidiarrhoeal drugs (ORS, Role of Zinc in diarrhea, Loperamide, codeine, diphenoxylate, octreotide, treatment of traveler's diarrhea).

1.6 Appetite Stimulants and Suppressants, Probiotics

Unit-2: Pharmacology of Endocrine Drugs (8 hrs)

2.1 Hypothalamic and pituitary hormones, parathormone, calcitonin, Vitamin D

2.2 Thyroid hormones and anti thyroid drugs
- Levothyroxine, Liothyronine
- Propylthiouracil, carbimazole, methimazole, radioactive I_2

2.3 Insulin-classification and various types
Oral hypoglycaemic agents – Tolbutamide, glipizide, glimepride, glicalazide, nateglimadie, Metformin, Rosiglitazone, Sitagliptin, Linagliptin & glucagon.

2.4 ACTH and corticosteroids: hydrocortisone, prednisolone, betamethasone, budesonide, fludrocortisone

2.5 Androgens and anabolic steroids: Estrogens, progesterone and oral contraceptives.

2.6 Drugs acting on the uterus: Oxytocin, misoprostol, ergometrine

Unit-3: Antimicrobials (22 hrs)

3.1 Selection and use of Antibacterial agents (Empirical therapy and definitive Therapy), Rational of combination of antimicrobials, Resistance of antimicrobials in example of β-lactamase and Mycobacterium).

3.2 **Sulfonamides**-Classification, MOA, Indication, Dosage, ADRs, Contraindication and Drug interactions of (Sulfacetamide, Silver sulfadiazine and Cotrimoxazole).

3.3 **Penicillin**-Classification, MOA, Indication, Dosage, ADRs, Contraindication and Drug interactions of (Benzyl penicillin, Procaine penicillin, Ampicillin + Cloxacillin, Amoxycillin, Flucloxacillin, Piperaciillin, Ticarcillin).

3.4 **Beta-lactamase inhibitors:** Clavulanic acid, Sulbactam, Tazobactam.

3.5 **Cephalosporin**-Classification, MOA, Indication, Dosage, ADRs, Contraindication and Drug interactions of (Cephalexin, Cefadroxil, Cefaclor, Cefuroxime, Ceftriaxone, Cefotoxime, Cefixime, Cepodoxime, Cefepime, Cefpirome, cephalosporin combination with β-lactamase inhibitors).

3.6 **Monobactams** :(Aztreonam)

3.7 **Carbapenems** :(Imipenam,Meropenem, Ertapenam)

3.8 **Tetracycline**-Classification, MOA, Indication, Dosage, ADRs, Contraindication and Drug interactions of (Tetracycline HCl, Doxycycline, Minocycline).

3.9 **Chloramphenicol**-MOA, Indication, Dosage, ADRs, Contraindication and Drug interactions.

3.10 **Macrolides**-MOA, Indication, Dosage, ADRs, Contraindication and Drug interactions of (Erythromycin, Clarithromycin, Azithromycin,).

3.11 **Aminoglycosides**-MOA, Indication, Dosage, ADRs, Contraindication and Drug interactions of (Streptomycin, Gentamicin, Kanamycin, Tobramicin, Amikacin, Neomycin)

3.12 **Miscellaneous Antibiotics drugs:** Vancomycin, Clindamycin, Nitrofurantion

3.12.1 **Classification, MOA of Fluoroquinolones**. Uses of Nalidixic acid, Norfloxacin, Ciprofloxacin Levofloxin, Ofloxacin, Gatifloxacin and other member.

3.12.2 **Antitubercular and Antileprotics**- Classification, 1st line and 2nd line agents, MOA, Indication, Dosage, ADRs, Contraindication and Drug interactions of (INH, Rifampicin, Pyrizenamide, Ethambutol, PAS, Cycloserine). WHO regimen for pulmonary and extra pulmonary tuberculosis, DOTS. Dapsone and Clofazemine, multidrug therapy

3.12.3 **Anthelmintics:** Classification, Piperazine, Diethyl carbamazine, Pyrantelpamoate, Mebendazole, Niclosamide, Praziquantel, Albendazole.

3.12.4 **Antiamoebic:** Metronidazole, Tinidazole, Secnidazole, Diloxanidefuroate.

3.12.5 **Antifungal:** Classification, MOA, Indication, Dosage, ADRs, Contraindication and Drug interactions of (Amphotericin-B, Ketoconazole, Clotrimazole, Fluconazole, Flucytosine, Griseofulvin, Itraconazole, Topical Antifungal (Terbinafine, Luliconazole).

3.12.6 **Antiviral:** Classification, MOA, Indication, Dosage, ADRs, Contraindication and Drug interactions of (Acyclovir, Ganciclovir, Amantadine). Antiretroviral agents: Zidovudine, Lamivudine, Nevirapine, Efavirenz, Indinavir, Enfurirtide.

Unit-4: Antineoplastic agents (4 hrs)

Classification, MOA, Indication, Dosage, ADRs, Contraindication and Drug interactions of:

4.1 **Alkylating agents:** (cyclophosphamide, chlorambucil, Cisplatin).

4.2 **Antimetabolites:** (mercaptopurine, 5-Flurouracil, methotrexate, azothioprine).

4.3 **Antibiotics:** (Doxorubicin, Mitomycin).

4.4 **Plant products :** (Vincristine, Vinblastine, Taxol),

4.5 **Others:** Mitotane, Tamoxifen, Imatinib, Bevacizumab,

Interferon alpha.

Unit-5: Immunosuppressant and Immunostimulants (4 hrs)

5.1 Glucocorticoids

5.2 Calcineurin inhibitors (cyclosporine and tacrolimus).

5.3 Antiproliferative and Antimetabolic Drugs (Sirolimus, Azathioprine, Mycophenolatemofetil, other cytotoxic and antimetabolic agents.

5.4 Biological antibodies: Anti-CD3 Monoclonal Antibodies.

5.5 Levamisole, Thalidomide. Bacillus Calmette-Guerin (BCG), nterferons, Interleukin-2,

Unit-6. Principles of Toxicology (4 hrs)

6.1 Definition of poison, general principles of management of poisoning with particular reference to barbiturates, opioids, organophosphates, paracetamol poisoning.

6.2 Heavy metals: Lead, Arsenic, Mercury, Iron
Heavy metal antagonists.BAL, DMSA, Penicillamine

PHAR 323 Lab Pharmacology-III Practical [48 Hours]

1. Stages of chloroform and ether anesthesia with and without premedication.
2. Study of phenobarbitone induced hypnosis (Demonstration).
3. Determination of analgesic activity (codeine/aspirin).
4. Study of anticonvulsant activity.
5. Study of local anesthetic activity.
   i) Surface anesthesia activity on rabbits.
   ii) Infiltration anesthesia using guinea pigs.
6. Identification of unknown drugs using rat ileum.
7. Seminars on the drugs studied in theory.

Books and other resources recommended (Latest edition)

1. C.R.Craig and R.E.Stitzel: Modem Pharmacology
2. Theodore W.Rall, Alan S.Nies and Palmer Taylor: Goodman Gilman's : The Pharmacological Basis of Therapeutics by Alfred Goodman Gilman.
3. D.R.Laurence and P.N.Bennett: Clinical Pharmacology.

4. K.D.Tripathi: Essentials of Medical Pharmacology.
5. R.S.Satoskar and S.D.Bhandarkar: Pharmacology and Pharmacotherapeutics.
6. F.S.K. Barar: Essentials of Pharmacotherapeuties.
7. H.P.Rang and M.M.Dale: Pharmacology.
8. James Crossland: Lewis's Pharmacology, revised.
9. Pharmacology by Lippincott.

For Practical

1. Pharmacological experiments on isolated preparations by Edinburgh University Pharmacology Staff, 1968.
2. Robert A.Turner and Peter Hebbom: Screening methods in Pharmacology, Vol.1 edited
3. S.K.Kulkarni: Handbook of experimental Pharmacology
4. M.N.Ghosh: Fundamentals of experimental pharmacology
5. Ian Kitchen: Text book of invitro Pharmacology
6. U.K.Sheth, N.K.Dadkar, UshaG.Kamat: Selected topics in Experimental Pharmacology
7. K. K. Pillai: Experimental Pharmacology, CBS, Delhi.

PHAR 324 Biopharmaceutics & Pharmacokinetics [48 Hours]

Unit-1: Concept, Definition and Introduction (3 hrs)

Biopharmaceutics and Pharmacokinetics and their role in formulation development and clinical setting. Pharamacokinetics Pharmacodynamics and clinical Pharmacokinetics with respect to design of dosage regimens. Plasma drug concentration Profile.

Unit-2: Review of Pharamacokinetics (10 hrs)

Absorption of Drug: Physicochemical. Physiological. Pharmaceutical. pH partition hypothesis, Pharmacokinetics of drug absorption-Zero order and first order absorption rate constant using Wagner–Nelson and Loo-Reigelman method

Drug distribution: Protein binding (intravascular and extravascular). Significance of drug-protein binding and drug displacement interactions. Kinetics of protein binding.

Drug metabolism: Study of factors affecting metabolism. Bioactivation and first pass effect.

Excretion: Introduction, types of drug excretion, Clearance concept, Mechanism of renal clearance, clearance ratio, determination of renal clearance. Extraction ratio, hepatic clearance, biliary excretion, Extrahepatic circulation.

Unit-3: Bioavailability and Bioequivalence (8 hrs)

Definition and concept of absolute & relative bioavailability. Methods of assessing bioavailability. Measures of bioavailability (C_{max}, t_{max}. AUC etc.), urine data, Bioequivalence study and introduction to various study designs. Single dose bioequivalence study and relevant statistics, Review of regulatory requirements for conducting bioequivalence study in Nepal and international prespective. Methods forenhancement of bioavailability. Clinical significance of bioavailability and bioequivalence.

Unit-4: Dissolution Studies (7 hrs)

Introduction to Biopharmaceutical classification system, Mechanism of dissolution, In-vitro studies and all latest models: Zero order, Matrix, First order, Higuchi. In-vitro in-vivo correlation (describe all types of correlations) -Definition, objectives & methods. Introduction to pharmacokinetic models. Physiologic versus compartment approach.

Unit-5: Compartment Models (5 hrs)

Concepts and their importance in the study of pharmacokinetics. One compartment open model.Assessment of pharmacokinetic parameters from plasma and urine data after i. v. bolus, i.v. infusion, i. v. injection with loading dose and oral administration. Percent absorbed time plot and determination of absorption rates based on one compartment model. Introduction to 'Two compartment model.'

Unit-6: Non-Linear Pharmacokinetics (4 hrs)

Causes of nonlinearity, Detection of non-linearity (saturation mechanism). Michaeles Menten equation. Definition of V_{max} and K_m. Determination of V_{max} and K_m. Significance of Non-Linear Pharmacokinetics: Case studies.

Unit-7: Clinical Pharmacokinetics (4 hrs)

Definition and scope, Therapeutic drug monitoring. Case study of Digoxin and theophyline. Individualization of Dosage. Dose adjustment in patients with and without renal and hepatic failure. Design of single dose bio-equivalence study and relevant statistics. Pharmacokinetic drug interactions and their significance in combination therapy.

Unit-8: Numerical (7 hrs)

Based on AUC, Elimination half life ($t_{1/2}$), Volume of distribution (V_d), Clearance (Cl), elimination rate constant (ke) and amount of drug (X). Dose adjustment in Renal Failure.

PHAR 324 Lab Biopharmaceutics & Pharmacokinetics Practical

[48 Hours]

Experiments designed for the estimation of various pharmacokinetic parameters with given data.

In-vitro-evaluation of different dosage forms for drug release.

Absorption studies – *In-vitro*.

Statistical treatment of pharmaceutical data.

Suggested Practical

1. *In-vitro* drug release study of the given powder dosage form using various dissolution media.

In-vitro drug release study of the given uncoated tablet dosage form using different dissolution media.

In-vitro drug release study of the given capsule dosage form using various dissolution media.

In-vitro drug release study of the given film coated dosage form using various dissolution media.

In-vitro dissolution study of the given sustained release dosage form.

In-vitro dissolution study of the given fast release (M.D, Dispersible etc.) dosage form.

To study the effect of hardness of tablet on dissolution rate.

To study the effect of various diluents on dissolution rate of dosage form (Tablets, Capsules, Ointment etc.).

To study the effect of formulation on drug release (powder, suspension etc.).

10. To determine the % protein binding of the given drugs.
11. To determine the effect of protein binding on drug bioavailability.
12. To calculate various Pharmacokinetic parameters from the given zero order drug release data.
13. To calculate various Pharmacokinetic parameters from the given first order drug release data.
14. To calculate the various Pharmacokinetic parameters from the given blood data of I.V. bolus injection (one compartment model).
15. To calculate various Pharmacokinetic parameters from the given urinary excretion data of I.V. bolus.injection using both methods (Rate of elimination & sigma minus method one compartment model).
16. To study the *in- vitro* drug- drug interaction.
17. To study the passive diffusion of the given drug using cellophane membrane.
18. To study the passive diffusion of the given drug using egg or goat membrane.
19. To determine the various Pharmacokinetic parameters from the given blood data of oral administration of dosge form.
20. Demonstration Experiments
    a) Dissolution Apparatus.
    b) Preparation of Buffers & membranes.
    c) Use of semilog paper.

d) Operation of colorimeter & U.V. spectrophotometer.

Books and other resources recommended (Latest edition)

1. Brahmankar and Jaiswal; Biopharmaceutics and Pharmacokinetics: A treatise; 2nd Edition; CBS Publication; 2009
2. Leon Shargel and Andrew B. C.Yu: Applied Biopharmaceutics and Pharmacokinetics 5th Edition; McGraw Hill; 2005.
3. Rowland and Tozer Text book of Clinical Pharmacokinetics 2nd edition, Lippincott Williams & Wilkins; 1995
4. Robert E. Notari, An Introduction to Biopharmaceutics and Clinical Pharmacokinetics: Fourth Edition, Revised and Expanded. Marcel Dekker, New York.2005
5. Remington: The Science and Practice of Pharmacy, 21st Edition. Philadelphia, PA: Lippincott Williams & Wilkins, 2005
6. J Swarbrick, Current Concepts in the Pharmaceutical Sciences: Biopharmaceutics, Lea & Febiger, Philadelphia (1970)
7. Javed Ali, Roop.K.Khar and Alka Ahuja: Textbook of Biopharmaceutics and Pharmacokinetics: 1st edition; Birla Publication, 2001-2002
8. Robinson, J.R.Lee, V.H.L. Controlled Drug Delivery: Fundamentals and Applications2nd edition, Macel Dekker, New York, 1987
9. H.F.Lodish and J.E.Rothman "The assembly of cell membranes Sci. Am. 240: 48-63, 1979
10. R.I.Oberle, G.L.Amidon; J. Pharmacokinetics and Biopharmaceutics, 15:529-544, 1987
11. A.Rubinstein, V.H.K.Li and J.R. Robinson In oral sustained release formulation, Design and Evaluation, New York, Pergamon, 1988 cap.
12. Wagner J.G. Fundamentals of Clinical Pharmacokinetics, Drugs Intelligence Publishers, Hamilton.
13. Wagner J.G. Pharmacokinetics for the Pharmaceutical Scientist, Technomic Publishing A.G. Basel, Switzerland.

PHAR 325 Biostatistics

Unit-1: Basic concepts of Stat
Data, Data Graphic, frequency
(Mean, Median, Mode, Harm
of data, range, Standard devia
SEM Applications in Pharma

Unit-2: Introduction to Pro
Binomial, Poisson and Norm

Unit-3: Sample and Samp
Sample size and its sig
application in pharmacy.

Unit-4: Hypothesis Testi
Concept of hypothesis,
statistical hypothesis, lev
statistics, chi-square test

Unit-5: Correlation an
Correlation analysis, Co
coefficient. Linear regr
Curve, stability study).
of variance: Introdu
pharmacokinetic study

Unit-6: Introduction
SPSS and EPI info, E

Books and other r

1. Health Researc
methods. WHO
2. Green, J. 200
London: Sage.
3. Methodology a
Wilkinson. Hi

PHAR 325 Biostatistics [48 Hours]

Unit-1: Basic concepts of Statistics (10 hrs)

Data, Data Graphic, frequency distribution measures of central tendency (Mean, Median, Mode, Harmonic mean, Geometric mean and scattering of data, range, Standard deviation, variance and coefficient of variation, SEM Applications in Pharmaceutical Validation)

Unit-2: Introduction to Probabilities Distribution (10 hrs)

Binomial, Poisson and Normal Probabilities distribution.

Unit-3: Sample and Sampling Method (5 hrs)

Sample size and its significance. Sampling techniques and their application in pharmacy.

Unit-4: Hypothesis Testing (8 hrs)

Concept of hypothesis, null and alternate hypothesis, formulation of statistical hypothesis, level of significance, type I and II errors, power, T-statistics, chi-square test

Unit-5: Correlation and Regression (10 hrs)

Correlation analysis, Correlation coefficient, Spearman's rank correlation coefficient. Linear regression analysis (applications in Beer's Lamberts Curve, stability study), Introduction to curve fitting techniques. Analysis of variance: Introduction and application of the test in the pharmacokinetic study.

Unit-6: Introduction to Software (5 hrs)

SPSS and EPI info, EPI data, End note

Books and other resources recommended Latest edition

1. Health Research Methodology- A guide for Training in Research methods. WHO.
2. Green, J. 2004. Qualitative methods for health research. 2nd ed. London: Sage.
3. Methodology and Techniques of Social Research by Bhandarkar and Wilkinson. Himalyan Publishing House

4. Research methodology-Methods and Techniques By CR Kothari. Wiley Eastren limited.
5. Polagar, S. 1995. Introduction to research in the health sciences. 3rd ed. Edinburgh: Churchill Livingstone.
6. A guide for Research proposal writing, National science Foundation.
7. Mike Saks and Judith Allsop. Researching Health Qualitative, Quantitative and Mixed Methods. Sage. ISBN: 978-1-4129-0364-6. Required.
8. Dr Katherine Jones and Katherine Hooper. Researching Health Companion. Sage.
9. S. Polgar and S.A. Thomas Introduction to Research in the Health Sciences, 5th edition. Churchill Livingstone Elsevier, New York (2008).
10. Denise F Polit and Cheryl Tatano beck- Nursing Research-Principles and Methods.7th edition.
11. Albert P.S., and Borkowf, C.B., 2002. "An introduction to biostatistics: randomization, hypothesis testing and sample size," in John I. Gallin (ed.), Principles and practice of clinical research, San Diego: Academic Press,
12. Brody, B.A., 1998. The Ethics of Biomedical Research: An International Perspective, Oxford: Oxford University Press.
13. Council for International Organizations of Medical Sciences, 2002. International ethical guidelines for biomedical research involving human subjects. Geneva: CIOMS.
14. Brett A, Grodin M (1991). Ethical aspects of human experimentation in health services research. JAMA 265:1854-57.

PHAR 326 SEM: Seminar-II [48 Hours]

- Students in a group of maximum five numbers shall be given topics related on scientific publication, review article, case study etc.
- Each group should present at least three topics for seminar work and internal examiner shall evaluate it.
- Among these topics, one topic shall be presented in final exam and evaluation will be done by external examiner.

SEVENTH SEMESTER

PHAR 411 Dosage Form Design [48 Hours]

Unit-1: Preformulation studies: (13 hrs)

1.1 Introduction, goals of preformulation, Study of physical properties of drug and their effect on formulation, stability and bioavailability.

- **Bulk characterization:**-Crystallinity and polymorphism, hygroscopicity, Fine particle characterization, Bulk density and study of powder flow properties (Carr's index, Hausner index, Angle of Repose)
- **Solubility Analysis:** Ionization constant–PKa; pH solubility profile and common ion effect–Ksp; effect of temperature; Solubilisation; Partition Coefficient and dissolution.
- **Stability Analysis:** Stability in toxicology formulation; Solution stability; PH rate profile; solid state stability; bulk stability; compatibility studies with excipient.

1.2 Study of chemical properties of drugs like hydrolysis, oxidation, reduction, racemization, polymerization etc., and their influence on formulation and stability of products.

1.3 Study of pro-drugs in solving problems related to stability, bioavailability and elegancy of formulations.

- Rationale for prodrug formation, potential prodrug candidates, Design and bioactivation, classification of prodrug (carrier linked prodrug, metabolic prodrug), pharmaceutical application of prodrug (Improvement of taste, odour, reduction of GI irritation, reduction of pain at site of injection, enhancement of solubility and dissolution of drug, chemical stability, prolonged duration of action, site specific drug delivery)

Unit-2: Design, development and process validation methods for pharmaceutical operations involved in the production of pharmaceutical products with special reference to tablets, suspensions. **(7 hrs)**

- Introduction to validation, importance of validation, process validation, types of process validation (Prospective, Concurrent, Retrospective and Revalidation), validation team responsibility, elements of validation (DQ, IQ, OQ and PQ)
- Process validation: Process validation activities (process design, process qualification and verification), change control, phases of process validation (Pre-Validation Phase or the Qualification Phase, Process Validation Phase, Process Qualification phase and Validation Maintenance Phase); Required Validation Documents: validation master plan (VMP), Validation protocol (VP), Validation report (VR) and Standard Operating procedure (SOP).
- Process validation method of solid dosage form (Tablet): Process overview of tablet manufacturing process, validation of process parameters in tablet manufacturing (Focus on process critical parameters of process stages of dry mixing, granulation, wet milling, drying, dry milling, lubrication, compression, coating and packing)
- Process validation method of suspension dosage form: Process overview; validation of process parameters of suspension manufacturing (mixing, size reduction, filling)

Unit-3: Stabilization and stability testing protocol for various pharmaceutical products (8 hrs)

- Brief introduction of rate kinetics and methods of determination of shelf life
- Protection against hydrolysis, oxidation and photochemical degradation.
- Stability testing: Accelerated analysis for chemical stability and limitation

(Arrhenius plot)

- Stability testing protocol: ICH guidelines for storage conditions, concept of climatic zone as per ICH, stress testing, accelerated and long term stability testing and on-going testing (focus on drug substance and drug product).
- DDA guidelines for stability testing 2007

Unit-4: GMP and Quality Assurance, Quality Audit and Quality Management system **(10 hrs)**

- GMP–Introduction, Relationship among Quality Elements (Quality Assurance, Good Manufacturing Practices (GMP) for Drugs and Quality control). Short description of Premises, Personnel and equipment. GMP regulation in Nepal including *"Ausadi Utpadan Kushal Samhita 2072"*.
- Quality Audit (Types: 3rd Party Audit, 2nd Party Audit, 1st Party Audits, Audit Categories: System Audit, Conformance Audit, Compliance Audit, Process Audit, Product Audit and Department Audit. Benefits of audit). Site Master File, GMP certification: Audit of Hardware, software and Practice.
- Quality Assurance: Concept, function and organizational Approach.
- ISO 9000 & ISO14000: Overview, Benefits, Elements, steps for registration, difference of GMP guidelines with ISO
- Concept of TQM (Definition, elements and Philosophies), Quality Review and Quality Documentation.

Unit-5: Design, development, production and evaluation of controlled released formulations (10 hrs)

- Introduction to CR/SR preparations, concept of controlled release formulation, challenges of CR drug delivery system, advantages and disadvantages, Factors influencing the design and performance of CR products (**physiochemical properties**: molecular size and diffusivity, aqueous solubility, ionization constant, partition coefficient, stability, **pharmacokinetic and pharmacodynamic considerations**: release rate and dose,

Biological factors: Absorption, distribution, metabolism and elimination half-life, therapeutic index, duration of action.

- Kinetics of drug release from CRDS: Zero order, first order, Hixson-Crowell Release Model, Higuchi Release Model and Korsmeyer-Peppas Release Model
- Oral controlled release systems: Dissolution controlled release (Matrix and encapsulated dissolution), diffusion controlled release (Reservoir and matrix system), dissolution and diffusion controlled release, osmotically controlled release, pH independent formulations, Ion exchange resins.
- Evaluation of CR formulations: Quality control methods (Identity, Purity, Strength) stability of the dosage form and drug in the dosage form, disintegration and dissolution, dosage form appearance, bioavailability of the drug from dosage form.

PHAR 411 Lab Dosage Form Design Practical [48 Hours]

1. Preformulation studies including drug-excipient compatibility studies, effect of stabilizers, preservatives etc. in dosage form design.
2. Experiments demonstrating improvement in bioavailability through pro-drug concept.
3. Stability evaluation of various dosage forms and their expiration dating.
4. Dissolution testing and data evaluation for oral solid dosage forms.
6. *In-vivo* bioavailability evaluation from plasma drug concentration and urinary excretion curves.
7. Design, development and evaluation of controlled release formulations.

Books and other resources recommended (Latest edition)

1. N.K. Jain, Controlled and Novel drug delivery. CBS Publishers and distributors. New Delhi.
2. Leon Lachman, Theory and Practice of Industrial Pharmacy, Varghese publishing house, 3rd edition.
3. Remington's, The Sciences and practice of pharmacy- Volume I, II. Lippincott Williams and Wilkins London, 20th edition.
4. Hillery and loyed, Drug delivery and targeting. Tylor and franicis London. 1st edition.
5. Yie W. Chien, Novel drug delivery systems. Mareel Dekker Inc.
6. Ansel, Howard, Pharmaceutical Dosage Forms and Drug Delivery Systems, Lippincott Williams and Wilkins London, 7th edition.
7. Hamed M. Abelon, Dissolution, Bioavailability and Bioequivalence, Mack Publishing Company, Pennsylvania.

PHAR 412 Pharmaceutical Management [48 Hours]

Unit-1: Concept of Management (8 hrs)

Administrative Management (Planning, Organizing, Staffing Directing and Controlling). Entrepreneurship development, Operative Management (Personnel, Materials, Production, Financial, Marketing, Time/space, Margin/Morale) Principles of Management (Coordination, Communication, Motivation, Decision Making, Leadership, Innovation Creativity, Delegation of Authority / Responsibility. Record Keeping), Identification of key points to give maximum thrust for development and perfection. Total Quality Management (TQM).

Unit-2: Pharmaceutical Marketing (8 hrs)

Functions, buying, selling, transportation, storage financed. Feedback information, channels of distribution, wholesale, retail, department store, multiple shop and mail order business.

Pricing: Meaning, importance, objectives, and determinants of price; pricing methods and strategies, issues in price management in pharmaceutical industry. An overview of Drug Price Control by Ministry Health, Government of Nepal, DDA.

Professional Sales Representative (PSR):

Duties of PSR, purpose of detailing, selection and training, supervising, norms for customer calls, motivating, evaluating, compensation and future prospects of the PSR in Nepal.

Unit-3: Salesmanship and Market Research (6 hrs)

Principle of sales promotion, advertising, ethics of sales, merchandising, literature, detailing, Recruitment, training, evaluation, compensation to the pharmacist. Measuring & Forecasting Market Demand-Major concept in demand measurement, Estimating current demand Geo-demographic analysis. Estimating industry sales, Market share and future demand. Market segmentation & Market targeting.

Unit-4: Introduction to Accountancy (5 hrs)

Introduction, Accounting Process, Bank Reconciliation, Trail Balance, Profit & Loss Account, Depreciation, Inventory management & Accounting, Long Lived Assets and Long term liabilities.

Unit-5: Material Management (4 hrs)

A brief description of basic principles of material management, major areas, scope, purchase, stores, inventory control and evaluation of materials management.

Unit-6: Production Management (6 hrs)

A brief description of the different aspects of Production Management. Visible and Invisible inputs, Methodology of Activities Performance Evaluation Technique Process, Flow, Process Know-how, Maintenance Management.

Unit-7: Introduction to Microeconomics (6 hrs)

Introduction, Supply/Demand and Elasticity, types of market (Monopoly, Competitive, Oligopoly, and Monopolistic Competition).

Unit 8: Practical Aspects of Pharmaceutical Sales and Marketing (5 hrs)

Conduct trainings on:

8.1 Marketing and Sales Plan Practice

8.2 Promotional Material designing

8.3 Observation of Sales call in the Market

Books and other resources recommended (Latest edition)

1. Beri, Market Research–Tata Mc Graw Hill
2. Chary S.N, Production and Operative Management/Tata Mc Graw Hill.
3. Datta A.K., Material Management / PHI.
4. Chadwick Leslie, The essence of management accounting / PHI.
5. Massie L. Joseph Essentials of Management / PHI.
6. Barthwal R.R, Industrial Economics / New Age International.

7. Shreenivasan K.R., An Introduction to Industrial Management / Vikas.
8. Daver Rustam S. Salesmanship and Publicity / Vikas.
9. Mukopadhyay Sekhar, Pharmaceutical Selling, Sterling Publishers.
10. Koontz H, Weihrich H, Essentials of Management, Tata Mc Graw Hill.
11. Vidya sagar Pharmaceutical Industrial Management, Pharma Book Syndicate
12. Rollins BR, Perri MA. Pharmaceutical Marketing. United State of America: Jones & Bartlett Learning; 2014.
13. Tootelian DE, Wertheimer al, Mikhailitchenko AN. Essentials of Pharmacy Management. 2nd. Pharmaceutical Press; 2012.

PHAR 413 Pharmacotherapeutics [48 Hours]

1. Important Disorders of Organ Systems and their Management:
   1.1. Cardiovascular Disorders–Hypertension, Congestive Heart Failure, Angina, Acute Myocardial Infarction, Cardiac arrhythmias **(6 hrs)**
   1.2 CNS Disorders: Epilepsy, Parkinsonism, Schizophrenia, Depression, Mania, Tension headache, Migraine, Clusture headache. **(6 hrs)**
   1.3 Respiratory Disease- Asthma, COPD **(2 hrs)**
   1.4. Gastrointestinal Disorders-Peptic ulcer, Ulcerative colitis, Hepatitis, Cirrhosis, Hemorrhoids, Anal Fissure, Piles **(6 hrs)**
   1.5. Endocrine Disorders-Diabetes mellitus and Thyroid Disorders **(3 hrs)**
   1.6 Infectious Diseases-Tuberculosis, Urinary Tract Infection, Enteric Infections, Upper Respiratory Infection, Leprosy **(5 hrs)**
   1.7 Hemopoietic Disorders-Anemia **(3 hrs)**
   1.8 Joint and Connective Tissue Disorders-Rheumatic Diseases (RA), Gout and Hyperuricaemia, Osteoarthritis (OA) **(2 hrs)**
   1.9 Neoplastic Diseases- Acute Leukaemia, Hodgkin's diseases **(2 hrs)**
2. Sexually transmitted Disease- Gonorrhea, Syphilis, AIDS **(2 hrs)**
   2.1 Renal Disease: Kidney Failure (Acute and Chronic) **(2 hrs)**
   2.2 Ocular Disease: Glaucoma, Cataracts, Macular Degeneration, Refractive error **(4 hrs)**
   2.3 Skin disease: Psoriasis, Acne, Hives, Warts, Cold sore, Candidiasis, Athletes foot, Carbuncle, Measles, Dermatophytsis, Shingles (Hepex Zoster) **(5 hrs)**

Books and other resources recommended (Latest edition)

1. Sathoskar, Pharmacology and Pharmacotherapeutics, Vol. 1 & 2, Publisher by Popular Prakashan, Mumbai.
2. Roger Walker and Cleve Edwards: Clinical Pharmacy and Therapeutics.
3. Current Medical Diagnosis and Treatment (CMDT)
4. Washington Manual and Medical therapeutics, 32nd Edition.
5. Bertram. G. Katzung, Basic and clinical pharmacology
6. J.G. Hardman and Lee E. Limbard, Good Mann & Gilmann: The Pharmacological basis of therapeutics, Mc Graw hill, Health Professions Dvn.
7. Lippincott Williams and Wilkins: Remington Pharmaceutical Sciences, 20th Edition. Hamsten, Drug interaction, Kven Stockley.
8. Laurence, DR and Bennet PN. Clinical Pharmacology, Scientific book agency
9. Dr. D.R Krishna, V. Klotz, Clinical pharmaco kinetics, Publ Springer Verlab
10. M Rowland and T N Tozer, "Clinical Pharmacokinetics" 2nd ed Lea & Febiger, NY.
11. Grahame smith and Aronson, Clinical pharmacology and drug therapy
12. Richard A Helms, Text Book of Therapeutics Drug and Disease Management Hardbound.
13. Herfindal E T and Hirschman JL, Williams and Wilkins, Clinical Pharmacy and Therapeutics

PHAR 414 Research Methodology [48 Hours]

1. Introduction, meaning and nature of research, scope and objective of research, type of researches, health research and its benefits. Research Ethics and plagiarism. Health research, policy and priorities, pharmaceutical researches, indicators in health researches, pharmaceutical researches, laboratory and survey research **(6 hrs)**
2. Introduction, significance of valid design **(1hr)**
3. Research design: Observational Study–types, design, example. Interventional study–types, design, example. Qualitative Research, meta-analysis, small topics. Foundations of Quantitative and qualitative Research Design. Identify different types of study design, including observational, pre-experimental and experimental designs, and their inherent threats to internal and external validity, **(7 hrs)**
4. Variables–types, example. Describe the basic issues related to measurement of variables. **(2hrs)**
5. Confounders and Bias: Confounding, control of confounding. Bias-types, control; blinding-types, double dummy technique; randomization–methods, measurement levels **(4 hrs)**
6. Data Analysis and Interpretation: **(21 hrs)**
   - 6.1. Gaussian curve, hypothesis testing **(1hr)**
   - 6.2. Confidence interval, p-value, effect size, power **(1hr)**
   - 6.3. Types of error, reducing error in test **(1 hr)**
   - 6.4. Parametric and non-parametric tests for difference between groups: data required, example **(2 hrs)**
   - 6.5. Chi-square test, Mc Nemar test-Assumption, example, interpretation **(2 hrs)**
   - 6.6. Tests for ordinal data-Assumption, example, interpretation **(2 hrs)**

6.7. Central limit theorem, t-distribution, different t-tests-Assumption, example, interpretation **(2 hrs)**

6.8. One way ANOVA-Assumption, example, interpretation, source of variation, post hoc tests **(2 hrs)**

6.9. One and two way ANOVA, multivariate ANOVA-Assumption, example, interpretation **(2 hrs)**

6.10. Relative risk, odds ratio, survival studies **(1 hr)**

6.11. Correlation-Types, Assumption, example, interpretation **(2 hrs)**

6.12. Regression-Types, Assumption, example, interpretation **(2 hrs)**

6.13. Topic selection, defining objective and research question, research hypothesis **(1 hr)**

6.14. Research report writing, types of report, draft report and presentation and dissemination plan **(2 hrs)**

7. Data entry in SPSS and other software–Lab Practice **(7hrs)**

Non-parametric tests (SPSS)-
T- tests, One- way ANOVA (SPSS)-
Correlation, Regression (SPSS)-

PHAR 414 Lab: Research Methodology and Proposal Design Practical [48 Hours]

Write a project proposal for 8th semester project work and conduct literature survey.

Books and other resources recommended (Latest edition)

1. Health Research Methodology- A guide for Training in Research methods. WHO.
2. Green, J. 2004. Qualitative methods for health research. 2nd ed. London: Sage.

3. Methodology and Techniques of Social Research by Bhandarkar and Wilkinson. Himalyan Publishing House
4. Research methodology-Methods and Techniques By CR Kothari-Wiley Eastren limited.
5. Polagar, S. 1995. Introduction to research in the health sciences. 3rd ed. Edinburgh: Churchill Livingstone.
6. A guide for Research proposal writing, National science Foundation.
7. Mike Saks and Judith Allsop. Researching Health Qualitative, Quantitative and Mixed Methods. Sage. ISBN: 978-1-4129-0364-6. Required.
8. Dr Katherine Jones and Katherine Hooper. Researching Health Companion. Sage.
9. S. Polgar and S.A. Thomas Introduction to Research in the Health Sciences, 5th edition. Churchill Livingstone Elsevier, New York (2008).
10. Denise F Polit and Cheryl Tatano beck- Nursing Research-Principles and Methods.7th edition.
11. Albert P.S., and Borkowf, C.B., 2002. "An introduction to biostatistics: randomization, hypothesis testing and sample size," in John I. Gallin (ed.), Principles and practice of clinical research, San Diego: Academic Press,
12. Brody, B.A., 1998. The Ethics of Biomedical Research: An International Perspective, Oxford: Oxford University Press.
13. Council for International Organizations of Medical Sciences, 2002. International ethical guidelines for biomedical research involving human subjects. Geneva: CIOMS.
14. Brett A, Grodin M (1991). Ethical aspects of human experimentation in health services research. JAMA 265:1854-57.

PHAR 415 Forensic Pharmacy [48 Hours]

Unit-1: Introduction (3 hrs)

History of pharmaceutical legislation, Pharmaceutical industry and pharmaceutical education in Nepal and Global Perspective.

Unit-2: Legislation to regulate Drugs and the profession of pharmacy in Nepal (22 hrs)

- Drugs Act 1978 (2035)
- Regulation made under drug Act-Drug Registration Regulation, Drug Consultative Council and Drug Advisory Regulations, Drug Standard Regulation and Drug Inspection Regulation
- Codes Made under regulation: Drug Manufacturing Codes, Drugs Sale and Distribution Codes
- Nepal Pharmacy Council Act and Regulations
- Policy and guidelines- National Health policy related to pharmacy practice, National Drug policy, Procedure for product registration system in Nepal, Hospital pharmacy establishment guidelines 2072 B.S., Drug Promotion Guideline

Unit–3: Other Acts related to Drugs (10 hrs)

- Company Act of Nepal
- Patents Act 1970.
- Nepal Health Research Council Act
- Narcotic drugs control act relating to pharmaceutical product and the relation of act with Drugs Act, 1978
- Consumer protection act
- Black marketing act

Unit–4: International Regulations (5 hrs)

- Drug Regulation guided by WHO
- A brief account about Indian Drug and Cosmetic act

- A brief account about the Drug & Cosmetic Act of UK, Australia and USA.

Unit 5: Practical Approaches (Assignment for student as practical) - (8 hrs)

5.1 Regulatory framework and pre-requisites for establishment of medicine manufacturing industry, procedure to be completed to bring a pharmaceutical product into the Nepalese market and export the product, based on Drugs Act and Drug Registration Regulation.

5.2 Current Good Manufacturing Practice in manufacturing, processing, packing or holding of finished pharmaceutical products and its certification process and impact on quality standard.

5.3 Practical demonstration and application of different schedules mentioned under Drug registration regulation 2038, Drug standard regulation 2043 and other schedules formed under Drug Act 2035.

Books and other recourses recommended (Latest edition)

1. Drug Act of Nepal and Regulations under it.
2. Forensic Pharmacy by B.M. Mithal
3. Laws of drugs in India–Hussain
4. Intellectual Property Law by R.K. Nagarajan
5. Text book of forensic pharmacy by C.K. Kokate and S.B.Gokhale published by Pharma book syndicate.
6. DDA Publication: Drug Bulletin and others.

PHAR 416 Dispensing and Community Pharmacy [48 Hours]

Unit-1: Community Pharmacy (4 hrs)

Definition, Scope of community pharmacy, different types of community pharmacy.

1.2. Professionalism in the Community Pharmacy Setting.

1.3. Roles and responsibilities of Community pharmacist, Code of Ethics.

Unit-2: Entrepreneurship in Community Pharmacy and developing business plan. **(2 hrs)**

Unit-3: Community Pharmacy Management (14 hrs)

3.1 Selection of site, Space layout, and design, Pharmacy workflow
3.2 Staff, Materials- coding, stocking
3.3 Legal requirements and legal structure of ownership.
3.4 Maintenance of various registers
3.5 Computerization of Pharmacy
3.6 Documentation in Community pharmacy
3.7 Patient care process in Community pharmacy

Unit-4: Inventory Control: (3hrs)

Purchasing and Inventory control in community pharmacy ABC, VED, EOQ, Lead time, safety stock

Unit-5: Prescription: (2 hrs)

Handling of prescription, source of errors in prescription, care required in dispensing procedures including labeling of dispensed products.

Unit-6: Pharmaceutical calculations (4 hrs)

Posology, calculation of doses for infants, adults and elderly patients; Enlarging and reducing recipes percentage solutions, allegation, alcohol dilution, proof spirit, isotonic solutions, displacement value etc.

Unit-7: Communication skills in Patient counseling (6 hrs)

Need for good communication, Key communication skills, strategies to overcome barriers. Patient compliance: Definition, Factors affecting compliance, role of pharmacist in improving the compliance. Patient information leaflets- content, design, & layouts, advisory labels.

Unit-8: Health Screening Services: (8 hrs)

Definition, importance, methods for screening, responding to symptoms. Role of Pharmacist in OTC drugs, Immunization, Nutrition and Dietary supplements. Smoking cessation, Obesity, Hypertension, Diabetes mellitus (TYPE II) and Family planning.

Unit-9: Good Community Pharmacy Practice: (5 hrs)

Requirements of premises/layout, equipment, manpower, of material, storage and inventory control services, documentation.

PHAR 416 Lab Community Pharmacy Practical [48 Hours]

1. Categorization and storage of Pharmaceutical products bases on legal requirements of labeling and storage.
2. Prescription handling and identification of drug interactions, incompatibilities.
3. Health screening services and study of equipment for:-Blood glucose determination (Glucometer), Blood pressure (BP apparatus) and Lung function test (Peak flow meter)
4. Demonstration of the Basic Medical practice and Procedure-Dressing, Suturing, injection
5. Layout and Design of community pharmacy to incorporate all pharmaceutical care services.
6. Interpretation of various pathological reports of blood and urine.
7. Techniques of administration of special dosage forms of drugs : Discussion and overhead picture presentation on proper techniques of administration of :-Inhaler, Eye drops and ointment, Ear drops, Nose drops, Dry syrups, Suppositories and Vaginal pessaries (Demonstration of these actual dosage forms and hands on experience at using them)
8. Problem solving / patient care analysis in pharmacy practice, taking drug history, patient counseling role play.
9. Project report on visit to the nearby Community for Counseling on the rational use of drugs and aspects of health care.
10. Training on first aid.

Books and other recourses recommended (Latest edition)

1. Churchill Livingstone, Edalker and Edwards- Clinical Pharmacy and Therapeutics 2nd ed. 1999
2. Clive Edwards and Paul Stillman - Minor Illness or Major Disease? Responding to symptoms in the Pharmacy, Pharma Press 1995.
3. Robinson Harma - Patient Care in Community Practice, A Handbook of Non Medical Healthcare, Pharma Press 1989.
4. Melanie J. Rantucci- Pharmacists talking with Patinents, A guide to Patient Conseling. Williams and Wilkins. 1997.
5. Cynthia Knapp Dlugosz, The Practitioner's quick reference to Non Prescription Durgs. American Pharmacists Association. 2009.
6. Jean Venable, Lynne Roman, Kristin Weitzel, Community Pharmacy Practice. American Pharmacists Association. 2009.
7. WHO Publications: Role of Pharmacist in Health Care, Good Pharmacy Practice, Operational principle for good procurement practice and WHO Revised drug strategies

EIGHTH SEMESTER

PHAR 421 Hospital Pharmacy [48 Hours]

1. History and Development of Hospital, Hospital pharmacy and Clinical Pharmacy in Nepal. (1 hr)

2. Organization and Structure: (1 hr)

Hospitals: Definition, Objectives and Functions, Classifications based on various criteria, Organization, Management and health delivery system in Nepal.

3. Hospital Pharmacy: (4 hrs)

3.1 Hospital Pharmacy, Definition, functions and objectives of hospital pharmacy, organization, planning and administration of modern hospital pharmacy services, Location, Layout & flow chart of material and men, personnel, and facilities required, including equipment,

3.2 Minimum Standards of practice in Hospital pharmacy.

3.3 Qualifications, requirements, abilities and evaluation of hospital pharmacist, responsibilities required for Hospital Pharmacists, workload and remuneration of hospital pharmacist, pharmacist assistants and supporting staffs, Job descriptions.

4. Drug Store Management and Inventory Control: (6 hrs)

4.1 Organization of drug store, Types of material stocked, Storage Condition, Budgeting for Drugs.

4.2 Purchase and Inventory Control Principles, Purchase procedures, Estimation of drug requirements, Determining drug types and quantities required, Lead time, Monthly consumption, Purchase Specifications, Requisition, Purchase order, Purchase record, Procurement and Stocking. Control on Purchase, Vendor selection, ABC analysis, VED analysis.

5. Drug Supply Management (9 hrs)

5.1 Selection and Quantification: Country's health service delivery system; Morbidity pattern, Essential Drug List, Standard Treatment Protocol, National Formulary, Organizing the list,

Quantification based on morbidity & consumption, adjusted consumption, Budgeting for Drugs.

5.2 Procurement: Procurement cycle; Effective procurement; Techniques; Process management; Suppliers; Tendering processes, Quality assurance

5.3 Storage & Distribution: Good storage practice; Warehouses, Storage facility; Quality control; System design, Information system; Cost of distribution; Distribution network; Supply Monitoring.

6. Drug Distribution Systems: (4 hrs)

6.1 Outpatient Dispensing; Method adopted, Guidelines for Hospital Drug Distribution Systems.

6.2 Inpatients Dispensing; Type of drug distribution systems; Individual prescription order, Floor stock system, Unit dose dispensing system (centralized and decentralized system), Satellite pharmacy services, Bed side pharmacy, charging policy, labeling.

6.3 Dispensing of controlled drugs, record keeping and stock maintenance.

6.4 New dispensing systems: Mechanical Drug Dispensing, Computerized Drug Dispensing.

7. Central Sterile Supply Unit and its management: (2 hrs)

Type of materials for sterilization, packaging of materials prior to sterilization, sterilization equipment, supply of sterile materials.

8. Hospital manufacturing and pre-packaging in the Hospital: (4 hrs)

8.1 Economic Considerations, Factors affecting make or buy decision, sterile manufacture and non- sterile manufacture, facilities and requirements.

8.2 Nutritional problems in hospitalized patients, Nutritional assessment and metabolic requirements, Disease specific support, Home parenteral nutrition with calculations

9. Hospital committees: (5 hrs)

Role of Pharmacists in different hospital committee and rational use of drugs

9.1 Drug and Therapeutic committee: Goals and Objectives, functions, role of DTC in drug management Cycle, Structure and organization of DTC
9.2 Infection control committee
9.3 Antibiotic monitoring committee
9.4 Research and Ethics committee

10. Nomenclature and uses of surgical Instruments, Surgical supplies and Surgical Dressings. (2 hrs)

11. Managing Formulary Process

Formulary process, Formulary list, Formulary manual, Standard Treatment Guidelines, Assessing New medicines **(4 hrs)**

12. Radiopharmaceuticals (5 hrs)

Type of radio Pharmaceuticals, Radioactive half-life, Units of Radioactivity and Dose, Facilities req. ed for the production of radiopharmaceuticals, Production of 99m chnetium, Measurement of radioactivity (Geiger-Muller countin. Liquid scintillation counting,Measurement of gamma radiation), Dosing, Radiation Hazards and role of pharmacist.

13. Computer application in hospital pharmacy (1 hr)

PHAR 421 Lab Hospital Pharmacy Practical [48 Hours]

1. Organizational chart of Hospital and hospital Pharmacy.
2. Layout design and workflow of hospital pharmacy.
3. Demonstration of surgical equipments and surgical dressings.
4. Drug List, Emergency Drug list.
5. Adverse Drug Reaction with causality assessment.
6. Drug dose calculation in Children, pregnancy and geriatric patients.
7. Case studies involving different diseases.
8. Prepare formulary of selective drugs.
9. Visit to Hospital pharmacy and prepare a report. (optional)
10. Drug Supply Management
    10.1 Study of latest edition of National List of Essential Medicines, Govt. Standard Treatment Protocols, Annual Report of Dept. of Health Services.

10.2 Study of existing govt. procurement list of medicines and vaccines.

10.3 Visit to warehouses (drugs and vaccines) and health facilities.

Books and other recourses recommended (Latest edition)

1. Lea and Gebiger, William E. Hassan- Hospital Pharmacy 3rd ed. 1974.
2. Birla Publications, Pratibha Nand and RK Khar- A textbook of Hospital and Clinical Pharmacy 1st ed. 2001.
3. Vallabh Publications, PC Dandiya and Mukul Mahur- A textbook of Hospital and Clinical Pharmacy 4th ed. 2005.
4. Churchill Livingstone, Edalker and Edwards- Clinical Pharmacy and Therapeutics 2nd ed. 1999
5. American Pharmaceutical Association, John Rovers and Jay Currie- A Practical Guide to Pharmaceutical Care 3rd ed. 2007.
6. Green and Harris - Pathology and Therapeutics for Pharmacists , Chapman and Hall ISBN 0-412-36000-4
7. Winfield and Richanrds-Pharmaceutical Practice, Churchill Livingstone 1998.
8. Diane M.Collett and Michael E.Aulton, Churchill Livingstone 1990.
9. Clive Edwards and Paul Stillman-Minor Illness or Major Disease? Responding to symptoms in the Pharmacy, Pharma Press 1995.
10. Alison Blenkinshopp and Paul Paxton-Symptom in Pharmacy, Blackwell Science 1995.
11. WHO Publications: Role of Pharmacist in Health Care, Good Pharmacy Practice, Operational principle for good procurement practice and WHO Revised drug strategies.
12. Book: Managing Drug Supply, Published by Management Science for Health (MSH), Kumarian Press, USA.

PHAR 422 Drug Delivery System [32 Hours]

Unit-1: Polymer Science (3 hrs)

Introduction, synthesis of polymers, polymer classification, biodegradation of polymers, properties of polymers, pharmaceutical application of polymers.

Unit-2: Sustained Release Formulations (4 hrs)

Introduction, concept, advantages and disadvantages. Physicochemical and biological properties of drugs relevant to sustained release formulations, evaluation of sustained release drug formulations.

Unit-3: Concept and System Design for Rate-controlled Drug Delivery (5 hrs)

Classification of controlled drug delivery systems, rate-programmed release, activation modulated and feedback-regulated drug delivery systems, effect of system parameters on controlled release drug delivery.

Unit-4: Mucoadhesive Drug Delivery Systems (6 hrs)

Concepts, advantages and disadvantages, structure of oral mucosa, transmucosal permeability, mucosal membrane models, mucoadhesive polymers, permeability enhancers, *in-vitro* and *in-vivo* methods for buccal absorption. Nasal and pulmonary drug delivery systems and its applications.

Unit-5: Parenteral Controlled Release Drug Delivery Systems (4 hrs)

Approaches for injectable controlled release formulations and development of implantable drug delivery systems.

Unit–6: Targeted drug delivery systems (6 hrs)

Principles of targeting, classification, advantages and disadvantages, biological processes and event involved in drug targeting, microspheres, magnetic microspheres, nanoparticles, liposomes, niosomes, dendrimers, resealed erythrocytes, and monoclonal antibodies.

Unit-7: Protein and peptide drug delivery (4 hrs)

Introduction, classification and structure of protein, drug delivery systems for proteins and peptides, manifestation of protein instability and stability.

PHAR 422 Lab Drug Delivery System practical [48 Hours]

1. Characterization of polymers.
2. Preparation and evaluation of polymeric microspheres.
3. Preparation and evaluation of microcapsules by different microencapsulation techniques.
4. Preparation and evaluation of matrix tablets using various polymers.
5. Formulation and evaluation of floating tablets.
6. Study on in vitro diffusion of drugs through various polymeric membranes.
7. Preparation and evaluation of buccal mucoadhesives systems.
8. Preparation and evaluation of drug-free polymeric films.
9. Preparation and evaluation of transdermal patches.
10. Preparation and evaluation of floating microspheres.
11. Preparation and characterization of liposomes.
12. Preparation and characterization of niosomes.
13. Study of in vitro dissolution of various sustained release formulations of marketed products.
14. Demonstration of skin sensitivity testing of TDDS on a suitable animal model.

Sample of experiment on DDS

1. Preparation and Evaluation of Matrix Tablets
2. Formulation and Evaluation of Film Coated Tablets.
3. Formulation and Evaluation of Enteric Coated Tablets.
4. Preparation and Evaluation of Transdermal Drug Delivery Systems.
5. Formulation and Evaluation of Mucoadhesive Delivery Systems.
6. Evaluation of Market SR Formulations.
7. Preparation and Evaluation of Alginate Beads.
8. Analytical Method Validation.

Books and other recourses recommended (Latest edition)

1. Fried J.R. Polymer Science & Technology, 2nd edition. Prientice-Hall India Pvt. Ltd.
2. Coleman M.M., Painter P.C. Fundamentals of Polymer Science: An Introductory Text. CRC Press.
3. Lliun Lisbeth, Davis Stanley S. Polymers in Controlled Drug Delivery.Wright Bristol.
4. Robinson J.R., Lee V.H.L. Controlled Drug Delivery. Marcel Dekker, Inc.
5. Juliano R.L., Drug Delivery Systems: Characteristics and Biomedical Applications. Oxford University Press.
6. Chien Y.W. Novel Drug Delivery Systems. Marcel Dekker, Inc.
7. Vyas S.P., Khar R.K. Controlled Drug Delivery-Concepts and Advances. Vallabh Prakashan.
8. Mathiowitz E. Encyclopedia of Controlled Delivery.John Wiley & Sons, Inc.
9. Jain N.K. Controlled and Novel Drug Delivery. CBS Publishers & Distributors.
10. Carstensent J. T. Drugs and Pharm.Sci.Series, vol. 43, Marcel Dekker Inc.
11. Johnson P., Lloyd-Jones, J.G. Drug Delivery Systems: Fundamentals and Techniques.VCH.
12. Audus K.L., Juliano R.L. Targeted Drug Delivery. Springer-Verlag.
13. Lee V.H.L. Peptide and Protein Drug Delivery. Marcelk Dekker, Inc.
14. Guy R.H., Hadgraft G. Transdermal Drug Delivery. Marcel Dekker, Inc.
15. Edith Mathiowitz, Donald E. Chickering, Claus-Michael Lehr. Bioadhesive Drug Delivery Systems: Fundamentals, Novel Approaches and Development. Marcel Dekker, Inc.
16. Kasliwal N. Liposomes/Niosomes As a Drug Delivery System. Lambert Academic Publishing.
17. Dietrich G., Goebel W. Vaccine Delivery Strategies. Horizon Scientific Press.

PHAR 423 Instrumental Analysis [48 Hours]

Unit-1: Ultraviolet and Visible Spectrophotometry (9 hrs)

Introduction, absorption laws, instrumentation, types of electronic transition, chromophore concept, auxochrome, absorption & intensity shifts, types of absorption bands, choice of solvent & solvent effects, Woodward-Feiser & Feiser-Kuhn rules for calculating absorption maxima, applications of UV spectroscopy.

Unit-2: Fluorimetry (2 hrs)

Introduction, principle, factors affecting fluorescence intensity, instrumentation & applications of fluorimetry.

Unit-3: Infrared Spectrophotometry (8 hrs)

Introduction, theory of IR spectroscopy, modes of vibration, factors affecting vibrational frequencies, instrumentation, position & intensity of absorption bands, sampling methods, applications of IR spectroscopy, interpretation of IR spectra, limitations of IR spectroscopy.

Unit-4: Nuclear Magnetic Resonance Spectroscopy including ^{13}C NMR (10 hrs)

Introduction, principle, instrumentation, number of signals, chemical shift & factors affecting chemical shift, internal standards, shielding & deshielding effects, solvents in nmr, splitting of signals, spin-spin coupling, coupling constant, double resonance (spin decoupling), nuclear overhauser effect (NOE), introduction to ^{13}C-NMR, applications of NMR spectroscopy, interpretation of NMR spectra

Unit-5: Mass Spectrometry: (6 hrs)

Introduction, principle, instrumentation, mass spectrogram, types of ion produced in mass spectrometer, index of hydrogen deficiency, nitrogen rule, ring rule, interpretation of molecular spectra & applications of mass spectroscopy.

Unit-6: Flame Photometry (2 hrs)
Introduction, principle, instrumentation, effect of solvent, applications in qualitative & quantitative analysis, methods of quantitative analysis, interferences in flame photometry & limitations of flame photometry.

Unit-7: Emission Spectroscopy (2 hrs)
Introduction, theory, instrumentation, advantage & disadvantage of emission spectroscopy, applications.

Unit-8: Atomic Absorption Spectroscopy (2 hrs)
Introduction, theory, instrumentation, detection limit & sensitivity, interference, applications of AAS.

Unit-9: X-ray Diffraction: (2 hrs)
Introduction, theory, instrumentation, applications.

Unit-10: Thermal methods (4 hrs)
Introduction to thermal methods; principle, instrumentation & application of differential thermal analysis (DTA), differential scanning calorimetry (DSC) & thermogravimetry (TG).

Unit-11: Radioimmunoassay (1 hr)

PHAR 423 Lab Instrumental Analysis Practical [48 Hours]

1. Quantitative estimation of formulations containing single drug or more than one drug, using uv-visible spectroscopy.
2. Estimation of Na, K, Ca ions using flame photometry.
3. Estimation of riboflavin, quinine using flame fluorimetry.
4. Tutorial to interpret the structure of simple organic compounds and drug molecules using UV, IR, NMR and Mass spectra.

Books and other recourses recommended (Latest edition)

1. Skoog, et al : Fundamentals of analytical chemistry, Thomson Brooks/ Cole
2. William Kemp: Organic Spectroscopy (3rd Ed.) 1991, Macmillan Press Ltd., London.
3. R. M. Silverstein, G. C. Balller and T. C. Morrill: Spectrometric Identification of Organic Compounds. (5th ed.) 1991, John Wiley and Sons, Inc. London.

4. Reference IR spectra of drug molecules BP, IPand JP.
5. John R. Dyer: Applications of Absorption Spectroscopy of Organic Compounds, 1965, Prentice-Hall, Inc., London.
6. BK Sharma: Instrumental & Chemical Methods of analysis: Goel Publication
7. Chatwal & Anand: Instrumental & Chemical Methods of analysis: Himalayan Publication
8. Beckett A H and Stenlake J B, Practical Pharmaceutical Chemistry Vol. II, The Athlone Press of the University of London.
9. G. Gauglitz and T. Vo-Dinh;Handbook of Spectroscopy; Wiley-VCH

PHAR 424 Clinical Pharmacy [32 Hours]

1. **Introduction to Clinical Pharmacy: (1 hr)**
   Objectives of clinical pharmacy, Scope of Clinical pharmacy, Role of Clinical pharmacists
2. **Patient data analysis and Prescribing guidelines: (6 hrs)**
   Interpretation of Clinical laboratory tests used in the evaluation of common disease states, Haematological parameters, Urine examination, Stool Examination, liver function tests, pulmonary function tests. Patient's Data collection. Paediatric patients, Geriatric patients, Pregnant and breast feeding women.
3. **Adverse drug reactions: (4 hrs)**
   ADRs with special emphasis on epidemiology, classification, risk factors, monitoring and detecting ADR, assessing causality, reporting ADRs.
4. **Drug interactions: (5 hrs)**
   Define drug-drug and drug-food interactions. Classify and explain mechanism of drug-drug interactions.
5. Drug dependence and Drug abuse **(1 hr)**
6. Describe the investigational drugs and phases of clinical trials, pharmacist's role in clinical trials, statistical methods of interpretation, legal and ethical considerations. **(5 hrs)**
7. Therapeutic drug monitoring and role of pharmacist. **(4 hrs)**
8. Drug and poison information services: **(6 hrs)**
   Introduction of drug information, Resources available, Design of literature searches, Critical evaluation of drug information and literature, Preparation of written and verbal reports and Development of a drug information data base and emergency treatment of poisoning.
9. TPN and Energy calculation, Nutrition value **(5 hrs)**

Books and other recourses recommended Latest edition

1. Birla Publications, Pratibha Nand and RK Khar- A textbook of Hospital and Clinical Pharmacy 1st ed. 2001.
2. Vallabh Publications, PC Dandiya and Mukul Mahur- A textbook of Hospital and Clinical Pharmacy 4th ed. 2005.
3. Churchill Livingstone, Edalker and Edwards- Clinical Pharmacy and Therapeutics 2nd ed. 1999
4. American Pharmaceutical Association, John Rovers and Jay Currie- A Practical Guide to Pharmaceutical Care 3rd ed. 2007.
5. Green and Harris - Pathology and Therapeutics for Pharmacists , Chapman and Hall ISBN 0-412-36000-4
6. Winfield and Richanrds-Pharmaceutical Practice, Churchill Livingstone 1998.
7. Clive Edwards and Paul Stillman - Minor Illness or Major Disease? Responding to symptoms in the Pharmacy, Pharma Press 1995.
8. Current Medical Diagnosis & Treatment Lawrence M. Tierney, Jr.Stephen J. McPhee,Maxine A. Papadakis

PHAR 425 Project Work: [288 Hours]

Final semester project work shall be assigned by the head of the department on the interest of students and on the basis of the facility availability to conduct research work inside the institute or outside. The study areas shall focus on core subjects of pharmacy like industrial pharmacy, hospital and community pharmacy, clinical pharmacy, pharmacology, pharmacognosy/natural product chemistry, analysis, microbiology, pharmaceutical marketing etc. The project work must be approved by the Head of the Department or Head of the Institution. Students will conduct the project work in a group of maximum three numbers. To perform research work on the given topic, supervisor will be appointed from the department. The project work shall be completed before to appear final end semester examination. External and the internal examiners shall do the assessment of the project work. Project work shall comprise of

- Objectives of the work
- Methodology
- Results
- Discussions
- Conclusions
- Recommendation and Limitations

PHAR 426 Professional Internship [304 Hours]

Internship is a phase of training where in a student is expected to have exposure on actual practice of pharmacy and health care and acquires skills under the supervision so that he or she may become capable of functioning independently.

Every student has to undergo minimum six weeks and 2 days internship in pharmaceutical industry and/or Hospital, and/or community pharmacy and regulatory bodies as per following table.

Placement	Duration	Total Duration	Total Hour (Per day 8 hrs)
Pharmaceutical Industry/ QA,QC Laboratory/ Hospital in different department exposures	4 weeks	6 weeks (6 wksX6 days= 36 days)	304 hours
Community Pharmacy	2 weeks		
Regulatory Bodies (DDA, NPC, NML)	2 days	2 days	

Industrial Internship:

Every student is sent to a Pharmaceutical Manufacturing Unit or National Medicine Laboratory or independent quality control laboratory having DDA permission and/or ISO-17025 for the period of 3 weeks to 4 weeks according to the place available. Pharmacy department requests a senior pharmacist to be a mentor of the internee. The mentor from the internship doing site will secretly evaluate the students for their interest, ability and learning attitude in a form provided by the department. Students visit every sections of the organization to fulfill the following objectives;

i) Observe and learn the quality assurance, manufacturing and quality control activities carried in the different sections of the organization,
ii) To acquire the practical skills where ever possible,
iii) Strictly maintain a daily diary duly signed by the mentor. All students have to submit the daily diary with the final report to the department.
iv) The faculty member should monitor at least twice within in the internship period for evaluation of daily activites and performance of the internee.
v) At the end of the internship, student submits a separate report signed by the mentor with daily diary.

Hospital/ Community Pharmacy Internship:

Students are allowed to do their internship in those hospitals where there at least one or more graduate pharmacists are working a hospital pharmacist. Students visit every sections of the hospital to fulfill the following objectives;

i) Learn and acquired skill to Provide pharmaceutical care to patients /Community.
ii) Learn and acquired skill for developing and managing medication distribution and control systems
iii) Acquired a skill for Managing the pharmacy outlet.
iv) Learn the system for Providing drug information and education.
v) Learn the system for reporting ADRs.
vi) Strictly maintain a daily diary duly signed by the mentor. All students have to submit the daily diary with the final report to the department.
vii) At the end of the internship, student submits a separate report signed by the mentor with daily diary.
viii) The faculty member should monitor at least twice within in the internship period for evaluation of daily activites and performance of the internee.

Annex: I

Question Papers Setting Pattern in Final Semester University Examination:

The final examination will be carried 80 marks for three hours examination written paper test. The examination questions patterns will be divided into the three parts.

Group A

MCQS, FM 20 marks for 20 questions and time period 20 mins.

MCQS= 20 X 1 =20)

Sample for MCQS: (there should be 4 options each quesion)

Question: 1. which of the following drug is agonist to Beta-2 receptor.....

a. Salbutmol b. Bromohexine c. Codeine d. Cetrizine

Group B

Problem Based Question: 1 (PBQ) FM; 15. At least three sub-questions should be asked and maximum up to five questions may be asked.

Mark Distributions=15marks= Divided into (5X3=15 or 3X5= 15)

a+b+c=15

Group C

LAQ (Long Answer Questions): Attempt any two questions out of three and FM: 20 and each question carry 10 marks.

20 marks= (2X10=20)

Q.1.....

Q.2.....

Q.3.....

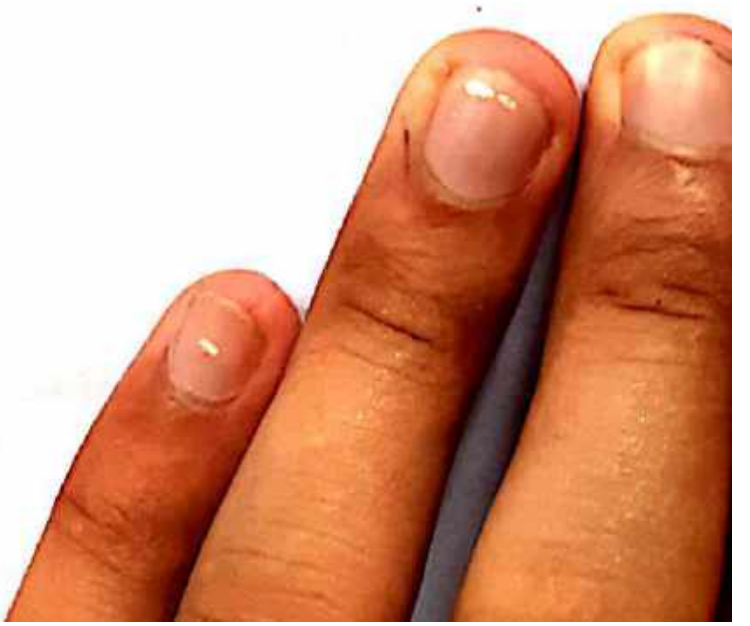
Group D

SAQ (Short Answer Questions): Attempt any five questions out of six and FM; 25 each question carry 5 marks.

Mark 25= (5X5= 25)

Q. 1
Q. 2
Q. 3
Q. 4
Q. 5
Q.6

Question papers are set according to the hour load given to the unit/s in the curriculum.



Annex: II

Guidelines Preparing Research Proposal

1. **Project Title**
   - Should be brief but specific
   - Not more than 15 words
2. **Proposal Introduction**
   - Should specify the problem being investigated and establish why it is important
   - Some references to the literature can be made
3. **Statement of Problem**
   - Should be stated clearly, concisely and definitively
   - Should express a relation between two or more variables
   - Should be expressed in an orderly system of relationships
   - Must indicate what was done in the study (i.e. what was tested, determined, affected, compared, analyzed, evaluated, etc.)
4. **Literature Review**
   - Should organize the note according to which aspect of the problem researcher address
   - Should write a discussion in your own words using all the relevant information
5. **Rationale /Justification**
   - Should have to elaborate the purpose statement, and present examples how the problem has manifested itself in society
   - Use the literature to help show why the study is needed, to explain why it is significant, or to justify its content

6. **Research Question**
    - Don't try to develop too many research questions 1 or 2 should be enough.
7. **Research Hypothesis**
    - Should state a relationship between at least two variables
    - Should not be too vague or general
    - Should be specific and simple
    - Should be properly expressed
    - Should be stated in the present tense
    - Should express its capability of being refuted; the prediction can be evaluated in terms of "yes, it occurred" or "no, it did not occur"
    - Should be in easily tested for
8. **Research Objectives**
    - Should be closely related to the statement of the problem and should cover the different aspects of the problems and its contributing factors in a coherent way and in a logical sequence
    - Should be short, precise and comprehensive
    - Should be target oriented with outcomes
    - Should be realistic and measurable for evaluation
    - Should be clearly phrased in operational terms, specifying exactly
        (i) what you plan to do,
        (ii) to whom it will be done,
        (iii) when it will be done, and
        (iv) for what purpose
    - Should have action verbs that are specific enough to be evaluated (e.g. to determine, to identify', to verify, to calculate, to describe, and to establish)

8.1 General Objectives

- Should be stated in one or two paragraphs outlining the broad prospective of the study in general terms

8.2 Specific Objectives

- Should be stated in number of ways preferably in sequential order or logically connected parts
- Should reflect towards the general objectives

9. Research Methodology

9.1 Site selection: Where? Include its justification

9.2 Methods: Quantitative method or Qualitative method or both

9.3 Study types:

9.3.1 Non-intervention (non-experiment) Studies

- Exploratory
- Descriptive (case / cross-sectional)
- Comparative or Analytical (cross-sectional / case-control / case control / cohort)

9.3.2 Intervention (Experiment) Studies

- Pre-experimental (one group pretest / posttest design)
- True experimental (pretest / posttest control and experimental group design)
- Quasi-experimental (pretest / posttest control and experimental group design without randomization or non-equivalent control design)

9.4 Variables: Dependant variables

- Independent variables
- Confounding variables (extraneous variables)
- Background variables (attribute variables /organismic variables) - Intervening variables (modifying variables)

9.5 Criteria: Inclusion criteria
Exclusion criteria

9.6 Sampling: Target Population

Sampling Units: Geographical (e.g. district, cities, wards etc.), Structural (e.g. a house, a flat etc.), Social Group (e.g. a family, a school etc.), and Individuals Sampling frame /

list: Should be up to date / should contain full information about the units, and should be reliable

9.7 Sample size:

- Should fulfill the requirements of efficiency, representativeness, reliability and flexibility
- Should be small enough to avoid unnecessary cost and large enough to avoid intolerable sample errors
- Write formula for sample size calculation

9.7 .1 Non Probability (Non Random) Sampling:

- Convenience (Haphazard) sampling
- Quota sampling
- Purposive (Judgmental) sampling
- Snowball sampling

9.7.2 Probability (Random) Sampling:

- Simple random sampling (with replacement / without replacement)
- Systematic sampling
- Stratified sampling
- Cluster sampling
- Multistage sampling

10. Design: draw conceptual framework

11. Plan for data collection techniques:

- Using available information
- Observing
- Interviewing (face to face)
- Administering written questionnaires
- Focus group discussion

12. Plan for data collection process:

Permission to proceed: Write about ethical consideration (informed / verbal consent)

Data collection: Write logistic of data collection - Who will collect what data? How long will it take to collect the data for each component of the study? In what sequence should data be collected? Write about ensuring quality and data handling.

13. Plan for data processing and analysis:

Write about sorting data, performing quality - control checks, categorizing, coding / decoding etc

Computer compilation

Statistical test

14. Pre-testing the Methodology

Clearly explain what aspects of your research methodology can be evaluated during pre-testing?

When do you want to carry out a pretest?

Which components should be assessed during the pretest?

Who should be involved in the pretest?

How long should the pretest last?

15. Work Plan

Duration of study

Tentative date of starting the project

Working schedule / Gantt chart

Plan for project administration, and monitoring including description of project staffs

16. Expected outcomes of the study and utilization of the research findings

17. Dissemination Plan

18. Budget

Include explanatory note on major budget items

19. Annexes

- References
- List of abbreviations (if necessary)
- Data collection instruments (including questionnaires)
- Informed consent format (if necessary)

Guideline of formatting Report

1. Font size
   a. Cover Title: 14-18
   b. Chapter title: 16
   c. Title: 14
   d. Sub-title- 12 Bold
   e. Text: 12
   f. Font: Times New Roman
2. Lines spacing-1.5
3. Bibliography/References- Vancouver
4. Page layout- Margins: 1.25" on left- and 1"- on right, top and bottom
5. The page numbers of preliminary pages should be in small roman numbers.
6. Start numeric page numbers from introduction
7. Logo of college or university size: 2.5"X2.5"(inch) and kept outer and inner first page, just below the title of research project.

Annex: III

General Guidelines for the Preparation of Project work Report for Bachelor in Pharmacy

Contents **Page**

1. Sequence of Items Required in the Thesis

A. Title Page

B. Approval/Signatures of Supervisor(s)

C. Declaration of authenticity

D. Certificate

E. Acknowledgement

F. Abstract

G. Abbreviations

H. Table of contents

I. List of Figures

J. List of Tables

K. Chapter I: Introduction

L. Chapter II: Literature Review

M. Chapter III: Materials and Methods/ Methodology

M. Chapter IV: Results and Discussion

N. Chapter V: Conclusion and Recommendation

O. Limitation

P. References

Q. Appendices or Annexes

2. Guidelines for the layout and format of the Thesis

1. The Preliminary pages before the beginning of Chapter except the title page must be numbered in Roman and in lower case.Eg: **i., ii., iii.,v., vi,** etc.
2. The Margins must be maintained in all the pages as follows:

   Left margin = **3 cm (1.18 inch)= 1.5"**

   Top margin = **2.5 cm (0.98 inch)=1.25"**

   Right and bottom margins = **2 cm (0.79 inch)=1"**
3. The position of the page number must be at the **bottom and centre** of the page.
4. For labeling of Chapters and Sections follow the systematic order:

   1. Chapter 1

      1.1 Section 1

         1.1.1 Sub-section 1

         1.1.2 Sub-section 2, etc.

      1.2 Section 2

      1.3 Section 3 etc.
5. Use **double line spacing**for all the text in the main body of the thesis.
6. Use the font **Times New Roman, 12 points** size for the main text.
7. Label Appendices or Annexes as: I, II, III, IV, etc.; and give name (title) to each.
8. Label figure captions at bottom of the figure indicating the Chapter number such as, Figure 1.1 for the first figure of chapter-1, Figure 1.2

for the second figure of Chapter-1, Figure 2.1 for the first figure of Chapter 2 and so on.

9. Label table headings at the top of the table and indicating the Chapter number, similar to the figures, e.g. Table 1.1, Table 1.2, table 2.2, etc.
10. Cite references in the text of the thesis according to the Vancouver style.

3. Sample Title Page

Title of the Project Work

Logo (2.5"X2.5") size

Submitted to Purbanchal University for the partial fulfillment ofthe degree of Bachelor of Pharmacy

SUBMITTED BY

Students Name and Registration Number

SUBMITTED TO

.....

.....

.....

Year of Completion

The page number should not appear on the Title

4. Sample Thesis Approval Page

PROJECT WORK APPROVAL

The Project work entitled**"Title of dissertation"**submitted by **Students Name(s)** in a partial fulfillment of the requirement for the Degree of Bachelor of Pharmacy, is approved.

.....

Name of Supervisor
Project Supervisor
Department of Pharmacy
College Name

Date.....

.....

Name of Principal/ HOD
Principal and HOD of Pharmacy
Department of Pharmacy
College Name

Date.....

.....

Name of External

External Examiner

Date.....

5. Sample Certification Page

CERTIFICATION

This is to certify that the project work entitled **"Title "** is a bonafied research work done by **Name of student(s)** in partial fulfillment of the requirement for the Degree of Bachelor of Pharmacy, which was carried out under my guidance and supervision during all stages of planning, execution and analysis.

The result of this work has not been previously submitted to any institution to acquire any other academic degree.

.....

Name of Supervisor(s)

Project Supervisor,

Department of Pharmacy

College Name

Date.....

6. Sample Declaration of Authenticity Page

DECLARATION OF AUTHENTICITY

It is hereby to declare that the project work **"Title"** is a bonafied and genuine research work carried out by **Name of Student(s)** which has been entirely carried out under the guidance and supervision of **Name of Supervisor, Current Post,** Department of Pharmacy,.....*College Name and address*

.....

The work contained in this project work is original and has not been previously submitted for degree at any other tertiary institution for the award of any other degree or diploma. To the best of our knowledge and beliefs, this dissertation contains no material previously or written by another person except where due reference is made.

.....
Student Name
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Student Name
PU Reg. No:

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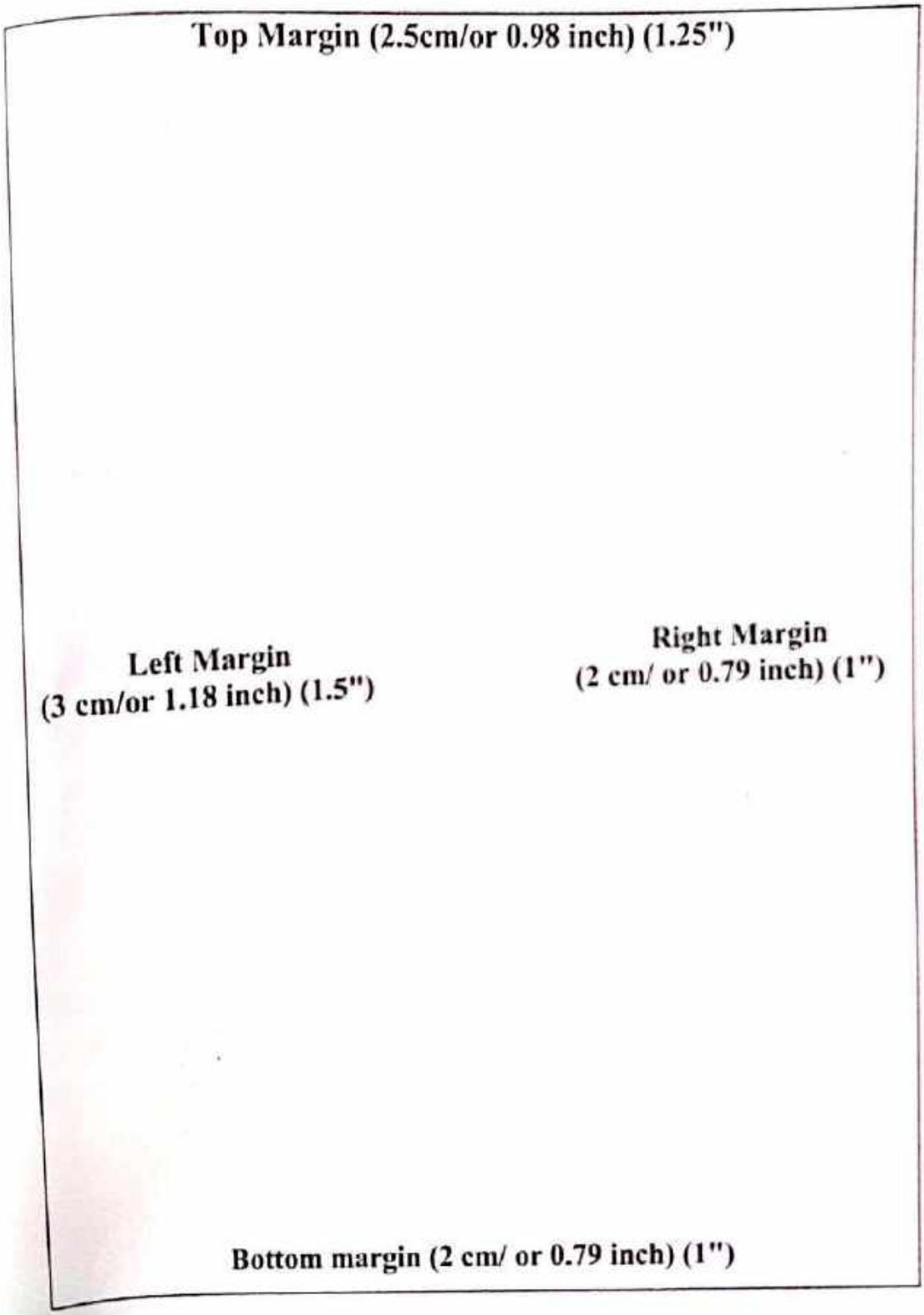
PU Reg. No:

7. Margin Requirements for the Pages of Thesis



8. Sample Figure Layout and Captions

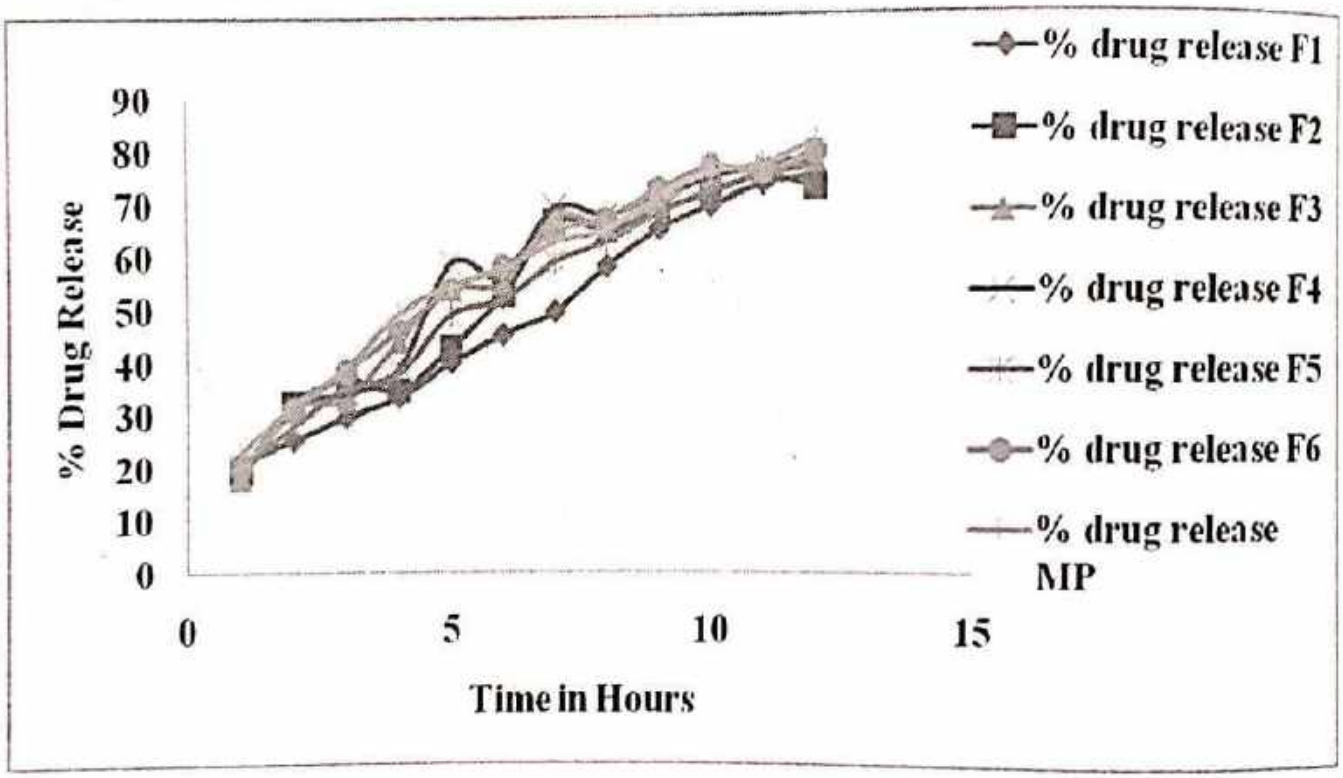


Fig No. 6.3: Comparative in-vitro drug release data for Metformin hydrochloride Floating tablets formulation (F1-F6) and marketed product

9. Sample Figure Layout and Captions

Table No. 5.2: Relationship Between Percentage(%)Compressibility and Powder Flow

% Compressibility range	Flow
5 to 15	Excellent (Free flowing granules)
12 to 16	Good (free flowing powdered granules)
18 to 21	Fair (Powdered granules)
23 to 28	Poor (very fluid powders)
28 to 35	Poor (fluid cohesive powders)
35 to 38	Very Poor (Fluid cohesive powders)
>40	Extremely poor (cohesive powders)

10. Sample Table of Contents

TABLE OF CONTENT

11. Sample List of Tables

LIST OF TABLES

12. Sample List of Figures

LIST OF FIGURES

13. Sample of Reference Listings

REFERENCES

Please cite the reference according to ***Vancouver style*** *in project work or research work.*

Annex: IV

Sample of Log book maintain monitoring sheet: Professional Intensive/ Research Project Work

Year: ..... yr. Semester: .....

Course Code :..... Course: B Pharm. (.....)

Name of student and College:.....

Name of Working Organization and address:.....

Name of Supervisor and Qualification:.....

S No.	Title	Date	Sig. of Supervisor
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Remarks:

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..... Seal of Organization: