ANNA UNIVERSITY, CHENNAI
AFFILIATED INSTITUTIONS
REGULATIONS 2017
B. TECH. PHARMACEUTICAL TECHNOLOGY
CHOICE BASED CREDIT SYSTEM

1. Program Educational Objectives (PEOs)

1. To prepare students for prosperous spectrum of career avenues in academia, advanced research, industries of pharmaceutical technology, biomedicine, biotechnology, law, business and government and other pharmaceutical pursuits through dissemination of knowledge and proficiency in engineering and technology fundamentals related to pharmaceutical technology and the ability to solve problems.
2. To transfuse in students the sense of confidence in professional endeavours application of the derived knowledge and appreciation of economic impact in a societal context.
3. To provide collegial and nurturing environment for the students to realize the professional, ethical obligations and their concern to protect the health and welfare of the public and to be accountable for the social and environmental impact of their practice.
4. To create an enjoyable educational environment in which students participate in multidisciplinary, team oriented, open-ended curricular and co-curricular activities that prepare them to work either individually and as an integrated team member.
5. To facilitate the students to gain the wisdom of fundamentals and advances to practice Pharmaceutical technology and interdisciplinary research as career of constructive service to society and higher learning.

2. Program Outcomes (POs)

After completion of graduation in Pharmaceutical Technology, the students will be able to demonstrate the ability to:

a. apply knowledge of mathematics, science and technology in the discipline
b. identify, formulate, research literature, and analyse complex engineering problems for its solution
c. design and develop system processes that meet the specified needs with appropriate consideration for public health, safety, cultural, societal, and environmental.
d. design the experiments, its analysis and interpretation of data, synthesis of the information using research-based knowledge for complex problems.
e. use modern engineering tools, software and equipment to meet the needs in the area of Pharmaceutical Technology
f. apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues relevant to the professional engineering practices.
g. apply knowledge of the impact of pharmaceutical technology solutions in a societal and global context
h. demonstrate ethical principles and commitment to responsibilities and norms of the Pharmaceutical technology practices
i. work effectively as an individual and as well as member in teams of diversified professionals
j. communicate effectively
k. understand the philosophies of project management principles in Pharmaceutical technology
l. showcase urge for self-education and life-long learning

3. Establish the correlation between the POs and the PEOs

PEOs	Programme Outcomes											
	a	b	c	d	e	f	g	h	i	j	k	l
1	✔	✔		✔	✔				✔		✔	✔
2	✔	✔	✔		✔	✔	✔	✔				✔
3					✔	✔	✔	✔			✔	✔
4				✔		✔		✔	✔	✔	✔	
5	✔	✔		✔	✔	✔					✔	✔

4. Mapping for B. Tech. Pharmaceutical Technology – R2017

	Subjects	a	b	c	d	e	f	g	h	i	j	k	l
	Semester – I												
	Communicative English									✔	✔		✔
	Engineering Mathematics I	✔	✔	✔	✔	✔	✔	✔		✔	✔	✔	✔
	Engineering Physics	✔		✔			✔			✔			
	Engineering Chemistry	✔		✔			✔			✔			
	Problem Solving and Python Programming	✔			✔	✔				✔			
	Engineering Graphics	✔		✔		✔							
	Problem Solving and Python Programming Laboratory	✔		✔	✔	✔		✔					
	Physics and Chemistry Laboratory	✔		✔		✔							
	Semester II												
	Technical English									✔	✔		✔
	Engineering Mathematics II	✔	✔	✔	✔	✔	✔			✔	✔	✔	
	Physics of Materials	✔	✔	✔	✔	✔	✔						
	Human Physiology	✔						✔			✔		✔
	Basic Civil and Mechanical Engineering	✔	✔	✔	✔		✔						
	Biochemistry	✔			✔	✔	✔	✔		✔			✔
	Engineering Practices Laboratory	✔		✔		✔							
	Biochemistry Laboratory			✔	✔							✔	
	Semester – III												
	Transform Techniques and Partial Differential Equations	✔	✔		✔								
	Chemical Engineering Thermodynamics	✔	✔	✔	✔	✔							
	Microbiology	✔	✔					✔					✔
	Pharmaceutical Chemistry	✔	✔	✔	✔	✔	✔	✔		✔	✔		
	Physical Pharmaceutics	✔					✔	✔	✔				✔
	Environmental science and Engineering		✔							✔	✔		✔

	Physical Pharmaceutics Laboratory	✔			✔	✔				✔	✔		
	Microbiology Laboratory	✔		✔					✔	✔			
	Interpersonal Skills/ Listening and Speaking									✔	✔		✔
	Semester – IV												
	Probability and Statistics	✔	✔	✔	✔	✔	✔	✔	✔		✔	✔	
	Stoichiometry and Chemical Process Calculations	✔	✔		✔					✔			
	Fluid Flow Operations	✔	✔			✔	✔			✔			
	Unit Operations in Pharma Industries	✔	✔	✔	✔			✔					✔
	Molecular Biology and Genetic Engineering	✔		✔	✔	✔	✔	✔	✔	✔			
	Pharmaceutical Analysis	✔	✔	✔	✔	✔	✔	✔					
	Analytical Methods and Instrumentation Laboratory	✔	✔	✔	✔	✔	✔	✔					
	Molecular Biology and Genetic Engineering Laboratory	✔		✔	✔	✔	✔	✔	✔	✔			
	Advanced Reading and Writing									✔	✔		✔
	Semester – V												
	Applied Chemical Reaction Engineering	✔	✔	✔				✔					
	Medicinal Chemistry	✔	✔	✔				✔	✔				
	Pharmacology and Chemotherapy	✔		✔		✔	✔						✔
	Fundamentals of Heat and Mass Transfer	✔	✔	✔		✔	✔	✔					
	Professional Communication												
	Physiology and Pharmacology Laboratory	✔		✔					✔	✔			
	Medicinal Chemistry Laboratory			✔	✔	✔	✔						
	Semester – VI												
	Total Quality Management					✔			✔	✔	✔	✔	✔
	Bioprocess Engineering		✔	✔				✔					
	Technology of Solid Dosage forms	✔	✔		✔	✔					✔	✔	✔
	Bioprocess Engineering Laboratory			✔					✔			✔	
	Technology of Dosage Forms Laboratory	✔		✔				✔		✔			
	Semester – VII												
	Biopharmaceutics and Pharmacokinetics	✔		✔	✔	✔		✔					
	Regulatory requirements in Pharmaceutical Industries	✔					✔	✔	✔				✔
	Chemistry of Natural Products	✔	✔		✔	✔	✔	✔					
	Biopharmaceutics and Pharmacokinetics Laboratory	✔			✔	✔				✔			
	Chemistry of Natural Products Laboratory	✔	✔		✔	✔	✔	✔					
	Semester VIII												
	Project Work	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔

ANNA UNIVERSITY, CHENNAI
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REGULATIONS 2017
B. TECH. PHARMACEUTICAL TECHNOLOGY
CHOICE BASED CREDIT SYSTEM
I TO VIII SEMESTERS (FULL TIME) CURRICULA AND SYLLABI

SEMESTER I

S. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	HS8151	Communicative English	HS	4	4	0	0	4
2	MA8151	Engineering Mathematics – I	BS	4	4	0	0	4
3	PH8151	Engineering Physics	BS	3	3	0	0	3
4	CY8151	Engineering Chemistry	BS	3	3	0	0	3
5	GE8151	Problem Solving and Python Programming	ES	3	3	0	0	3
6	GE8152	Engineering Graphics	ES	6	2	0	4	4
PRACTICALS								
7	GE8161	Problem Solving and Python Programming Laboratory	ES	4	0	0	4	2
8	BS8161	Physics and Chemistry Laboratory	BS	4	0	0	4	2
			TOTAL	**31**	**19**	**0**	**12**	**25**

SEMESTER II

S. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	HS8251	Technical English	HS	4	4	0	0	4
2	MA8251	Engineering Mathematics – II	BS	4	4	0	0	4
3	PH8254	Physics of Materials	BS	3	3	0	0	3
4	PY8201	Human Physiology	PC	3	3	0	0	3
5	BE8252	Basic Civil and Mechanical Engineering	ES	4	4	0	0	4
6	PY8202	Biochemistry	PC	3	3	0	0	3
PRACTICALS								
7	GE8261	Engineering Practices Laboratory	ES	4	0	0	4	2
8	PY8211	Biochemistry Laboratory	PC	4	0	0	4	2
			TOTAL	**29**	**21**	**0**	**8**	**25**

SEMESTER III

S. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	MA8353	Transforms and Partial Differential Equations	BS	4	4	0	0	4
2	PE8491	Chemical Engineering Thermodynamics	PC	3	3	0	0	3
3	BT8291	Microbiology	PC	3	3	0	0	3
4	PY8301	Pharmaceutical Chemistry	PC	3	3	0	0	3
5	PY8302	Physical Pharmaceutics	PC	3	3	0	0	3
6	GE8291	Environmental Science and Engineering	HS	3	3	0	0	3
PRACTICALS								
7	PY8311	Physical Pharmaceutics Laboratory	PC	4	0	0	4	2
8	BT8361	Microbiology Laboratory	PC	4	0	0	4	2
9	HS8381	Interpersonal Skills/Listening and Speaking	EEC	2	0	0	2	1
			TOTAL	**29**	**19**	**0**	**10**	**24**

SEMESTER IV

S. No.	COURSE CODE	CO URSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	MA8391	Probability and Statistics	BS	4	4	0	0	4
2	PY8401	Stoichiometry and Chemical Process Calculations	PC	3	3	0	0	3
3	PY8402	Fluid Flow Operations	PC	3	3	0	0	3
4	PY8403	Unit Operations in Pharma Industries	PC	5	3	2	0	4
5	PY8404	Molecular Biology and Genetic Engineering	PC	4	4	0	0	4
6	PY8405	Pharmaceutical Analysis	PC	3	3	0	0	3
PRACTICALS								
7	PY8411	Analytical Methods and Instrumentation Laboratory	PC	4	0	0	4	2
8	PY8412	Molecular Biology and Genetic Engineering Laboratory	PC	4	0	0	4	2
9	HS8461	Advanced Reading and Writing	EEC	2	0	0	2	1
			TOTAL	**32**	**20**	**2**	**10**	**26**

SEMESTER V

S. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	BT8691	Applied Chemical Reaction Engineering	ES	3	3	0	0	3
2.	PY8501	Medicinal Chemistry	PC	4	4	0	0	4
3.	PY8502	Pharmacology and Chemotherapy	PC	4	4	0	0	4
4.	FD8491	Fundamentals of Heat and Mass Transfer	PC	5	3	2	0	4
5.		Professional Elective I	PE	3	3	0	0	3
6.		Open Elective I*	OE	3	3	0	0	3
PRACTICALS								
7.	PY8511	Physiology and Pharmacology Laboratory	PC	4	0	0	4	2
8.	PY8512	Medicinal Chemistry Laboratory	PC	4	0	0	4	2
9.	HS8581	Professional Communication	EEC	2	0	0	2	1
			TOTAL	**32**	**20**	**2**	**10**	**26**

* - Course from the curriculum of the other UG Programmes

SEMESTER VI

S. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	GE8077	Total Quality Management	HS	3	3	0	0	3
2	BT8591	Bioprocess Engineering	PC	3	3	0	0	3
3	PY8601	Technology of Solid Dosage forms	PC	4	4	0	0	4
4		Professional Elective II	PE	3	3	0	0	3
5		Professional Elective III	PE	3	3	0	0	3
6		Professional Elective IV	PE	3	3	0	0	3
PRACTICALS								
7	PY8611	Bioprocess Engineering Laboratory	PC	4	0	0	4	2
8	PY8612	Technology of Dosage Forms Laboratory	PC	4	0	0	4	2
			TOTAL	**27**	**19**	**0**	**8**	**23**

SEMESTER VII

S. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	PY8701	Biopharmaceutics and Pharmacokinetics	PC	3	3	0	0	3
2	PY8702	Regulatory Requirements in Pharmaceutical Industries	PC	3	3	0	0	3
3	PY8703	Chemistry of Natural Products	PC	3	3	0	0	3
4		Professional Elective V	PE	3	3	0	0	3
5		Professional Elective VI	PE	3	3	0	0	3
6		Open Elective II*	OE	3	3	0	0	3
PRACTICALS								
7	PY8711	Biopharmaceutics and Pharmacokinetics Laboratory	PC	4	0	0	4	2
8	PY8712	Chemistry of Natural Products Laboratory	PC	4	0	0	4	2
			TOTAL	**26**	**18**	**0**	**8**	**22**

* - Course from the curriculum of the other UG Programmes

SEMESTER VIII

S. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
PRACTICALS								
1	PY8811	Project Work	EEC	20	0	0	20	10
			TOTAL	**20**	**0**	**0**	**20**	**10**

TOTAL CREDITS: 181

PROFESSIONAL ELECTIVES (PE)

PROFESSIONAL ELECTIVE I, SEMESTER V

S. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1.	PY8001	Basic Laboratory Animal Science	PE	3	3	0	0	3
2.	PY8002	Fundamentals of Material Science and Engineering	PE	3	3	0	0	3
3.	GE8071	Disaster Management	PE	3	3	0	0	3

PROFESSIONAL ELECTIVE II, SEMESTER VI

S. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1.	PY8003	Technology of Semisolid Dosage Forms	PE	3	3	0	0	3
2.	BT8071	Biological Spectroscopy	PE	3	3	0	0	3
3.	PY8004	Fundamentals of Polymer Science and Engineering	PE	3	3	0	0	3

4.	PY8005	Validation in Pharmaceutical Industries	PE	3	3	0	0	3
5.	CH8791	Transport Phenomena	PE	3	3	0	0	3
6.	GE8073	Fundamentals of Nanoscience	PE	3	3	0	0	3

PROFESSIONAL ELECTIVE III, SEMESTER VI

S. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1.	PY8006	Herbal Technology	PE	3	3	0	0	3
2.	PY8007	Regulatory Toxicology	PE	3	3	0	0	3
3.	BT8791	Immunology	PE	3	3	0	0	3
4.	BT8091	Instrumentation and Process Control	PE	3	3	0	0	3
5.	GE8076	Professional Ethics in Engineering	PE	3	3	0	0	3
6.	BT8651	Bioinformatics	PE	5	3	2	0	4

PROFESSIONAL ELECTIVE IV, SEMESTER VI

S. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1.	PY8008	Vaccine Technology	PE	3	3	0	0	3
2.	PY8009	Technology of Fine Chemicals and Bulk Drugs	PE	3	3	0	0	3
3.	PY8010	Advanced Medicinal Chemistry	PE	3	3	0	0	3
4.	PY8011	Nutraceuticals	PE	3	3	0	0	3
5.	PY8012	Pharmacogenomics	PE	3	3	0	0	3

PROFESSIONAL ELECTIVE V, SEMESTER VII

S. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1.	PY8013	Technology of Sterile Products	PE	3	3	0	0	3
2.	PY8014	Introduction to Biomaterials and Tissue Engineering	PE	3	3	0	0	3
3.	PY8015	IPR for Pharma Industry	PE	3	3	0	0	3
4.	PY8016	Computer Aided Drug Design	PE	3	3	0	0	3
5.	PY8071	Clinical Trials	PE	3	3	0	0	3
6.	PY8017	Pharmacovigilance	PE	3	3	0	0	3
7.	GE8074	Human Rights	PE	3	3	0	0	3

PROFESSIONAL ELECTIVE VI, SEMESTER VII

S. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1.	PY8018	Pharmaceutical Nanotechnology	PE	3	3	0	0	3
2.	PY8019	Protein Structure, Function and Proteomics	PE	3	3	0	0	3
3.	PY8020	Pharmaceutical Packaging Technology	PE	3	3	0	0	3
4.	PY8021	Experimental Design and Analysis	PE	3	3	0	0	3
5.	PY8022	Safety and Health Evaluation	PE	3	3	0	0	3

SUBJECT AREAWISE DETAILS

HUMANITIES AND SOCIAL SCIENCES (HS)

S. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1.	HS8151	Communicative English	HS	4	4	0	0	4
2.	HS8251	Technical English	HS	4	4	0	0	4
3.	GE8291	Environmental Science and Engineering	HS	3	3	0	0	3
4.	GE8077	Total Quality Management	HS	3	3	0	0	3

BASIC SCIENCES (BS)

S. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1.	MA8151	Engineering Mathematics I	BS	4	4	0	0	4
2.	PH8151	Engineering Physics	BS	3	3	0	0	3
3.	CY8151	Engineering Chemistry	BS	3	3	0	0	3
4.	BS8161	Physics and Chemistry Laboratory	BS	4	0	0	4	2
5.	MA8251	Engineering Mathematics II	BS	4	4	0	0	4
6.	PH8254	Physics of Materials	BS	3	3	0	0	3
7.	MA8353	Transform and Partial Differential Equations	BS	4	4	0	0	4
8.	MA8391	Probability and Statistics	BS	4	4	0	0	4

ENGINEERING SCIENCES (ES)

S. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1.	GE8151	Problem Solving and Python Programming	ES	3	3	0	0	3
2.	GE8152	Engineering Graphics	ES	4	2	0	4	4
3.	GE8161	Problem Solving and Python Programming Laboratory	ES	4	0	0	4	2
4.	BE8252	Basic Civil and Mechanical Engineering	ES	4	4	0	0	4
5.	GE8261	Engineering Practices Laboratory	ES	4	0	0	4	2
6.	BT8691	Applied Chemical Reaction Engineering	ES	3	3	0	0	3

PROFESSIONAL CORE (PC)

S. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1.	PY8201	Human Physiology	PC	3	3	0	0	3
2.	PY8202	Biochemistry	PC	3	3	0	0	3
3.	PY8211	Biochemistry Laboratory	PC	4	0	0	4	2
4.	PE8491	Chemical Engineering	PC	3	3	0	0	3

		Thermodynamics						
5.	BT8291	Microbiology	PC	3	3	0	0	3
6.	PY8301	Pharmaceutical Chemistry	PC	3	3	0	0	3
7.	PY8302	Physical Pharmaceutics	PC	3	3	0	0	3
8.	PY8311	Physical Pharmaceutics Laboratory	PC	4	0	0	4	2
9.	BT8361	Microbiology Laboratory	PC	4	0	0	4	2
10.	PY8401	Stoichiometry and Chemical Process Calculations	PC	3	3	0	0	3
11.	PY8402	Fluid Flow Operations	PC	3	3	0	0	3
12.	PY8403	Unit Operations in Pharma Industries	PC	4	4	0	0	4
13.	PY8404	Molecular Biology and Genetic Engineering	PC	4	4	0	0	4
14.	PY8405	Pharmaceutical Analysis	PC	3	3	0	0	3
15.	PY8411	Analytical Methods and Instrumentation Laboratory	PC	4	0	0	4	2
16.	PY8412	Molecular Biology and Genetic Engineering Laboratory	PC	4	0	0	4	2
17.	PY8501	Medicinal Chemistry	PC	4	4	0	0	4
18.	PY8502	Pharmacology and Chemotherapy	PC	4	4	0	0	4
19.	FD8491	Fundamentals of Heat and Mass Transfer	PC	5	3	2	0	4
20.	PY8511	Physiology and Pharmacology Laboratory	PC	4	0	0	4	2
21.	PY8512	Medicinal Chemistry Lab	PC	4	0	0	4	2
22.	BT8591	Bioprocess Engineering	PC	3	3	0	0	3
23.	PY8601	Technology of Solid Dosage forms	PC	4	4	0	0	4
24.	PY8611	Bioprocess Engineering Lab	PC	4	0	0	4	2
25.	PY8612	Technology of Dosage Forms Laboratory	PC	4	0	0	4	2
26.	PY8701	Biopharmaceutics and Pharmacokinetics	PC	3	3	0	0	3
27.	PY8702	Regulatory Requirements in Pharmaceutical Industries	PC	3	3	0	0	3
28.	PY8703	Chemistry of Natural Products	PC	3	3	0	0	3
29.	PY8711	Biopharmaceutics and Pharmacokinetics Laboratory	PC	4	0	0	4	2
30.	PY8712	Chemistry of Natural Products Laboratory	PC	4	0	0	4	2

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1.	HS8381	Interpersonal Skills/Listening and Speaking	EEC	2	0	0	2	1
2.	HS8461	Advanced Reading and Writing	EEC	2	0	0	2	1
3.	HS8581	Professional Communication	EEC	2	0	0	2	1
4.	PY8811	Project Work	EEC	20	0	0	20	10

SUMMARY

S. No.	Subject Area	Credits Per Semester								Total Credits
		I	II	III	IV	V	VI	VII	VIII	
1	**HS**	4	4	3	-	-	3	-	-	14
2	**BS**	12	7	4	4	-	-	-	-	27
3	**ES**	9	6	-	-	3	-	-	-	18
4	**PC**	-	8	16	21	16	11	13	-	85
5	**PE**	-	-	-	-	3	9	6	-	18
6	**OE**	-	-	-	-	3	-	3	-	6
7	**EEC**	-	-	1	1	1	-	-	10	13
Total		**25**	**25**	**24**	**26**	**26**	**23**	**22**	**10**	**181**

HS8151 **COMMUNICATIVE ENGLISH** **L T P C**
4 0 0 4

OBJECTIVES:

- To develop the basic reading and writing skills of first year engineering and technology students.
- To help learners develop their listening skills, which will, enable them listen to lectures and comprehend them by asking questions; seeking clarifications.
- To help learners develop their speaking skills and speak fluently in real contexts.
- To help learners develop vocabulary of a general kind by developing their reading skills

UNIT I SHARING INFORMATION RELATED TO ONESELF/FAMILY& FRIENDS 12

Reading- short comprehension passages, practice in skimming-scanning and predicting- **Writing**- completing sentences - developing hints. **Listening**- short texts- short formal and informal conversations. **Speaking-** introducing oneself - exchanging personal information- **Language development**- Wh- Questions- asking and answering-yes or no questions- parts of speech. **Vocabulary development-**- prefixes- suffixes- articles.- count/ uncount nouns.

UNIT II GENERAL READING AND FREE WRITING 12

Reading - comprehension-pre-reading-post reading- comprehension questions (multiple choice questions and /or short questions/ open-ended questions)-inductive reading- short narratives and descriptions from newspapers including dialogues and conversations (also used as short Listening texts)- register- **Writing** – paragraph writing- topic sentence- main ideas- free writing, short narrative descriptions using some suggested vocabulary and structures –**Listening**- telephonic conversations. **Speaking –** sharing information of a personal kind—greeting – taking leave- **Language development** – prepositions, conjunctions **Vocabulary development-** guessing meanings of words in context.

UNIT III GRAMMAR AND LANGUAGE DEVELOPMENT 12

Reading- short texts and longer passages (close reading) **Writing-** understanding text structure- use of reference words and discourse markers-coherence-jumbled sentences **Listening** – listening to longer texts and filling up the table- product description- narratives from different sources. **Speaking**- asking about routine actions and expressing opinions. **Language development**- degrees of comparison- pronouns- direct vs indirect questions- **Vocabulary development –** single word substitutes- adverbs.

UNIT IV READING AND LANGUAGE DEVELOPMENT 12

Reading- comprehension-reading longer texts- reading different types of texts- magazines **Writing**- letter writing, informal or personal letters-e-mails-conventions of personal email- **Listening**- listening to dialogues or conversations and completing exercises based on them. **Speaking-** speaking about oneself- speaking about one's friend- **Language development-** Tenses- simple present-simple past- present continuous and past continuous- **Vocabulary development**- synonyms-antonyms- phrasal verbs

UNIT V EXTENDED WRITING 12

Reading- longer texts- close reading –**Writing**- brainstorming -writing short essays **–** developing an outline- identifying main and subordinate ideas- dialogue writing-**Listening** – listening to talks- conversations- **Speaking –** participating in conversations- short group conversations-**Language development**-modal verbs- present/ past perfect tense - **Vocabulary development**-collocations- fixed and semi-fixed expressions

TOTAL : 60 PERIODS

OUTCOMES:

At the end of the course, learners will be able to:

- Read articles of a general kind in magazines and newspapers.
- Participate effectively in informal conversations; introduce themselves and their friends and express opinions in English.
- Comprehend conversations and short talks delivered in English
- Write short essays of a general kind and personal letters and emails in English.

TEXT BOOKS:

1. Board of Editors. **Using English** A Coursebook for Undergarduate Engineers and Technologists**.** Orient BlackSwan Limited, Hyderabad: 2015**.**
2. Richards, C. Jack. **Interchange Students' Book-2** New Delhi: CUP, 2015.

REFERENCES

1. Bailey, Stephen. **Academic Writing: A practical guide for students**. New York: Rutledge,2011.
2. Comfort, Jeremy, et al. **Speaking Effectively : Developing Speaking Skillsfor BusinessEnglish.** Cambridge University Press, Cambridge: Reprint 2011.
3. Dutt P. Kiranmai and RajeevanGeeta. **Basic Communication Skills,** Foundation Books: 2013.
4. Means,L. Thomas and Elaine Langlois. **English & Communication For Colleges.** CengageLearning ,USA: 2007.
5. Redston, Chris &Gillies Cunningham **Face2Face** (Pre-intermediate Student's Book& Workbook) Cambridge University Press, New Delhi: 2005.

MA8151 ENGINEERING MATHEMATICS-I L T P C

4 0 0 4

OBJECTIVES :

- The goal of this course is to achieve conceptual understanding and to retain the best traditions of traditional calculus. The syllabus is designed to provide the basic tools of calculus mainly for the purpose of modelling the engineering problems mathematically and obtaining solutions. This is a foundation course which mainly deals with topics such as single variable and multivariable calculus and plays an important role in the understanding of science, engineering, economics and computer science, among other disciplines.

UNIT I DIFFERENTIAL CALCULUS 12

Representation of functions - Limit of a function - Continuity - Derivatives - Differentiation rules - Maxima and Minima of functions of one variable.

UNIT II FUNCTIONS OF SEVERAL VARIABLES 12

Partial differentiation – Homogeneous functions and Euler's theorem – Total derivative – Change of variables – Jacobians – Partial differentiation of implicit functions – Taylor's series for functions of two variables – Maxima and minima of functions of two variables – Lagrange's method of undetermined multipliers.

UNIT III INTEGRAL CALCULUS 12

Definite and Indefinite integrals - Substitution rule - Techniques of Integration - Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration of rational functions by partial fraction, Integration of irrational functions - Improper integrals.

UNIT IV MULTIPLE INTEGRALS 12

Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of solids – Change of variables in double and triple integrals.

UNIT V DIFFERENTIAL EQUATIONS 12

Higher order linear differential equations with constant coefficients - Method of variation of parameters – Homogenous equation of Euler's and Legendre's type – System of simultaneous linear differential equations with constant coefficients - Method of undetermined coefficients.

TOTAL : 60 PERIODS

OUTCOMES :

After completing this course, students should demonstrate competency in the following skills:

- Use both the limit definition and rules of differentiation to differentiate functions.
- Apply differentiation to solve maxima and minima problems.
- Evaluate integrals both by using Riemann sums and by using the Fundamental Theorem of Calculus.
- Apply integration to compute multiple integrals, area, volume, integrals in polar coordinates, in addition to change of order and change of variables.
- Evaluate integrals using techniques of integration, such as substitution, partial fractions and integration by parts.
- Determine convergence/divergence of improper integrals and evaluate convergent improper integrals.
- Apply various techniques in solving differential equations.

TEXT BOOKS :

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014.
2. James Stewart, "Calculus: Early Transcendentals", Cengage Learning, 7th Edition, New Delhi, 2015. [For Units I & III - Sections 1.1, 2.2, 2.3, 2.5, 2.7(Tangents problems only), 2.8, 3.1 to 3.6, 3.11, 4.1, 4.3, 5.1(Area problems only), 5.2, 5.3, 5.4 (excluding net change theorem), 5.5, 7.1 - 7.4 and 7.8].

REFERENCES :

1. Anton, H, Bivens, I and Davis, S, "Calculus", Wiley, 10th Edition, 2016.
2. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics", Narosa Publications, New Delhi, 3rd Edition, 2007.
3. Narayanan, S. and Manicavachagom Pillai, T. K., "Calculus" Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2007.
4. Srimantha Pal and Bhunia, S.C, "Engineering Mathematics" Oxford University Press, 2015.
5. Weir, M.D and Joel Hass, "Thomas Calculus", 12th Edition, Pearson India, 2016.

PH8151	ENGINEERING PHYSICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To enhance the fundamental knowledge in Physics and its applications relevant to various streams of Engineering and Technology.

UNIT I PROPERTIES OF MATTER 9

Elasticity – Stress-strain diagram and its uses - factors affecting elastic modulus and tensile strength – torsional stress and deformations – twisting couple - torsion pendulum: theory and experiment - bending of beams - bending moment – cantilever: theory and experiment – uniform and non-uniform bending: theory and experiment - I-shaped girders - stress due to bending in beams.

UNIT II WAVES AND FIBER OPTICS 9

Oscillatory motion – forced and damped oscillations: differential equation and its solution – plane progressive waves – wave equation. Lasers : population of energy levels, Einstein's A and B coefficients derivation – resonant cavity, optical amplification (qualitative) – Semiconductor lasers: homojunction and heterojunction – Fiber optics: principle, numerical aperture and acceptance angle - types of optical fibres (material, refractive index, mode) – losses associated with optical fibers - fibre optic sensors: pressure and displacement.

UNIT III THERMAL PHYSICS 9

Transfer of heat energy – thermal expansion of solids and liquids – expansion joints - bimetallic strips - thermal conduction, convection and radiation – heat conductions in solids – thermal conductivity - Forbe's and Lee's disc method: theory and experiment - conduction through compound media (series and parallel) – thermal insulation – applications: heat exchangers, refrigerators, ovens and solar water heaters.

UNIT IV QUANTUM PHYSICS 9

Black body radiation – Planck's theory (derivation) – Compton effect: theory and experimental verification – wave particle duality – electron diffraction – concept of wave function and its physical significance – Schrödinger's wave equation – time independent and time dependent equations – particle in a one-dimensional rigid box – tunnelling (qualitative) - scanning tunnelling microscope.

UNIT V CRYSTAL PHYSICS 9

Single crystalline, polycrystalline and amorphous materials – single crystals: unit cell, crystal systems, Bravais lattices, directions and planes in a crystal, Miller indices – inter-planar distances - coordination number and packing factor for SC, BCC, FCC, HCP and diamond structures - crystal imperfections: point defects, line defects – Burger vectors, stacking faults – role of imperfections in plastic deformation - growth of single crystals: solution and melt growth techniques.

TOTAL : 45 PERIODS

OUTCOMES:

Upon completion of this course,

- the students will gain knowledge on the basics of properties of matter and its applications,
- the students will acquire knowledge on the concepts of waves and optical devices

and their applications in fibre optics,

- the students will have adequate knowledge on the concepts of thermal properties of materials and their applications in expansion joints and heat exchangers,
- the students will get knowledge on advanced physics concepts of quantum theory and its applications in tunneling microscopes, and
- the students will understand the basics of crystals, their structures and different crystal growth techniques.

TEXT BOOKS:

1. Bhattacharya, D.K. & Poonam, T. "Engineering Physics". Oxford University Press, 2015.
2. Gaur, R.K. & Gupta, S.L. "Engineering Physics". Dhanpat Rai Publishers, 2012.
3. Pandey, B.K. & Chaturvedi, S. "Engineering Physics". Cengage Learning India, 2012.

REFERENCES:

1. Halliday, D., Resnick, R. & Walker, J. "Principles of Physics". Wiley, 2015.
2. Serway, R.A. & Jewett, J.W. "Physics for Scientists and Engineers". Cengage Learning, 2010.
3. Tipler, P.A. & Mosca, G. "Physics for Scientists and Engineers with Modern Physics'. W.H.Freeman, 2007.

CY8151 ENGINEERING CHEMISTRY L T P C
3 0 0 3

OBJECTIVES:

- To make the students conversant with boiler feed water requirements, related problems and water treatment techniques.
- To develop an understanding of the basic concepts of phase rule and its applications to single and two component systems and appreciate the purpose and significance of alloys.
- Preparation, properties and applications of engineering materials.
- Types of fuels, calorific value calculations, manufacture of solid, liquid and gaseous fuels.
- Principles and generation of energy in batteries, nuclear reactors, solar cells, wind mills and fuel cells.

UNIT I WATER AND ITS TREATMENT 9

Hardness of water – types – expression of hardness – units – estimation of hardness of water by EDTA – numerical problems – boiler troubles (scale and sludge) – treatment of boiler feed water – Internal treatment (phosphate, colloidal, sodium aluminate and calgon conditioning) external treatment – Ion exchange process, zeolite process – desalination of brackish water - Reverse Osmosis.

UNIT II SURFACE CHEMISTRY AND CATALYSIS 9

Adsorption: Types of adsorption – adsorption of gases on solids – adsorption of solute from solutions – adsorption isotherms – Freundlich's adsorption isotherm – Langmuir's adsorption isotherm – contact theory – kinetics of surface reactions, unimolecular reactions, Langmuir - applications of adsorption on pollution abatement.

Catalysis: Catalyst – types of catalysis – criteria – autocatalysis – catalytic poisoning and catalytic promoters - acid base catalysis – applications (catalytic convertor) – enzyme catalysis– Michaelis – Menten equation.

UNIT III ALLOYS AND PHASE RULE 9

Alloys: Introduction- Definition- properties of alloys- significance of alloying, functions and effect of alloying elements- Nichrome and stainless steel (18/8) – heat treatment of steel. Phase rule: Introduction, definition of terms with examples, one component system -water system - reduced phase rule - thermal analysis and cooling curves - two component systems - lead-silver system - Pattinson process.

UNIT IV FUELS AND COMBUSTION 9

Fuels: Introduction - classification of fuels - coal - analysis of coal (proximate and ultimate) - carbonization - manufacture of metallurgical coke (Otto Hoffmann method) - petroleum - manufacture of synthetic petrol (Bergius process) - knocking - octane number - diesel oil - cetane number - natural gas - compressed natural gas (CNG) - liquefied petroleum gases (LPG) - power alcohol and biodiesel. Combustion of fuels: Introduction - calorific value - higher and lower calorific values- theoretical calculation of calorific value - ignition temperature - spontaneous ignition temperature - explosive range - flue gas analysis (ORSAT Method).

UNIT V ENERGY SOURCES AND STORAGE DEVICES 9

Nuclear fission - controlled nuclear fission - nuclear fusion - differences between nuclear fission and fusion - nuclear chain reactions - nuclear energy - light water nuclear power plant - breeder reactor - solar energy conversion - solar cells - wind energy. Batteries, fuel cells and supercapacitors: Types of batteries – primary battery (dry cell) secondary battery (lead acid battery, lithium-ion-battery) fuel cells – H_2-O_2 fuel cell.

TOTAL: 45 PERIODS

OUTCOMES:

- The knowledge gained on engineering materials, fuels, energy sources and water treatment techniques will facilitate better understanding of engineering processes and applications for further learning.

TEXT BOOKS:

1. S. S. Dara and S. S. Umare, “A Textbook of Engineering Chemistry”, S. Chand & Company LTD, New Delhi, 2015
2. P. C. Jain and Monika Jain, “Engineering Chemistry” Dhanpat Rai Publishing Company (P) LTD, New Delhi, 2015
3. S. Vairam, P. Kalyani and Suba Ramesh, “Engineering Chemistry”, Wiley India PVT, LTD, New Delhi, 2013.

REFERENCES:

1. Friedrich Emich, “Engineering Chemistry”, Scientific International PVT, LTD, New Delhi, 2014.
2. Prasanta Rath, “Engineering Chemistry”, Cengage Learning India PVT, LTD, Delhi, 2015.
3. Shikha Agarwal, “Engineering Chemistry-Fundamentals and Applications”, Cambridge University Press, Delhi, 2015.

GE8151 PROBLEM SOLVING AND PYTHON PROGRAMMING L T P C

3 0 0 3

OBJECTIVES:

- To know the basics of algorithmic problem solving
- To read and write simple Python programs.
- To develop Python programs with conditionals and loops.

- To define Python functions and call them.
- To use Python data structures –- lists, tuples, dictionaries.
- To do input/output with files in Python.

UNIT I ALGORITHMIC PROBLEM SOLVING 9

Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, guess an integer number in a range, Towers of Hanoi.

UNIT II DATA, EXPRESSIONS, STATEMENTS 9

Python interpreter and interactive mode; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; modules and functions, function definition and use, flow of execution, parameters and arguments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.

UNIT III CONTROL FLOW, FUNCTIONS 9

Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.

UNIT IV LISTS, TUPLES, DICTIONARIES 9

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: selection sort, insertion sort, mergesort, histogram.

UNIT V FILES, MODULES, PACKAGES 9

Files and exception: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file.

OUTCOMES:

Upon completion of the course, students will be able to

- Develop algorithmic solutions to simple computational problems
- Read, write, execute by hand simple Python programs.
- Structure simple Python programs for solving problems.
- Decompose a Python program into functions.
- Represent compound data using Python lists, tuples, dictionaries.
- Read and write data from/to files in Python Programs.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Allen B. Downey, ``Think Python: How to Think Like a Computer Scientist'', 2nd edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016 (http://greenteapress.com/wp/think-python/)

2. Guido van Rossum and Fred L. Drake Jr, “An Introduction to Python – Revised and updated for Python 3.2, Network Theory Ltd., 2011.

REFERENCES:

1. Charles Dierbach, “Introduction to Computer Science using Python: A Computational Problem-Solving Focus, Wiley India Edition, 2013.
2. John V Guttag, “Introduction to Computation and Programming Using Python’’, Revised and expanded Edition, MIT Press , 2013
3. Kenneth A. Lambert, “Fundamentals of Python: First Programs”, CENGAGE Learning, 2012.
4. Paul Gries, Jennifer Campbell and Jason Montojo, “Practical Programming: An Introduction to Computer Science using Python 3”, Second edition, Pragmatic Programmers, LLC, 2013.
5. Robert Sedgewick, Kevin Wayne, Robert Dondero, “Introduction to Programming in Python: An Inter-disciplinary Approach, Pearson India Education Services Pvt. Ltd., 2016.
6. Timothy A. Budd, “Exploring Python”, Mc-Graw Hill Education (India) Private Ltd.,, 2015.

GE8152 ENGINEERING GRAPHICS L T P C
2 0 4 4

OBJECTIVES:

- To develop in students, graphic skills for communication of concepts, ideas and design of Engineering products.
- To expose them to existing national standards related to technical drawings.

CONCEPTS AND CONVENTIONS (Not for Examination) 1

Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning.

UNIT I PLANE CURVES AND FREEHAND SKETCHING 7+12

Basic Geometrical constructions, Curves used in engineering practices: Conics – Construction of ellipse, parabola and hyperbola by eccentricity method – Construction of cycloid – construction of involutes of square and circle – Drawing of tangents and normal to the above curves.

Visualization concepts and Free Hand sketching: Visualization principles –Representation of Three Dimensional objects – Layout of views- Freehand sketching of multiple views from pictorial views of objects

UNIT II PROJECTION OF POINTS, LINES AND PLANE SURFACE 6+12

Orthographic projection- principles-Principal planes-First angle projection-projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method and traces Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

UNIT III PROJECTION OF SOLIDS 5+12

Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes by rotating object method.

UNIT IV PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES 5+12

Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones.

UNIT V ISOMETRIC AND PERSPECTIVE PROJECTIONS 6+12

Principles of isometric projection – isometric scale –Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions - Perspective projection of simple solids-Prisms, pyramids and cylinders by visual ray method .

TOTAL: 90 PERIODS

OUTCOMES:

On successful completion of this course, the student will be able to

- familiarize with the fundamentals and standards of Engineering graphics
- perform freehand sketching of basic geometrical constructions and multiple views of objects.
- project orthographic projections of lines and plane surfaces.
- draw projections and solids and development of surfaces.
- visualize and to project isometric and perspective sections of simple solids.

TEXT BOOK:

1. Natrajan K.V., “A text book of Engineering Graphics”, Dhanalakshmi Publishers, Chennai, 2009.
2. Venugopal K. and Prabhu Raja V., “Engineering Graphics”, New Age International (P) Limited, 2008.

REFERENCES:

1. Basant Agarwal and Agarwal C.M., “Engineering Drawing”, Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.
2. Bhatt N.D. and Panchal V.M., “Engineering Drawing”, Charotar Publishing House, 50th Edition, 2010.
3. Gopalakrishna K.R., “Engineering Drawing” (Vol. I&II combined), Subhas Stores, Bangalore, 2007.
4. Luzzader, Warren.J. and Duff,John M., “Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
5. N S Parthasarathy And Vela Murali, “Engineering Graphics”, Oxford University, Press, New Delhi, 2015.
6. Shah M.B., and Rana B.C., “Engineering Drawing”, Pearson, 2nd Edition, 2009.

Publication of Bureau of Indian Standards:

1. IS 10711 – 2001: Technical products Documentation – Size and lay out of drawing sheets.
2. IS 9609 (Parts 0 & 1) – 2001: Technical products Documentation – Lettering.
3. IS 10714 (Part 20) – 2001 & SP 46 – 2003: Lines for technical drawings.
4. IS 11669 – 1986 & SP 46 – 2003: Dimensioning of Technical Drawings.
5. IS 15021 (Parts 1 to 4) – 2001: Technical drawings – Projection Methods.

Special points applicable to University Examinations on Engineering Graphics:

1. There will be five questions, each of either or type covering all units of the syllabus.

2. All questions will carry equal marks of 20 each making a total of 100.
3. The answer paper shall consist of drawing sheets of A3 size only. The students will be permitted to use appropriate scale to fit solution within A3 size.

The examination will be conducted in appropriate sessions on the same day

GE8161	PROBLEM SOLVING AND PYTHON PROGRAMMING LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- To write, test, and debug simple Python programs.
- To implement Python programs with conditionals and loops.
- Use functions for structuring Python programs.
- Represent compound data using Python lists, tuples, dictionaries.
- Read and write data from/to files in Python.

LIST OF PROGRAMS

1. Compute the GCD of two numbers.
2. Find the square root of a number (Newton's method)
3. Exponentiation (power of a number)
4. Find the maximum of a list of numbers
5. Linear search and Binary search
6. Selection sort, Insertion sort
7. Merge sort
8. First n prime numbers
9. Multiply matrices
10. Programs that take command line arguments (word count)
11. Find the most frequent words in a text read from a file
12. Simulate elliptical orbits in Pygame
13. Simulate bouncing ball using Pygame

PLATFORM NEEDED

Python 3 interpreter for Windows/Linux

OUTCOMES:

Upon completion of the course, students will be able to

- Write, test, and debug simple Python programs.
- Implement Python programs with conditionals and loops.
- Develop Python programs step-wise by defining functions and calling them.
- Use Python lists, tuples, dictionaries for representing compound data.
- Read and write data from/to files in Python.

TOTAL :60 PERIODS

BS8161	PHYSICS AND CHEMISTRY LABORATORY (Common to all branches of B.E. / B.Tech Programmes)	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To introduce different experiments to test basic understanding of physics concepts applied in optics, thermal physics, properties of matter and liquids.

LIST OF EXPERIMENTS: PHYSICS LABORATORY (Any 5 Experiments)

1. Determination of rigidity modulus – Torsion pendulum
2. Determination of Young's modulus by non-uniform bending method
3. (a) Determination of wavelength, and particle size using Laser
   (b) Determination of acceptance angle in an optical fiber.
4. Determination of thermal conductivity of a bad conductor – Lee's Disc method.
5. Determination of velocity of sound and compressibility of liquid – Ultrasonic interferometer
6. Determination of wavelength of mercury spectrum – spectrometer grating
7. Determination of band gap of a semiconductor
8. Determination of thickness of a thin wire – Air wedge method

TOTAL: 30 PERIODS

OUTCOMES:

Upon completion of the course, the students will be able to

1. apply principles of elasticity, optics and thermal properties for engineering applications.

CHEMISTRY LABORATORY: (Any seven experiments to be conducted)

OBJECTIVES:

- To make the student to acquire practical skills in the determination of water quality parameters through volumetric and instrumental analysis.
- To acquaint the students with the determination of molecular weight of a polymer by viscometery.

1. Estimation of HCl using Na_2CO_3 as primary standard and Determination of alkalinity in water sample.
2. Determination of total, temporary & permanent hardness of water by EDTA method.
3. Determination of DO content of water sample by Winkler's method.
4. Determination of chloride content of water sample by argentometric method.
5. Estimation of copper content of the given solution by Iodometry.
6. Determination of strength of given hydrochloric acid using pH meter.
7. Determination of strength of acids in a mixture of acids using conductivity meter.
8. Estimation of iron content of the given solution using potentiometer.
9. Estimation of iron content of the water sample using spectrophotometer (1, 10-Phenanthroline / thiocyanate method).
10. Estimation of sodium and potassium present in water using flame photometer.
11. Determination of molecular weight of polyvinyl alcohol using Ostwald viscometer.
12. Pseudo first order kinetics-ester hydrolysis.
13. Corrosion experiment-weight loss method.
14. Determination of CMC.
15. Phase change in a solid.
16. Conductometric titration of strong acid vs strong base.

OUTCOMES:

- The students will be outfitted with hands-on knowledge in the quantitative chemical analysis of water quality related parameters.

TOTAL: 30 PERIODS

TEXTBOOKS:

1. Vogel's Textbook of Quantitative Chemical Analysis (8^{TH} edition, 2014)

HS8251 **TECHNICAL ENGLISH** **L T P C**
4 0 0 4

OBJECTIVES:

The Course prepares second semester engineering and Technology students to:

- Develop strategies and skills to enhance their ability to read and comprehend engineering and technology texts.
- Foster their ability to write convincing job applications and effective reports.
- Develop their speaking skills to make technical presentations, participate in group discussions.
- Strengthen their listening skill which will help them comprehend lectures and talks in their areas of specialisation.

UNIT I INTRODUCTION TECHNICAL ENGLISH 12

Listening- Listening to talks mostly of a scientific/technical nature and completing information-gap exercises- **Speaking** –Asking for and giving directions- **Reading** – reading short technical texts from journals- newsapapers- **Writing**- purpose statements – extended definitions – issue- writing instructions – checklists-recommendations-**Vocabulary Development**- technical vocabulary **Language Development** –subject verb agreement - compound words.

UNIT II READING AND STUDY SKILLS 12

Listening- Listening to longer technical talks and completing exercises based on them-**Speaking** – describing a process-**Reading** – reading longer technical texts- identifying the various transitions in a text- paragraphing- **Writing**- interpreting cgarts, graphs- **Vocabulary Development-** vocabulary used in formal letters/emails and reports **Language Development-** impersonal passive voice, numerical adjectives.

UNIT III TECHNICAL WRITING AND GRAMMAR 12

Listening- Listening to classroom lectures/ talkls on engineering/technology -**Speaking** – introduction to technical presentations- **Reading** – longer texts both general and technical, practice in speed reading; **Writing**-Describing a process, use of sequence words- **Vocabulary Development-** sequence words- Misspelled words. **Language Development-** embedded sentences

UNIT IV REPORT WRITING 12

Listening- Listening to documentaries and making notes. **Speaking** – mechanics of presentations- **Reading** – reading for detailed comprehension- **Writing**- email etiquette- job application – cover letter –Résumé preparation(via email and hard copy)- analytical essays and issue based essays--**Vocabulary Development**- finding suitable synonyms-paraphrasing-. **Language Development-** clauses- if conditionals.

UNIT V GROUP DISCUSSION AND JOB APPLICATIONS 12

Listening- TED/Ink talks; **Speaking** –participating in a group discussion -**Reading**– reading and understanding technical articles **Writing**– Writing reports- minutes of a meeting- accident and survey-**Vocabulary Development- verbal analogies Language Development-** reported speech .

TOTAL :60 PERIODS

OUTCOMES: At the end of the course learners will be able to:

- Read technical texts and write area- specific texts effortlessly.
- Listen and comprehend lectures and talks in their area of specialisation successfully.

- Speak appropriately and effectively in varied formal and informal contexts.
- Write reports and winning job applications.

TEXT BOOKS:

1. Board of editors. **Fluency in English A Course book for Engineering and Technology.** Orient Blackswan, Hyderabad: 2016.
2. Sudharshana.N.P and Saveetha. C. **English for Technical Communication**. Cambridge University Press: New Delhi, 2016.

REFERENCES

1. Booth-L. Diana**, Project Work,** Oxford University Press**,** Oxford: 2014.
2. Grussendorf, Marion, **English for Presentations,** Oxford University Press, Oxford: 2007
3. Kumar, Suresh. E. **Engineering English**. Orient Blackswan: Hyderabad,2015.
4. Means, L. Thomas and Elaine Langlois, **English & Communication For Colleges.** Cengage Learning, USA: 2007
5. Raman, Meenakshi and Sharma, Sangeetha- **Technical Communication Principles and Practice.**Oxford University Press: New Delhi,2014.

Students can be asked to read Tagore, Chetan Bhagat and for supplementary reading.

MA8251 ENGINEERING MATHEMATICS – II L T P C
4 0 0 4

OBJECTIVES :

- This course is designed to cover topics such as Matrix Algebra, Vector Calculus, Complex Analysis and Laplace Transform. Matrix Algebra is one of the powerful tools to handle practical problems arising in the field of engineering. Vector calculus can be widely used for modelling the various laws of physics. The various methods of complex analysis and Laplace transforms can be used for efficiently solving the problems that occur in various branches of engineering disciplines.

UNIT I MATRICES 12

Eigenvalues and Eigenvectors of a real matrix – Characteristic equation – Properties of Eigenvalues and Eigenvectors – Cayley-Hamilton theorem – Diagonalization of matrices – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms.

UNIT II VECTOR CALCULUS 12

Gradient and directional derivative – Divergence and curl - Vector identities – Irrotational and Solenoidal vector fields – Line integral over a plane curve – Surface integral - Area of a curved surface - Volume integral - Green's, Gauss divergence and Stoke's theorems – Verification and application in evaluating line, surface and volume integrals.

UNIT III ANALYTIC FUNCTIONS 12

Analytic functions – Necessary and sufficient conditions for analyticity in Cartesian and polar coordinates - Properties – Harmonic conjugates – Construction of analytic function - Conformal mapping – Mapping by functions $w = z + c, cz, \frac{1}{z}, z^2$ - Bilinear transformation.

UNIT IV COMPLEX INTEGRATION **12**

Line integral - Cauchy's integral theorem – Cauchy's integral formula – Taylor's and Laurent's series – Singularities – Residues – Residue theorem – Application of residue theorem for evaluation of real integrals – Use of circular contour and semicircular contour.

UNIT V LAPLACE TRANSFORMS **12**

Existence conditions – Transforms of elementary functions – Transform of unit step function and unit impulse function – Basic properties – Shifting theorems -Transforms of derivatives and integrals – Initial and final value theorems – Inverse transforms – Convolution theorem – Transform of periodic functions – Application to solution of linear second order ordinary differential equations with constant coefficients.

TOTAL: 60 PERIODS

OUTCOMES :

After successfully completing the course, the student will have a good understanding of the following topics and their applications:

- Eigenvalues and eigenvectors, diagonalization of a matrix, Symmetric matrices, Positive definite matrices and similar matrices.
- Gradient, divergence and curl of a vector point function and related identities.
- Evaluation of line, surface and volume integrals using Gauss, Stokes and Green's theorems and their verification.
- Analytic functions, conformal mapping and complex integration.
- Laplace transform and inverse transform of simple functions, properties, various related theorems and application to differential equations with constant coefficients.

TEXT BOOKS :

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014.
2. Kreyszig Erwin, "Advanced Engineering Mathematics ", John Wiley and Sons, 10th Edition, New Delhi, 2016.

REFERENCES :

1. Bali N., Goyal M. and Watkins C., "Advanced Engineering Mathematics", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), New Delhi, 7th Edition, 2009.
2. Jain R.K. and Iyengar S.R.K., " Advanced Engineering Mathematics ", Narosa Publications, New Delhi , 3rd Edition, 2007.
3. O'Neil, P.V. "Advanced Engineering Mathematics", Cengage Learning India Pvt., Ltd, New Delhi, 2007.
4. Sastry, S.S, "Engineering Mathematics", Vol. I & II, PHI Learning Pvt. Ltd, 4th Edition, New Delhi, 2014.
5. Wylie, R.C. and Barrett, L.C., "Advanced Engineering Mathematics "Tata McGraw Hill Education Pvt. Ltd, 6th Edition, New Delhi, 2012.

PH8254	PHYSICS OF MATERIALS (Common to courses offered in Faculty of Technology except Fashion Technology)	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce the physics of various materials relevant to different branches of technology

UNIT I PREPARATION OF MATERIALS 9

Phases - phase rule – binary systems – tie line rule – lever rule – phase diagram – invariant reactions - nucleation – homogeneous and heterogeneous nucleation – free energy of formation of a critical nucleus – Thin films – preparation: PVD, CVD method – Nanomaterials Preparation: wet chemical, solvothermal, sol-gel method.

UNIT II CONDUCTING MATERIALS 9

Classical free electron theory - expression for electrical conductivity – thermal conductivity, - Wiedemann-Franz law – electrons in metals: particle in a three-dimensional box- degenerate states – Fermi-Dirac statistics – density of energy states – electron in periodic potential (concept only) – electron effective mass – concept of hole. Superconducting phenomena, properties of superconductors – Meissner effect and isotope effect. Type I and Type II superconductors, High T_c superconductors – Magnetic levitation and SQUIDS.

UNIT III SEMICONDUCTING MATERIALS 9

Elemental Semiconductors - Compound semiconductors - Origin of band gap in solids (qualitative) - carrier concentration in an intrinsic semiconductor (derivation) – Fermi level – variation of Fermi level with temperature – electrical conductivity – band gap determination – carrier concentration in n-type and p-type semiconductors (derivation) – variation of Fermi level with temperature and impurity concentration – Hall effect – determination of Hall coefficient – LED - Solar cells.

UNIT IV DIELECTRIC AND MAGNETIC MATERIALS 9

Dielectric, Paraelectric and ferroelectric materials - Electronic, Ionic, Orientational and space charge polarization – Internal field and deduction of Clausius Mosotti equation – dielectric loss – different types of dielectric breakdown – classification of insulating materials and their applications - Ferroelectric materials - Introduction to magnetic materials - Domain theory of ferromagnetism, Hysteresis, Soft and Hard magnetic materials – Anti-ferromagnetic materials – Ferrites, magnetoresistance materials.

UNIT V NEW MATERIALS AND APPLICATIONS 9

Metallic glasses – Shape memory alloys: Copper, Nickel and Titanium based alloys – graphene and its properties - Ceramics: types and applications – Composites: classification, role of matrix and reinforcement – processing of fibre reinforced plastics and fibre reinforced metals – Biomaterials: hydroxyapatite – PMMA – Silicone - Sensors: Chemical Sensors - Bio-sensors – conducting, semiconducting and photoresponsive polymers.

TOTAL : 45 PERIODS

OUTCOMES:

At the end of the course, the students will able to

- gain knowledge on phase diagrams and various material processing methods,
- acquire knowledge on basics of conducting materials, superconductors and their applications
- get knowledge on the functioning of semiconducting materials and their applications in LED and solar cells,
- understand the functioning of various dielectric and magnetic materials ,
- have the necessary understanding on various advanced materials.

TEXT BOOKS:

1. Balasubramaniam, R. “Callister's Materials Science and Engineering”. Wiley India Pvt. Ltd. 2014.

2. Kasap, S.O. “Principles of Electronic Materials and Devices”. McGraw-Hill Education, 2007.
3. Wahab, M.A. “Solid State Physics: Structure and Properties of Materials”. Narosa Publishing House, 2009.

REFERENCES

1. Askeland, D. “Materials Science and Engineering”. Brooks/Cole, 2010
2. Raghavan, V. “Materials Science and Engineering : A First course”. PHI Learning, 2015.
3. Smith, W.F., Hashemi, J. & Prakash. R. “Materials Science and Engineering”. Tata Mcgraw Hill Education Pvt. Ltd., 2014.

PY8201 HUMAN PHYSIOLOGY L T P C
3 0 0 3

OBJECTIVES:

- To explain physiological mechanism of various organ systems and to explain the pathophysiology of underlying common diseases.

UNIT I HEAMATOLOGY 9

Composition and functions of blood, functions of plasma proteins, reaction of blood, coagulation of blood, coagulation factors, functions of bone marrow, erythropoiesis, functions of hemoglobin, blood groups.

UNIT II PHYSIOLOGY OF MUSCLES 9

Physiology and properties of skeletal muscle,, smooth muscle, cardiac muscle, Physiology of muscular contraction, excitability and contractibility, isotonic and isometric contractions, refractory period, tonicity, electromyography.

UNIT III RESPIRATORY SYSTEM 9

Functions of respiratory system, role of ciliated epithelium, pleural cavity and intra pleural pressure, mechanism of breathing, resistance to breathing, pulmonary volumes, mechanism of gaseous exchange, control of respiration.

UNIT IV CARDIOVASCULAR SYSTEM 9

Introduction to circulation, functions of circulation, anatomical considerations of heart, cardiac impulse, cardiac cycle, heart sounds, electrocardiogram, heart rate, cardiac output, blood pressure, factors influencing blood pressure, blood velocity, functions of pulmonary circulation, coronary circulation, nervous control and reflex control of blood flow.

UNIT V ENDOCRINE AND REPRODUCTIVE SYSTEM 9

Physiology of Pituitary, thyroid, parathyroid, adrenal and pancreatic hormones and disorders of these glands, endocrine control of growth and metabolism; pineal, thymus, testes, ovaries, physiology of reproductive systems, sex hormones, physiology of fertilization, menstruation, menopause, spermatogenesis and oogenesis, pregnancy and parturition and clinical disorders

TOTAL: 45 PERIODS

OUTCOMES:

- The student should be able to locate, identify and functionally describe the organ systems of human body. Must be able to utiize appropriate reference resources to clarify and expand knowledge of physiology and pathophysiology.

TEXT BOOKS

1. Guyton, A.C. and Hall, J.E., "Textbook of Medical Physiology", 11th Edition, Saunders, 2006.
2. CC Chatterjee. Human Physiology Volume I and II. Medical Allied Agency, Kolkata, Special Edition, 2011.
3. Stuart Ira Fox. Human physiology. 12th ed. Mac Graw Hill. 2011.
4. Dee Unglaub Silverthorn. Human physiology - An integrated approach. Fifth edition. Pearson Education, Inc., 2012.

REFERENCES

1. Carola, R., Harley J.P. and Noback C.R., "Human Anatomy & Physiology", 2nd Edition, McGraw – Hill, 1992.
2. Vander, A.J., Sherman J.H. and Luciano D.S., "Human Physiology: The Mechanisms of Body Function", 5th Edition, McGraw – Hill, 1990.
3. Waugh, Anne and Allison Grant, "Ross and Wilson Anatomy and Physiology in Health and Illness", 10th Edition, Churchill – Livingstone / Elsevier), 2006.

BE8252 BASIC CIVIL AND MECHANICAL ENGINEERING L T P C
4 0 0 4

OBJECTIVES:

To impart basic knowledge on Civil and Mechanical Engineering.

- To familiarize the materials and measurements used in Civil Engineering.
- To provide the exposure on the fundamental elements of civil engineering structures.
- To enable the students to distinguish the components and working principle of power plant units, IC engines, and R & AC system.

A – OVER VIEW

UNIT I SCOPE OF CIVIL AND MECHANICAL ENGINEERING 10

Overview of Civil Engineering - Civil Engineering contributions to the welfare of Society – Specialized sub disciplines in Civil Engineering – Structural, Construction, Geotechnical, Environmental, Transportation and Water Resources Engineering

Overview of Mechanical Engineering - Mechanical Engineering contributions to the welfare of Society –Specialized sub disciplines in Mechanical Engineering - Production, Automobile, Energy Engineering - Interdisciplinary concepts in Civil and Mechanical Engineering.

B – CIVIL ENGINEERING

UNIT II SURVEYING AND CIVIL ENGINEERING MATERIALS 10

Surveying: Objects – classification – principles – measurements of distances – angles – leveling – determination of areas– contours - examples.

Civil Engineering Materials: Bricks – stones – sand – cement – concrete – steel - timber - modern materials

UNIT III BUILDING COMPONENTS AND STRUCTURES 15

Foundations: Types of foundations - Bearing capacity and settlement – Requirement of good foundations.

Civil Engineering Structures: Brickmasonry – stonemasonry – beams – columns – lintels – roofing – flooring – plastering – floor area, carpet area and floor space index - Types of Bridges and Dams – water supply - sources and quality of water - Rain water harvesting - introduction to high way and rail way.

C – MECHANICAL ENGINEERING

UNIT IV INTERNAL COMBUSTION ENGINES AND POWER PLANTS 15

Classification of Power Plants - Internal combustion engines as automobile power plant – Working principle of Petrol and Diesel Engines – Four stroke and two stroke cycles – Comparison of four stroke and two stroke engines – Working principle of steam, Gas, Diesel, Hydro - electric and Nuclear Power plants –- working principle of Boilers, Turbines, Reciprocating Pumps (single acting and double acting) and Centrifugal Pumps

UNIT V REFRIGERATION AND AIR CONDITIONING SYSTEM 10

Terminology of Refrigeration and Air Conditioning. Principle of vapour compression and absorption system–Layout of typical domestic refrigerator–Window and Split type room Air conditioner.

OUTCOMES:

On successful completion of this course, the student will be able to

- appreciate the Civil and Mechanical Engineering components of Projects.
- explain the usage of construction material and proper selection of construction materials.
- measure distances and area by surveying
- identify the components used in power plant cycle.
- demonstrate working principles of petrol and diesel engine.
- elaborate the components of refrigeration and Air conditioning cycle.

TOTAL: 60PERIODS

TEXTBOOKS:

1. Shanmugam Gand Palanichamy MS,“Basic Civil and Mechanical Engineering”,Tata McGraw Hill PublishingCo.,NewDelhi,1996.

REFERENCES:

1. Palanikumar, K. Basic Mechanical Engineering, ARS Publications, 2010.
2. Ramamrutham S.,“Basic Civil Engineering”, Dhanpat Rai Publishing Co.(P) Ltd.1999.
3. Seetharaman S.,“BasicCivil Engineering”,AnuradhaAgencies,2005.
4. ShanthaKumar SRJ.,“Basic Mechanical Engineering”, Hi-tech Publications, Mayiladuthurai, 2000.
5. Venugopal K. and Prahu Raja V., “Basic Mechanical Engineering”, Anuradha Publishers, Kumbakonam,2000.

PY8202 BIOCHEMISTRY L T P C

3 0 0 3

OBJECTIVE

- To enable students learn the fundamentals of Biochemical Processes and Biomolecules.

UNIT I BIOCHEMICAL ORGANIZATION AND BIOENERGETICS 8

Scope of clinical biochemistry, component of the cell, structure and biochemical functions, membrane structure and functions, transport through biological cell membrane, transport mechanism, the concept of free energy.

UNIT II BIOMOLECULES 12

Carbohydrates – classification, properties. starch, glycogen, dextrin, inulin, cellulose, metabolism of carbohydrates – gluconeogenesis, glycogenolysis, glycolysis, citric acid cycle and its biological significance, role of sugar in nucleotide biosynthesis and pentose phosphate pathway. **Lipids** – Classification, properties- sterols, essential fatty acids, eicosanoids, phospholipids, sphingolipids, oxidation of fatty acids, α,β - oxidation and biosynthesis of cholesterol and porphyrin **Proteins and amino acids** – Classification, properties, essential and non essential amino acids, biosynthesis of amino acids. **Nucleic acids** –genetic code, nucleic acids, and structure of DNA and RNA, purine biosynthesis and pyrimidine biosynthesis.

UNIT III BIOENERGETICS 7

High energy compounds, respiratory chain, ATP cycle, Calculation of ATP during oxidation of glucose and fatty acids. General concept of oxidation and reduction, electron transport chain, oxidative phosphorylation, uncouplers and theories of biological oxidation, chemiosmotic hypothesis.

UNIT IV MACROMOLECULES, VITAMINS, HORMONES, ENZYMES 10

Structure of haemoglobin, immunoglobulins and nucleoprotein, classification and their properties, occurrence, functions, requirements, deficiency manifestations and role of vitamins as coenzyme, chemical nature and properties, hormones, Enzyme classification and their properties, mechanism of action, enzyme induction and inhibition, coenzyme significance and enzymes of clinical importance.

UNIT V BIOCHEMISTRY OF CLINICAL DISEASES 8

Diabetes mellitus, atherosclerosis, Renal failure and obesity, hormonal disorders, aging, inborn errors of metabolism organ function tests

TOTAL: 45 PERIODS

TEXTBOOKS

1. Lehninger A.L., Nelson D.L. and Cox M.M. Principles of Biochemistry. CBS publishers and distributers
2. Murray R.K., Granner D.K., Mayes P.A. and Rodwell V.W. Harpers Biochemistry. Appleton and Lange , Stanford ,Conneticut.
3. Thomas M. Devlin.Textbook of Biochemistry with clinical correlations. Wiley Liss Publishers

REFERENCES

1. Burtis & Ashwood W.B. Tietz Textbook of Clinical chemistry. Saunders Company
2. Lubert Stryer W.H. Biochemistry. Freeman and company, New york.
3. Donald Voet & Judith G. Voet. Biochemistry. John Wiley and Sons ,Inc.
4. Rama Rao. Textbook of Biochemistry.
5. Deb. Textbook of Biochemistry.

GE8261 **ENGINEERING PRACTICES LABORATORY** **L T P C**
0 0 4 2

OBJECTIVES:

- To provide exposure to the students with hands on experience on various basic engineering practices in Civil, Mechanical, Electrical and Electronics Engineering.

GROUP A (CIVIL & MECHANICAL)

I CIVIL ENGINEERING PRACTICE 13

Buildings:

(a) Study of plumbing and carpentry components of residential and industrial buildings. Safety aspects.

Plumbing Works:

(a) Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, elbows in household fittings.

(b) Study of pipe connections requirements for pumps and turbines.

(c) Preparation of plumbing line sketches for water supply and sewage works.

(d) Hands-on-exercise:

Basic pipe connections – Mixed pipe material connection – Pipe connections with different joining components.

(e) Demonstration of plumbing requirements of high-rise buildings.

Carpentry using Power Tools only:

(a) Study of the joints in roofs, doors, windows and furniture.

(b) Hands-on-exercise:

Wood work, joints by sawing, planing and cutting.

II MECHANICAL ENGINEERING PRACTICE 18

Welding:

(a) Preparation of butt joints, lap joints and T- joints by Shielded metal arc welding.

(b) Gas welding practice

Basic Machining:

(a) Simple Turning and Taper turning

(b) Drilling Practice

Sheet Metal Work:

(a) Forming & Bending:

(b) Model making – Trays and funnels.

(c) Different type of joints.

Machine assembly practice:

(a) Study of centrifugal pump

(b) Study of air conditioner

Demonstration on:

(a) Smithy operations, upsetting, swaging, setting down and bending. Example – Exercise – Production of hexagonal headed bolt.

(b) Foundry operations like mould preparation for gear and step cone pulley.

(c) Fitting – Exercises – Preparation of square fitting and V – fitting models.

GROUP B (ELECTRICAL & ELECTRONICS)

III ELECTRICAL ENGINEERING PRACTICE **13**

1. Residential house wiring using switches, fuse, indicator, lamp and energy meter.
2. Fluorescent lamp wiring.
3. Stair case wiring
4. Measurement of electrical quantities – voltage, current, power & power factor in RLC circuit.
5. Measurement of energy using single phase energy meter.
6. Measurement of resistance to earth of an electrical equipment.

IV ELECTRONICS ENGINEERING PRACTICE **16**

1. Study of Electronic components and equipments – Resistor, colour coding measurement of AC signal parameter (peak-peak, rms period, frequency) using CR.
2. Study of logic gates AND, OR, EX-OR and NOT.
3. Generation of Clock Signal.
4. Soldering practice – Components Devices and Circuits – Using general purpose PCB.
5. Measurement of ripple factor of HWR and FWR.

TOTAL: 60 PERIODS

OUTCOMES:

On successful completion of this course, the student will be able to

- fabricate carpentry components and pipe connections including plumbing works.
- use welding equipments to join the structures.
- Carry out the basic machining operations
- Make the models using sheet metal worksIllustrate on centrifugal pump, Air conditioner, operations of smithy, foundary and fittings
- Carry out basic home electrical works and appliances
- Measure the electrical quantities
- Elaborate on the components, gates, soldering practices.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

CIVIL

1. Assorted components for plumbing consisting of metallic pipes, plastic pipes, flexible pipes, couplings, unions, elbows, plugs and other fittings.	15 Sets.
2. Carpentry vice (fitted to work bench)	15 Nos.
3. Standard woodworking tools	15 Sets.
4. Models of industrial trusses, door joints, furniture joints	5 each
5. Power Tools: (a) Rotary Hammer	2 Nos
(b) Demolition Hammer	2 Nos
(c) Circular Saw	2 Nos
(d) Planer	2 Nos
(e) Hand Drilling Machine	2 Nos
(f) Jigsaw	2 Nos

MECHANICAL

1. Arc welding transformer with cables and holders	5 Nos.
2. Welding booth with exhaust facility	5 Nos.
3. Welding accessories like welding shield, chipping hammer,	

wire brush, etc.	5 Sets.
4. Oxygen and acetylene gas cylinders, blow pipe and other welding outfit.	2 Nos.
5. Centre lathe	2 Nos.
6. Hearth furnace, anvil and smithy tools	2 Sets.
7. Moulding table, foundry tools	2 Sets.
8. Power Tool: Angle Grinder	2 Nos
9. Study-purpose items: centrifugal pump, air-conditioner	One each.

ELECTRICAL

1. Assorted electrical components for house wiring	15 Sets
2. Electrical measuring instruments	10 Sets
3. Study purpose items: Iron box, fan and regulator, emergency lamp	1 each
4. Megger (250V/500V)	1 No.
5. Power Tools: (a) Range Finder	2 Nos
(b) Digital Live-wire detector	2 Nos

ELECTRONICS

1. Soldering guns	10 Nos.
2. Assorted electronic components for making circuits	50 Nos.
3. Small PCBs	10 Nos.
4. Multimeters	10 Nos.
5. Study purpose items: Telephone, FM radio, low-voltage power supply	

PY8211 BIOCHEMISTRY LABORATORY L T P C
0 0 4 2

AIM

- To learn and understand the principles behind the qualitative and quantitative estimation of biomolecules (proteins, carbohydrates, lipids, metabolites etc.,) and laboratory analysis of the same in the body fluids.

EXPERIMENTS

1. Preparation and measurement of pH of standard buffers (phosphate, carbonate, borate, TRIS etc.,).
2. Qualitative analysis of carbohydrates (monosaccharides, disaccharides, polysaccharides etc.,)
3. Enzymatic hydrolysis of glycogen by a and ß amylase
4. Qualitative analysis of proteins
5. Qualitative analysis of lipids (triglycerides, cholesterol, phospholipids etc.,)
6. Quantitative analysis of proteins (Lowrys method, Bradford, UV)
7. Quantitative analysis of carbohydrates (Benedict's method etc.,) lipids
8. Quantitative analysis of lipids (Benedict's method etc.,)
9. Quantitative estimation of blood glucose
10. Acid hydrolysis and action of salivary amylase on starch
11. Estimation of chloride, glucose, ammonia and creatinine in urine.
12. Quantitative estimation of serum cholesterol by Libermann Burchard's method

Equipment needed for 20 students:

1.UV-Visible Spectrophotometers -----1 No.

2. pH meter-----2 Nos.
3. Centrifuge---1 No.
4. Hot air oven ---1 No.
Glasswares, chemicals as required.

TOTAL: 60 PERIODS

TEXT BOOKS

1. Practical Biochemistry by R.C. Gupta and S. Bhargavan.
2. Introduction of Practical Biochemistry by David T. Phummer. (II Edition)

REFERENCES

1. Harpers Biochemistry Ed. R.K. Murray, D.K. Granner, P.A. Mayes and V.W.Rodwell, Appleton and Lange, Stanford, Conneticut.
2. Textbook of Biochemistry with clinical correlations. Ed. Thomas M. Devlin. Wiley Liss Publishers

MA8353 TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS L T P C
4 0 0 4

OBJECTIVE:

- To introduce the basic concepts of PDE for solving standard partial differential equations.
- To introduce Fourier series analysis which is central to many applications in engineering apart from its use in solving boundary value problems.
- To acquaint the student with Fourier series techniques in solving heat flow problems used in various situations.
- To acquaint the student with Fourier transform techniques used in wide variety of situations.
- To introduce the effective mathematical tools for the solutions of partial differential equations that model several physical processes and to develop Z transform techniques for discrete time systems.

UNIT I PARTIAL DIFFERENTIAL EQUATIONS 12

Formation of partial differential equations – Singular integrals - Solutions of standard types of first order partial differential equations - Lagrange's linear equation - Linear partial differential equations of second and higher order with constant coefficients of both homogeneous and non-homogeneous types.

UNIT II FOURIER SERIES 12

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series – Half range cosine series – Complex form of Fourier series – Parseval's identity – Harmonic analysis.

UNIT III APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS 12

Classification of PDE – Method of separation of variables - Fourier Series Solutions of one dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two dimensional equation of heat conduction.

UNIT IV FOURIER TRANSFORMS 12

Statement of Fourier integral theorem – Fourier transform pair – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity.

UNIT V Z - TRANSFORMS AND DIFFERENCE EQUATIONS 12

Z-transforms - Elementary properties – Inverse Z-transform (using partial fraction and residues) – Initial and final value theorems - Convolution theorem - Formation of difference equations – Solution of difference equations using Z - transform.

TOTAL: 60 PERIODS

OUTCOMES:

Upon successful completion of the course, students should be able to:

- Understand how to solve the given standard partial differential equations.
- Solve differential equations using Fourier series analysis which plays a vital role in engineering applications.
- Appreciate the physical significance of Fourier series techniques in solving one and two dimensional heat flow problems and one dimensional wave equations.
- Understand the mathematical principles on transforms and partial differential equations would provide them the ability to formulate and solve some of the physical problems of engineering.
- Use the effective mathematical tools for the solutions of partial differential equations by using Z transform techniques for discrete time systems.

TEXT BOOKS:

1. Grewal B.S., "Higher Engineering Mathematics", 43rd Edition, Khanna Publishers, New Delhi, 2014.
2. Narayanan S., Manicavachagom Pillay.T.K and Ramanaiah.G "Advanced Mathematics for Engineering Students", Vol. II & III, S.Viswanathan Publishers Pvt. Ltd, Chennai, 1998.

REFERENCES:

1. Andrews, L.C and Shivamoggi, B, "Integral Transforms for Engineers" SPIE Press, 1999.
2. Bali. N.P and Manish Goyal, "A Textbook of Engineering Mathematics", 9th Edition, Laxmi Publications Pvt. Ltd, 2014.
3. Erwin Kreyszig, "Advanced Engineering Mathematics ", 10th Edition, John Wiley, India, 2016.
4. James, G., "Advanced Modern Engineering Mathematics", 3rd Edition, Pearson Education, 2007.
5. Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
6. Wylie, R.C. and Barrett, L.C., "Advanced Engineering Mathematics "Tata McGraw Hill Education Pvt. Ltd, 6th Edition, New Delhi, 2012.

PE8491 CHEMICAL ENGINEERING THERMODYNAMICS L T P C

3 0 0 3

OBJECTIVE:

- Students will learn PVT behaviour of fluids, laws of thermodynamics, thermodynamic property relations and their application to fluid flow, power generation and refrigeration processes.

UNIT I 9

Scope of thermodynamics, basic concepts and definitions, Equilibrium state and phase rule, Energy, Work, Temperature and Zeroth Law of Thermodynamics, reversible and irreversible process, Ideal gas- Equation of State involving ideal and real gas, Law of corresponding states, Compressibility chart, First Law of Thermodynamics and its consequences.

UNIT II **9**

Joule's experiment, internal energy, enthalpy, Application of first Law of Thermodynamics for Flow and non flow processes. Limitations of the first Law , statements of second Law of Thermodynamics and its Applications ,Heat Engine, Heat Pump/Refrigerator, Carnot cycle and Carnot theorem, Thermodynamic Temperature scale, Entropy , Clausius inequality, Third law of thermodynamics.

UNIT III **9**

Refrigeration and liquefaction process, Thermodynamic Potentials, thermodynamic correlation, Maxwell relations, criteria for Equilibria and stability. Clapeyron equation

UNIT IV **9**

Partial molar properties, ideal and non-ideal solutions, standard states definition and choice, Gibbs-Duhem equation, activity and property change of mixing, excess properties of mixtures.

UNIT V **9**

Activity coefficient-composition models, thermodynamic consistency of phase equilibria, ChemicalReaction equilibria, Extent of reaction, equilibrium constant and standard free energy change

TOTAL: 45 PERIODS

OUTCOME:

- The course will help the students to know about engineering thermodynamics and understand the practical implications of thermodynamic law in engineering design.

TEXT BOOKS:

1. Sonntag, Borgnakke, Van Wylen, Fundamentals of Thermodynamics, 7th Edition, Wiley India, New Delhi, 2009.
2. Narayanan, K.V. A Textbook of Chemical Engineering Thermodynamics Prentice Hall India, 2004
3. Smith, van Ness and Abbott, "Chemical Engineering Thermodynamics", 7th Edition, McGraw Hill, New York, 2005

REFERENCES:

1. S. I. Sandler, Chemical, Biochemical and Engineering Thermodynamics, Wiley New York, 2006
2. Y V C Rao, "Chemical Engineering Thermodynamics", Universities Press, Hyderabad 2005.
3. Pradeep ahuja," Chemical Engineering Thermodynamics", PHI Learning Ltd (2009).
4. GopinathHalder," Introduction to Chemical Engineering Thermodynamics", PHI Learning Ltd (2009).

BT8291 **MICROBIOLOGY** **L T P C**

3 0 0 3

OBJECTIVES

- To introduce students to the principles of Microbiology to emphasize structure and biochemical aspects of various microbes.
- To solve the problems in microbial infection and their control.

UNIT I INTRODUCTION **6**

Basics of microbial existence; history of microbiology, classification and nomenclature of microorganisms, microscopic examination of microorganisms, light and electron microscopy;

principles of different staining techniques like gram staining, acid fast, capsular staining, flagellar staining.

UNIT II MICROBES- STRUCTURE AND MULTIPLICATION 12

Structural organization and multiplication of bacteria, viruses, algae and fungi, with special mention of life history of actinomycetes, yeast, mycoplasma and bacteriophages.

UNIT III MICROBIAL NUTRITION, GROWTH AND METABOLISM 12

Nutritional requirements of bacteria; different media used for bacterial culture; growth curve and different methods to quantify bacterial growth; aerobic and anaerobic bioenergetics and utilization of energy for biosynthesis of important molecules.

UNIT IV CONTROL OF MICROORGANISMS 6

Physical and chemical control of microorganisms; host-microbe interactions; anti-bacterial, anti-fungal and anti-viral agents; mode of action and resistance to antibiotics; clinically important microorganisms.

UNIT V INDUSTRIAL AND ENVIRONMENTAL MICROBIOLOGY 9

Primary metabolites; secondary metabolites and their applications; preservation of food;production of penicillin, alcohol, vitamin B-12; biogas; bioremediation; leaching of ores by microorganisms; biofertilizers and biopesticides; microorganisms and pollution control; biosensors

TOTAL: 45 PERIODS

TEXT BOOKS

1. Talaron K, Talaron A, Casita, Pelczar and Reid. Foundations in Microbiology, W.C. Brown Publishers, 1993.
2. Pelczar MJ, Chan ECS and Krein NR, Microbiology, Tata McGraw Hill Edition, New Delhi, India.
3. Prescott L.M., Harley J.P., Klein DA, Microbiology, 3rd Edition, Wm. C. Brown Publishers, 1996..

PY8301 PHARMACEUTICAL CHEMISTRY L T P C

3 0 0 3

OBJECTIVES:

- To inculcate understanding of the properties and principles of medicinal agents that originates from organic and inorganic sources and their application in pharmaceutical industry.
- To provide the basic functional group identification, molecular rearrangement, chemical bonding with their reaction mechanism.
- To provide the fundamental principles involved in the identification, preparation of pharmaceutical aids and to apply the principle of coordination compounds in pharmaceutical substances.

UNIT I STRUCTURE AND PROPERTIES 9

Molecular orbital theory, hybrid orbitals, polarity of bonds and molecules, dipole moment, resonance, inductive, mesomeric and electromeric effects, intramolecular and intermolecular hydrogen bonding.

UNIT II CHEMISTRY OF ALIPHATIC, AROMATIC AND HETEROAROMATIC COMPOUNDS 9

Characteristics of organic compounds, structure, nomenclature, preparation and reaction mechanism of alkyl and aryl halides (Mechanism of SN1, SN2, E1 and E2), Huckel's rule, structures, synthesis, properties and chemical reactions of benzenoid and nonbenzenoid compounds, mechanism of aromatic electrophilic and nucleophilic substitution. General principles of heterocyclic synthesis – Methods of preparation and reactions of Pyridines – Pyrroles – Thiophenes – Furans – Quinolines – Isoquinolines.

UNIT III PRINCIPLES OF TEST FOR PURITY IN PHARMACEUTICAL SUBSTANCES 9

Identification and characterization of impurities in Pharmaceutical substances, Limit tests: Definition, importance, general procedure for limit test for chlorides, sulphates, iron, arsenic, heavy metals and lead with suitable examples.

UNIT IV STUDY OF ORGANIC REACTIONS AND MOLECULAR REARRANGEMENTS 9

Hoesch reaction, Formylation reactions, Gattermann Reaction, Gattermann-Koch reaction, Vilsmeier reaction, Reimar-Tiemann reaction, Wolff rearrangement, Schmidt reaction. Curtius rearrangement, Catalytic dehydrogenation, Meerwein-Ponndorf-Verley, $NaBH_4$, Clemmenson, Sandmeyer, Ullmann, Azo coupling, Deamination, Benzidine rearrangement.

UNIT V PHARMACEUTICAL AIDS AND CO-ORDINATION COMPOUNDS 9

Preparation and properties of various agents such as – Sodium bisulphate, Sodium metabisulphate, Sulphur dioxide, Bentonite, Magnesium stearate, Zinc stearate, Aluminium sulphate, Sodium carboxy methyl cellulose, Sodium methylparaben- Theory of co-ordination compounds with special reference to application in Pharmacy such as – EDTA, Dimercaprol, Penicillamine, 1, 10-Phenanthroline.

TOTAL: 45 PERIODS

OUTCOMES:

The student will be able to

- Identify the functional groups in pharmaceutical substances and make predictions of chemical bonding along with their reaction mechanism.
- Identify and estimate the purity of drugs and its application.
- Apply the knowledge in the development and synthesis of new drug molecule with special reference to organic, inorganic and coordination chemistry.

TEXT BOOKS:

1. Francis A. Carey (Author), Richard J. Sundberg, Advanced Organic Chemistry, Part A: Structure and Mechanisms 5th Edition, Springer Publishers, 2000.
2. N V Chenchu Lakshmi, Pharmaceutical Inorganic chemistry: Theory and practice, 1stEdition,Pearson Education India,2012.
3. R.K. Sharma, Text Book of Coordination Chemistry, 1stEdition,Discovery Publishing House Pvt. Ltd.2011.

REFERENCES:

1. Michael B. Smith, Jerry March, March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, 6thEdition,Wiley,2007

2. Lutz F. Tietze, Theophil Eicher, Ulf Diederichsen, Andreas Speicher, Reactions and Syntheses in the Organic Chemistry Laboratory, 1st Edition, Wiley – VCH,2007
3. P. L. Soni, VandnaSoni, Coordination Chemistry: Metal Complexes, 1st Edition, CRC Press, 2013.

PY8302 PHYSICAL PHARMACEUTICS L T P C
3 0 0 3

OBJECTIVES:

- To acquire the fundamental principles and concepts involved in pharmaceutical powders, liquid flow, dispersions, drug diffusion, dissolution, complexation and protein binding.
- To provide the knowledge about kinetics and drug stability

UNIT I MICROMERITICS AND POWDER RHEOLOGY 9

Particle size and distribution, particle number, methods for determining particle volume, optical microscopy, sieving, sedimentation, Dynamic light scattering (DLS) technique, measurement of particle shape, specific surface, methods for determining surface area, permeability, adsorption, derived properties of powders, porosity, packing arrangement, densities, bulkiness and flow properties.

UNIT II SURFACE AND INTERFACIAL PHENOMENON, VISCOSITY AND RHEOLOGY 9

Liquid interface, surface and interfacial tension, surface free energy, measurement of surface and interfacial tensions, free energy, spreading coefficient, adsorption at liquid interfaces, surface active agents, HLB classification, solubilization, detergency, adsorption at solid interface, solid gas and solid-liquid interface, complex films, electrical properties of interface. Newtonian system, Law of flow, kinematic viscosity, effect of temperature on viscosity, non-Newtonian systems, plastic, pseudoplastic, dilatant, thixotropy, thixotropy in formulation, determination of viscosity: capillary, falling ball, rotational viscometers.

UNIT III DISPERSION SYSTEMS 9

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

UNIT IV DIFFUSION, DISSOLUTION, COMPLEXATION &PROTEIN BINDING 9

Definitions, Steady state diffusion, Procedures and apparatus for diffusion, dissolution and drug release, factors affecting dissolution, Complexation and protein binding; Metal complexes, organic molecular complexes, inclusion compounds, methods of analysis of complexes, crystalline structures of complexes and thermodynamic basis of stability constants. Protein binding and drug action, protein binding studies.

UNIT V KINETICS AND DRUG STABILITY 9

General considerations and concepts of drug reaction kinetics; zero order, first order and pseudo first order, half-life determination, Influence of temperature, light, catalytic species, solvent and other factors, Stabilization of drugs, Accelerated stability study, expiration dating.

TOTAL: 45 PERIODS

OUTCOMES:

- To know the fundamental properties of pharmaceutical solids

- To understand the surface, interfacial phenomena and the rheology of liquids
- Ability to understand the principles, characters and applications of pharmaceutical dispersions.
- To acquire the knowledge about drug diffusion, dissolution, complexation and protein binding.
- To be familiar with the degradation pathways, stabilization of drugs and their expiry date calculation.

TEXT BOOKS:

1. Manavalan, R. and Ramasamy. C. "Physical Pharmaceutics" 2nd Ed., Vignesh Publishers, 2015.
2. C.V.S. Subrahmanyam, Text book of physical pharmaceutics, 3rdEdn., Vallabhprakashan, 2015.
3. Hadkar. U. B., Physical Pharmacy, NiraliPrakashan; 12th edition, 2017.

REFERENCES:

1. Alfred N. Martin, Patrick J. Sinko, Martin's Physical Pharmacy and Pharmaceutical Sciences: Physical Chemical and Biopharmaceutical Principles in the Pharmaceutical Sciences, sixth edition, Lippincott Williams & Wilkins, 2011.
2. David B. Troy, Paul Beringer, Remington: The science and practice of pharmacy, 21st Edition, Lippincott Williams and Wilkins, 2006
3. Humphrey Moynihan and Abinacrean "Physicochemical Basis of Pharmaceuticals" Oxford University Press, 2009.

GE8291 ENVIRONMENTAL SCIENCE AND ENGINEERING L T P C
3 0 0 3

OBJECTIVES:

- To study the nature and facts about environment.
- To finding and implementing scientific, technological, economic and political solutions to environmental problems.
- To study the interrelationship between living organism and environment.
- To appreciate the importance of environment by assessing its impact on the human world; envision the surrounding environment, its functions and its value.
- To study the dynamic processes and understand the features of the earth‟s interior and surface.
- To study the integrated themes and biodiversity, natural resources, pollution control and waste management.

UNIT I ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY 14

Definition, scope and importance of environment – need for public awareness - concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers – energy flow in the ecosystem – ecological succession – food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to biodiversity definition: genetic, species and ecosystem diversity – biogeographical classification of India – value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global, national and local levels – India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic

species of India – conservation of biodiversity: In-situ and ex-situ conservation of biodiversity. Field study of common plants, insects, birds; Field study of simple ecosystems – pond, river, hill slopes, etc.

UNIT II ENVIRONMENTAL POLLUTION 8

Definition – causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards – solid waste management: causes, effects and control measures of municipal solid wastes – role of an individual in prevention of pollution – pollution case studies – disaster management: floods, earthquake, cyclone and landslides. Field study of local polluted site – Urban / Rural / Industrial / Agricultural.

UNIT III NATURAL RESOURCES 10

Forest resources: Use and over-exploitation, deforestation, case studies- timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and over- utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. case studies – Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification – role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles. Field study of local area to document environmental assets – river / forest / grassland / hill / mountain.

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT 7

From unsustainable to sustainable development – urban problems related to energy – water conservation, rain water harvesting, watershed management – resettlement and rehabilitation of people; its problems and concerns, case studies – role of non-governmental organization- environmental ethics: Issues and possible solutions – climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies. – wasteland reclamation – consumerism and waste products – environment production act – Air (Prevention and Control of Pollution) act – Water (Prevention and control of Pollution) act – Wildlife protection act – Forest conservation act – enforcement machinery involved in environmental legislation- central and state pollution control boards- Public awareness.

UNIT V HUMAN POPULATION AND THE ENVIRONMENT 6

Population growth, variation among nations – population explosion – family welfare programme – environment and human health – human rights – value education – HIV / AIDS – women and child welfare – role of information technology in environment and human health – Case studies.

TOTAL: 45 PERIODS

OUTCOMES:

- Environmental Pollution or problems cannot be solved by mere laws. Public participation is an important aspect which serves the environmental Protection. One will obtain knowledge on the following after completing the course.
- Public awareness of environmental is at infant stage.
- Ignorance and incomplete knowledge has lead to misconceptions
- Development and improvement in std. of living has lead to serious environmental disasters

TEXT BOOKS:

1. Benny Joseph, "Environmental Science and Engineering", Tata McGraw-Hill, New Delhi, 2006.
2. Gilbert M. Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, 2004.

REFERENCES:

1. Dharmendra S. Sengar, "Environmental law", Prentice hall of India PVT LTD,New Delhi, 2007.
2. Erach Bharucha, "Textbook of Environmental Studies", Universities Press(I) PVT, LTD, Hydrabad, 2015.
3. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, 2005.
4. G. Tyler Miller and Scott E. Spoolman, "Environmental Science", Cengage Learning India PVT, LTD, Delhi, 2014.

PY8311 PHYSICAL PHARMACEUTICS LABORATORY L T P C
0 0 4 2

OBJECTIVES:

- To practice the determination of fundamental properties of dosage forms of powders and dispersions.
- To study the kinetics and stability aspects of pharmaceuticals.

LIST OF EXPERIMENTS:

1. Studies on polymorphs, their identification and properties.
2. Determination of particle size, particle size distribution and surface area using various methods of particle size analysis.
3. Determination of derived properties of powders like density, porosity, compressibility, angle of repose, etc.
4. Determination of surface/interfacial tension, HLB value and critical micellar concentration (CMC) of surfactants.
5. Study of rheological properties of various types of systems using different viscometers.
6. Study of different types of colloids and their properties.
7. Preparation of various types of suspensions and determination of their sedimentation parameters.
8. Preparation and stability studies of emulsions.
9. Studies on different types of complexes and determination of their stability constants.
10. Studies on protein binding of drugs
11. Determination of half-life, rate constant and order of reaction.
12. Preparation of pharmaceutical buffers and determination of buffer capacity.
13. Determination of shelf life of a product based on Arrhenius principle

TOTAL: 60 PERIODS

LIST OF EQUIPMENTS FOR BATCH OF 30 STUDENTS

- Optical Microscope
- Sieve shaker
- Anderson pipette
- Ostwald's viscometer
- Brookfield viscometer
- Stability chamber
- Bulk density apparatus

OUTCOMES:

On completion of the course the students will able to

- Characterize and evaluate the properties of powders by using suitable methods.
- Plan and carryout the stability studies and determine the stability of various dosage forms.
- Calculate the rate constants and determine the various order of reactions involved in pharmaceutical systems and process.

TEXT BOOKS:

1. CVS Subrahmanyam, SG Vasantharaju, Laboratory Manual of Physical Pharmacy, 2nd Ed., Vallabh Prakashan, 2009.
2. Manavalan, R. and Ramasamy. C. "Physical Pharmaceutics" 2nd Ed., Vignesh Publishers, 2015.

REFERENCES:

1. Eugene L. Parrott, Witold Saski, Experimental Pharmaceutics, 4th edn., Burgess Pub. Co., 1977.
2. Howard C. Ansel, Pharmaceutical Calculations, 13th edn., LWW, 2009,
3. Dr. U. B. Hadkar, Practical Physical Pharmacy & Physical Pharmaceutics, Nirali Prakashan, Pune,2008.

BT8361 MICROBIOLOGY LABORATORY L T P C

0 0 4 2

OBJECTIVE:

- To demonstrate various techniques to learn the morphology, identification and propagation of microbes

Experiments

1. Introduction, Laboratory Safety, Use of Equipment; Sterilization Techniques
2. Culture Media-Types and Use; Preparation of Nutrient broth and agar
3. Culture Techniques, Isolation and Preservation of Cultures- Broth: flask, test tubes; Solid:Pour plates, streak plates, slants, stabs
4. Microscopy – Working and care of Microscope
5. Microscopic Methods in the Study of Microorganisms., Microscopic identification of yeast/mould
6. Staining Techniques Simple, Differential- Gram's Staining, spore /capsule staining
7. Quantification of Microbes: Sampling and Serial Dilution; Bacterial count in Soil – TVC
8. Effect of Disinfectants- Phenol Coefficient
9. Antibiotic Sensitivity Assay
10. Growth Curve in Bacteria and Yeast
11. Effect of pH, Temperature, UV radiation on Growth Bacteria

TOTAL: 60 PERIODS

OUTCOMES:

Students will be able to

- Understand the advanced technical information pertaining to laboratory bio-safety and preventive measures from pathogenic microorganism.
- Know the various aseptic techniques and sterilization methods.
- Develop the minimum skills to work on several important techniques for the study of microorganisms in the laboratory.

Equipment Needed for 30 Students

Autoclave	1
Hot Air Oven	1
Incubators	2
Light Microscopes	4
Incubator Shaker	1
Colorimeter	2
Lamina Flow Chamber	2

Glassware, Chemicals, Media as required

TEXT BOOKS

1. Cappuccino, J.G. and N. Sherman "Microbiology: A Laboratory Manual", 4th Edition, Addison-Wesley, 1999.
2. Collee, J.G. etal., "Mackie & McCartney Practical Medical Microbiology" 4th Edition, ChurchillLivingstone, 1996.

HS8381	INTERPERSONAL SKILLS/LISTENING&SPEAKING	L	T	P	C
		0	0	2	1

OBJECTIVES: The Course will enable learners to:

- Equip students with the English language skills required for the successful undertaking of academic studies with primary emphasis on academic speaking and listening skills.
- Provide guidance and practice in basic general and classroom conversation and to engage in specific academic speaking activities.
- improve general and academic listening skills
- Make effective presentations.

UNIT I

Listening as a key skill- its importance- speaking - give personal information - ask for personal information - express ability - enquire about ability - ask for clarification Improving pronunciation - pronunciation basics taking lecture notes - preparing to listen to a lecture - articulate a complete idea as opposed to producing fragmented utterances.

UNIT II

Listen to a process information- give information, as part of a simple explanation - conversation starters: small talk - stressing syllables and speaking clearly - intonation patterns - compare and contrast information and ideas from multiple sources- converse with reasonable accuracy over a wide range of everyday topics.

UNIT III

Lexical chunking for accuracy and fluency- factors influence fluency, deliver a five-minute informal talk - greet - respond to greetings - describe health and symptoms - invite and offer - accept - decline - take leave - listen for and follow the gist- listen for detail

UNIT IV

Being an active listener: giving verbal and non-verbal feedback - participating in a group discussion - summarizing academic readings and lectures conversational speech listening to and participating in conversations - persuade.

UNIT V

Formal and informal talk - listen to follow and respond to explanations, directions and instructions in academic and business contexts - strategies for presentations and interactive communication - group/pair presentations - negotiate disagreement in group work.

TOTAL: 30 PERIODS

OUTCOMES: At the end of the course Learners will be able to:

- Listen and respond appropriately.
- Participate in group discussions
- Make effective presentations
- Participate confidently and appropriately in conversations both formal and informal

TEXT BOOKS:

1. **B**rooks,Margret. **Skills for Success. Listening and Speaking**. **Level 4** Oxford University Press, Oxford: 2011.
2. Richards,C. Jack. & David Bholke. **Speak Now Level 3.** Oxford University Press, Oxford: 2010

REFERENCES:

1. Bhatnagar, Nitin and MamtaBhatnagar**. Communicative English for Engineers and Professionals.** Pearson: New Delhi, 2010.
2. Hughes, Glyn and Josephine Moate**. Practical English Classroom.** Oxford University Press: Oxford, 2014.
3. Vargo, Mari**. Speak Now Level 4.** Oxford University Press: Oxford, 2013.
4. Richards C. Jack. **Person to Person (Starter).** Oxford University Press: Oxford, 2006.
5. Ladousse, Gillian Porter**. Role Play.** Oxford University Press: Oxford, 2014

MA8391 PROBABILITY AND STATISTICS L T P C
4 0 0 4

OBJECTIVES:

- This course aims at providing the required skill to apply the statistical tools in engineering problems.
- To introduce the basic concepts of probability and random variables.
- To introduce the basic concepts of two dimensional random variables.
- To acquaint the knowledge of testing of hypothesis for small and large samples which plays an important role in real life problems.
- To introduce the basic concepts of classifications of design of experiments which plays very important roles in the field of agriculture and statistical quality control.

UNIT I PROBABILITY AND RANDOM VARIABLES 12

Probability – The axioms of probability – Conditional probability – Baye's theorem - Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions.

UNIT II TWO - DIMENSIONAL RANDOM VARIABLES 12

Joint distributions – Marginal and conditional distributions – Covariance – Correlation and linear regression – Transformation of random variables – Central limit theorem (for independent and identically distributed random variables).

UNIT III TESTING OF HYPOTHESIS 12

Sampling distributions - Estimation of parameters - Statistical hypothesis - Large sample tests based on Normal distribution for single mean and difference of means -Tests based on t, Chi-square and F distributions for mean, variance and proportion - Contingency table (test for independent) - Goodness of fit.

UNIT IV DESIGN OF EXPERIMENTS 12

One way and Two way classifications - Completely randomized design – Randomized block design – Latin square design - 2^2 factorial design.

UNIT V STATISTICAL QUALITY CONTROL 12

Control charts for measurements (X and R charts) – Control charts for attributes (p, c and np charts) – Tolerance limits - Acceptance sampling.

TOTAL: 60 PERIODS

OUTCOMES:

Upon successful completion of the course, students will be able to:

- Understand the fundamental knowledge of the concepts of probability and have knowledge of standard distributions which can describe real life phenomenon.
- Understand the basic concepts of one and two dimensional random variables and apply in engineering applications.
- Apply the concept of testing of hypothesis for small and large samples in real life problems.
- Apply the basic concepts of classifications of design of experiments in the field of agriculture and statistical quality control.
- Have the notion of sampling distributions and statistical techniques used in engineering and management problems.

TEXT BOOKS:

1. Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.
2. Milton. J. S. and Arnold. J.C., "Introduction to Probability and Statistics", Tata McGraw Hill, 4th Edition, 2007.

REFERENCES:

1. Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8th Edition, 2014.
2. Papoulis, A. and Unnikrishnapillai, S., "Probability, Random Variables and Stochastic Processes", McGraw Hill Education India, 4th Edition, New Delhi, 2010.
3. Ross, S.M., "Introduction to Probability and Statistics for Engineers and Scientists", 3rd Edition, Elsevier, 2004.
4. Spiegel. M.R., Schiller. J. and Srinivasan, R.A., "Schaum's Outline of Theory and Problems of Probability and Statistics", Tata McGraw Hill Edition, 2004.
5. Walpole. R.E., Myers. R.H., Myers. S.L. and Ye. K., "Probability and Statistics for Engineers and Scientists", Pearson Education, Asia, 8th Edition, 2007.

PY8401 STOICHIOMETRY AND CHEMICAL PROCESS CALCULATIONS L T P C
3 0 0 3

OBJECTIVE:

This course will enable students

- To introduce the basic calculation techniques, laws about the behaviour of gases, liquids and solids, for analysing and designing chemical processing equipment with the help of data sources containing relevant physical and chemical properties.

UNIT I UNITS AND DIMENSIONS 9

Fundamental and derived units, conversion, dimensional consistency of equations, conversions of equations, Dimensional and dimensionless constants, mass and volume relations, Stoichiometric and composition relations.

UNIT II IDEAL GASES AND VAPOUR PRESSURE 9

Ideal gas law, Dalton's Law, Amagat's Law and Average molecular weight of gaseous mixtures. Effect of temperature on vapour pressure, Vapour pressure plot (Cox chart), Vapour pressures of miscible and immiscible liquids and solutions, Raoult's Law and Henry's Law.

UNIT III HUMIDITY AND SOLUBILITY 9

Partial saturation, Humidity- Absolute Humidity, Vaporization process, Molal humidity, Relative and percentage saturation, dew point, humid heat, wet bulb and dry bulb temperatures, use of humidity charts, adiabatic vaporization and adiabatic saturation temperature.

UNIT IV MATERIAL BALANCE 9

Tie substance, limiting reactant, excess reactant, General material balance equation for steady and unsteady state, Typical steady state material balances in distillation, absorption, extraction, crystallization. Combustion of coal, fuel gases and sulphur – Recycling operations – Bypassing streams – Degree of conversion – Excess reactant – Limiting reactant- Selectivity and Yield.

UNIT V ENERGY BALANCE 9

General steady state energy balance equation, Heat capacity, Enthalpy, Heat of formation, Heat of reaction, Heat of combustion and Calorific values. Heat of solution, Heat of mixing, Heat of crystallization, determination of ΔHR at standard and elevated temperatures, Theoretical flame temperature and adiabatic flame temperature.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of this course the student will

- Have clear idea of various types of unit systems and they will be able to convert units from one form of the unit to other.
- Have sound strategy for solving and developing mathematical relations for material and energy balance calculations for reaction and separation processes.
- Analyze the behaviour of recycle processes, performing approximate material balances by hand and setting up calculations for rigorous solution by computer.

TEXT BOOKS:

1. Narayanan, K.V. and Lakshmikutty, B. "Stoichiometry and Process Calculations", 2nd Edition., PHI Learning Pvt. Ltd., 2017
2. Bhatt, B.I. and Thakore, S.M., "Stoichiometry", 5th Edition, Tata McGraw Hill Education Pvt. Ltd, 2011.

3. Gavhane, K. A. “Introduction to Process Calculations”, Nirali Publication, 2016.

REFERENCES:

1. Venkataramani, V., Anantharaman, N. and MeeraSheriffaBegumK. M. “Process Calculations”,2nd ed.PHI Learning Pvt. Ltd., 2011
2. Himmelblau, D. M. and Riggs,B.J. “Basic Principles and Calculations in Chemical Engineering", 8thEdition, Prentice Hall International series, 2012.
3. Sikdar, C.D., "Chemical Process Calculations", PHI Learning Pvt. Ltd., 2013.

PY8402 FLUID FLOW OPERATIONS L T P C
3 0 0 3

OBJECTIVES:

- To provide the basic fundamental knowledge about the flow properties of different types of fluids and its momentum balance.
- To provide the knowledge about the various transporting and metering devices of fluid flow in bulk pharmaceutical manufacturing and in chemical process.

UNIT I PROPERTIES OF FLUIDS AND CONCEPT OF PRESSURE 9

Introduction–Physical properties of fluids–Types of fluids–Fluid statics and its applications - Pressure–Density–Height relationships–Pressure measurement–Units and dimensions – Dimensional analysis–Dimensionless numbers.

UNIT II MOMEMTUM BALANCE AND ITS APPLICATIONS 9

Kinematics of fluidflow–Streamline–Streamtube–Velocity potential–Newtonian and non-newtonian fluids –Time dependent fluids –Reynolds number experiment andsignificance –Continuity Equation– Momentum balance – Potential flow – Bernoulli's equation–Correction for fluid friction– Correction for pump work.

UNIT III FLOW OF INCOMPRESSIBLE FLUIDS THROUGH DUCTS 9

Flow of incompressible fluids in pipes–Laminar and turbulent flow through closed conduits– Velocity profile and frictionact or for smooth and rough pipes–Heat loss due to friction in pipes and Fittings.

UNIT IV FLOW OF FLUIDS THROUGH SOLIDS 9

Formdrag–Skindrag–Dragco-efficient–Flow around solids and packed beds–Friction factor for packed beds– Ergun's Equation– Motion of particles through fluids–Motion under gravitational and centrifugal fields–Terminal settling velocity–Fluidization –Mechanism– Types–General properties–Applications.

UNIT V TRANSPORTATION AND METERING 9

Measurement of fluid flow–Orificemeter–Venturimeter–Pitottube–Rotameter–Weirs and notches – Hot wire anemometers–Transportation offluids–Positive displacement pumps– Rotary and Reciprocating pumps – Centrifugal pumps –Performance andcharacteristics– Airlift and diaphragm pumps.

TOTAL: 45 PERIODS

OUTCOMES:

The student will be able to

- Understand fundamental concepts in fluids, such as density, viscosity, pressure and temperature.

- Apply the mass, energy and momentum balance equations in fluid flow problems.
- Analyse and solve the problems involving laminar and turbulent frictional flow, fluid dragon particles, packed beds and pumps involving Newtonian and non-Newtonian fluid flow in chemical engineering equipment's.

TEXT BOOKS:

1. W.L. McCabe, J.C. Smith, P. Harriott, "Unit operations of Chemical Engineering", 7th ed., McGraw-Hill, 2017.
2. W.M. Deen, "Introduction to Chemical Engineering Fluid Mechanics (Cambridge Series in Chemical Engineering)", Cambridge University Press, UK, 2016.
3. James Patrick Abulencia, Louis Theodore, "Fluid Flow for the Practicing Chemical Engineer", Wiley, 2009.

REFERENCES:

1. Bansal,R.K., "Fluid Mechanics and Hydraulic machines", Laxmi Publications (P)Ltd., 2017.
2. Nevers,N.D., "Fluid Mechanics for Chemical Engineers", 3rd ed., McGraw-Hill,2005

PY8403 UNIT OPERATIONS IN PHARMA INDUSTRIES L T P C
3 2 0 4

OBJECTIVE:

- To provide the basic fundamentals and various unit operations such as size reduction, separation, filtration, centrifugation, crystallization and evaporation.

UNIT I MATERIALS OF PHARMACEUTICAL PLANT CONSTRUCTION 15

Overview of composition, corrosion, resistance, properties and applications of the materials of construction with special reference to stainless steel and glass- Industrial Hazards and Safety Precautions – Mechanical, Chemical, Electrical, Fire and Dust hazards, etc.

UNIT II SIZE REDUCTION & SEPARATION 15

Properties and characterization of particulate solids — Introduction to storage and conveying of solids - Analysis and technical methods for size determination of powders - Size reduction equipment – Screening equipment

UNIT III CRYSTALLIZATION 15

Characters of crystals like purity, size, shape, geometry, habit, forms, size and its factors- Solubility curves- Super saturation theory and its limitations- nucleation mechanism and crystal growth- crystallisers- Swenson Walker crystalliser - Caking of crystals and its prevention and numerical problems on yields.

UNIT IV FILTRATION AND CENTRIFUGATION 15

Theory of filtration, filter aids, filter media- Factors affecting filtration- industrial filters including filter press, rotary filter, edge filter, etc., - mathematical problems on filtration. Principles of centrifugation- industrial centrifugal filters - sedimentation centrifuges.

UNIT V MIXING 15

Mixing of powdered materials – Mechanism of random mixing and interactive mixing. Sampling techniques, size and mixing indices. Factors affecting the mixing process. Types, characteristics and operation of mixers.

TOTAL (L:45 + T:30):75 PERIODS

OUTCOMES:

The student will be able to

- Recognise the various categories of materials used in pharmaceutical industry.
- Apprehend the fundamental concepts of Size reduction, separation, filtration, centrifugation in Pharmaceutical industry.
- Comprehend the fundamental concepts of crystallization and evaporation

TEXT BOOKS:

1. McCabe WL, Smith J.C and Harriott “Unit operations of Chemical Engineering”McGraw Hill International Book Co. London 2004.
2. Girish K.Jani, “Pharmaceutical Engineering I, Unit Operation I” B.S.ShahPrakashan,India, 2006.
3. Cooper and Gunn's Tutorial Pharmacy, Edited by S J Carter, CBS Publishers, New Delhi, 2005

REFERENCES:

1. Badger, W.L and Banchero, J.T “Introduction to Chemical Engineering” Tata McGrawHill, 2002
2. Coulson, J.M. and Richardson, J.F.”Chemical Engineering” 3rd Edition, ButterworthHeinemann Publication, 2001.
3. K. Sambamurthy, Pharmaceutical Engineering New Age International (P) Ltd., Publishers, New Delhi, 1998.

PY8404 MOLECULAR BIOLOGY AND GENETIC ENGINEERING L T P C
4 0 0 4

OBJECTIVES:

- To expose students to application of recombinant DNA technology in biotechnological research.
- To train students in strategizing research methodologies employing cloning, construction of DNA libraries
- To illustrate creative use of modern tools and techniques for manipulation and analysis of genomic sequences.

UNIT I MOLECULAR GENETICS 12

Bacterial conjugation, transduction and transformation, prokaryotic and eukaryotic genome organization; Introduction to nucleic acids, Nucleic acids as genetic material, Structure and function of DNA and RNA, DNA replication, Overview of differences in prokaryotic and eukaryotic DNA replication, Telomere replication in eukaryotes. Mutagens, DNA mutations and their mechanism, various types of repair mechanisms.

UNIT II TRANSCRIPTION AND TRANSLATION 12

Structure and function of mRNA, rRNA and tRNA. RNA synthesis: Initiation, elongation and termination of RNA synthesis, Translation: Introduction to Genetic code: Elucidation of genetic code, Codon degeneracy, Wobble hypothesis and its importance, Steps in translation: Initiation, Elongation and termination of protein synthesis. Inhibitors of protein synthesis. Post-translational modifications and its importance. Organization of genes in prokaryotic and eukaryotic chromosomes.

UNIT III RECOMBINANT DNA TECHNOLOGY 12

Manipulation of DNA – Restriction and Modification enzymes. Characteristics of cloning and expression vectors based on plasmid and bacteriophage, Vectors for yeast, insect and mammalian systems, Prokaryotic and eukaryotic expression host systems, Introduction of recombinant DNA in to host: Insulin, Interferons, Erythropoietin, DNA libraries: Construction of genomic and cDNA libraries.

UNIT IV SEQUENCING AND AMPLIFICATION OF DNA 12

Amplification of DNA; Types of PCR, Real-time PCR/qPCR – SYBR green assay, Taqman assay, Site directed mutagenesis. Organization and structure of genomes, Maxam Gilbert's and Sanger Coulson's and automated methods of DNA sequencing, Next generation sequencing technologies, Genetic maps and Physical maps.

UNIT V GENOME ANALYSIS AND GENOMICS 12

Gene therapy and Transgenic technology, Introduction to Functional genomics, Microarrays, Serial Analysis of Gene expression (SAGE), Web resources for Genomics, Regulation of Eukaryotic Gene Expression by Small RNAs (RNA Interference, RNAi).

TOTAL: 60 PERIODS

OUTCOMES:

By the end of this course, students will be able to

- Describe the basic structure of nucleic acids, identify the principles of DNA replication, transcription and translation of proteins
- To produce the commercially important recombinant proteins
- Understand about gene expression and genome sequencing techniques

TEXT BOOKS:

1. David Friedfeld "Molecular Biology." Narosa Publications, 1999.
2. Primrose SB and R. Twyman "Principles of Gene Manipulation & Genomic Blackwell Science Publications, 2006.
3. Principles of Genome Analysis and Genomics by S.B. Primrose and R.M. Twyman, Third Edition (Blackwell Publishing), 2003.

REFERENCES:

1. Tropp, Burton. "Molecular Biology: Genes to Proteins". 3rd Edition. Jones andBartlett, 2008.
2. Ansubel FM, Brent R, Kingston RE, Moore DD, "Current Protocols in Molecular Biology"Greene Publishing Associates, NY, 1998
3. Genomes 3 by T.A.Brown, Third Edition (Garland Science Publishing), 2007.

PY8405 PHARMACEUTICAL ANALYSIS L T P C

3 0 0 3

OBJECTIVE:

- To facilitate students to acquire knowledge about the principles and operations of various modern analytical instruments.

UNIT I UV-VISIBLE SPECTROSCOPY 9

Theory of atomic and molecular spectra, Electronic transitions, Beer and Lambert's law, Derivation and deviations, Chromophores, Auxochromes, Spectral shifts, Solvent effect on absorption

spectra. Instrumentation - Sources of radiation, wavelength selectors, sample cells, Detectors- Barrier layer cell, Photo tube, PMT, PDA detectors; Applications in pharmaceuticals.

UNIT II ATOMIC ABSORPTION SPECTROSCOPY 9

Principles, Instrumentation, Operation – single and double beam spectroscopy; sampling technique – Detection limit, Difference between Atomic absorption spectroscopy and Flame spectroscopy; Applications in pharmaceuticals.

UNIT III INFRARED AND NMR SPECTROSCOPY 9

Principles of vibrational spectroscopy – Instrumentation and sampling techniques – Applications in pharmaceutical sciences – NMR principles – Instrumentation – Applications in pharmaceuticals.

UNIT IV MASS SPECTROMETRY 9

Basic principles, instrumentation and ionization methods; atmospheric pressure ionization (API), chemical ionization (CI), electron impact ionization (EI), fast atom bombardment (FAB), matrix assisted laser desorption ionization (MALDI), time of flight (TOF); Applications in pharmaceuticals.

UNIT V CHROMATOGRAPHIC METHODS 9

History, origin and classification of chromatography: Column Chromatography: principle, theory, column operations, instrumentation, derivatisation methods and applications; High Performance Liquid Chromatography: Principle, instrumentation, solvents system, packing materials and applications; Thin Layer Chromatography: Principle, instrumentation, solvents, packing materials and applications in pharmaceuticals.

TOTAL: 45 PERIODS

OUTCOMES:

- Develops ability to handle the modern analytical instruments like UV/Vis, IR, NMR, Mass spectroscopy and HPLC.
- Develops ability to involve in Qualitative and Quantitative analysis of various pharmaceutical agents.
- Develops ability to involve in phytochemical and biological standardization of pharmaceutical products.

TEXT BOOKS:

1. A. H. Beckett & J. B. Stenlake, “Practical Pharmaceutical Chemistry”, Part II, 4th Edition,Bloomsbury Academic, 2001.
2. Hobert H. Willard, “Instrumental Methods of Analysis”, 7th Edition,CBS Publishers & Distributors, 2004.
3. B.K. Sharma, “Instrumental Method of Chemical Analysis”, Krishna’s Education Publishers, 2014.
4. P. D. Sethi, “HPTLC: High Performance Thin Layer Chromatography: Quantitative Analysis of Pharmaceutical Formulations”, 1st edition, CBS, 2013.

REFERENCES:

1. Robert M. Silverstein, Francis X .Webster , David J. Kiemle,David L. Bryce, cirtemortcepS” identification of Organic Compounds”, 8th Edition, Wiley, 2014.
2. Mendham J, “Vogel’s Text Book of Quantitative Chemical Analysis”, 6th Edition, Pearson Education 2009.
3. Douglas A. Skoog, F. James Holler, Stanley R. Crouch, “Principles of Instrumental Analysis”, 7th Edition, Brooks Cole, 2017.
4. William Kemp, “Organic Spectroscopy” W.H. Freeman, New York, 3rd Edition, 2011.

PY8411 ANALYTICAL METHODS AND INSTRUMENTATION LABORATORY L T P C
0 0 4 2

OBJECTIVE:

- To carry out analytical experiments related to spectroscopic and chromatographic techniques.

LIST OF EXPERIMENTS

1. Calibration of volumetric glasswares.
2. Establishing standard operating procedure (SOP) and Calibration records for analytical balance, pH meter and UV/Vis spectroscopy.
3. Determination of λ_{max}.
4. Effect of change in physio-chemical parameters on absorbance spectrum of a drug molecule.
5. Quantitative and qualitative analysis of drug molecule using standard comparison method by UV/Vis spectroscopy and HPLC.
6. Quantitative analysis of drug molecule using E1%1cm method by UV/Vis spectroscopy.
7. Quantitative analysis of drug molecule using calibration graph method by UV/Vis spectroscopy and HPLC.
8. Separation and identification of mixtures of drugs by TLC.
9. Separation and identification of amino acids by paper chromatography.
10. Identification of functional group of a drug molecule by IR spectroscopy.
11. Determination of impurities by limit test.
12. Quantitative analysis by titrimetric methods.

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

- Digital weighing balance
- Digital pH meter
- UV chamber
- TLC chamber
- UV/Vis spectroscopy
- HPLC
- IR spectroscopy

OUTCOMES:

Student will be able to perform,

- Preparation and standardization of various assay reagents with respect to chemical and drug analysis.
- Separation and quantification of drugs molecules by chromatographic and spectral techniques.

REFERENCES:

1. Atherden L.M, “Bentley and Driver’s Textbook of Pharmaceutical Chemistry”, 8th Edition, Oxford University Press, 2004.
2. Siddiqui, Anees A, “Pharmaceutical Analysis”. Vol.I& II, 3rd edition, CBS Publishers, 2014.
3. Takeru Higuchi, Einar Brochmann, Hanffen Hanssen, Hamffen Hanssen, “Pharmaceutical Analysis” 1st Edition, CBS Publishers, 2005.
4. Loyd V. Allen Jr, “Remington: The Science and Practice of Pharmacy”. Vol. I & II, 22nd Edition, Pharmaceutical Press;, 2012.
5. Kenneth A. Connors, “Text book of Pharmaceutical Analysis”, 3rd Edition, John wiley and sons, New York, 2007.

PY8412 MOLECULAR BIOLOGY AND GENETIC ENGINEERING LABORATORY L T P C
0 0 4 2

OBJECTIVES:

- To understand the principle of nucleic acid isolation.
- To understand the principles of PCR and their uses in genetic engineering.
- To gain a thorough knowledge about nucleic acid hybridization.
- To learn history of DNA sequencing and current methods and gene synthesis

LIST OF EXPERIMENTS:

1. Preparation of Genomic DNA
2. PCR amplification of gene from the genomic DNA
3. Preparation of plasmid DNA
4. Detection of Plasmid DNA by Agarose gel electrophoresis
5. Restriction Digestion of the vector and Insert
6. Ligation and Transformation of*E.coli*
7. Lysate PCR confirmation.
8. Restriction & gel elution of DNA fragments
9. Electroporation of Yeast
10. SDS-PAGE analysis of purified protein
11. Western blot confirmation of expressed protein (anti his)
12. ELISA– Quantification of proteins.
13. RNA Isolation
14. cDNA preparation from RNA
15. Site directed mutagenesis
16. Southern hybridization experiment

TOTAL: 60 PERIODS

LIST OF EQUIPMENTS REQUIRED FOR 30 STUDENTS

- PCR machine
- Electrophoretic assemblies for DNA and protein separations
- ELISA reader
- Ultracentrifuge
- Laminar air flow cabinets
- Cooling centrifuge

OUTCOMES:

By the end of this course, students will be able to:

- Describe the main principles, methods for preparation and cloning of DNA in various organisms.
- Express clearly about the gene amplification and methods for analysis of DNA, such as hybridization, restriction analysis and gene expressions.
- Express clearly about the analysis of protein expressions.

REFERENCES:

1. Old RW, Primrose SB, “Principles of Gene Manipulation, An Introduction to GeneticEngineering “, Blackwell Science Publications, 1993.

2. Ansubel FM, Brent R, Kingston RE, Moore DD, “Current Protocols in Molecular Biology, “Greene Publishing Associates, NY, 2003

3. S. John Vennison, “Laboratory manual for Genetic Engineering”, Eastern economy edition, 2009.

HS8461	ADVANCED READING AND WRITING	L	T	P	C
		0	0	2	1

OBJECTIVES:

- Strengthen the reading skills of students of engineering.
- Enhance their writing skills with specific reference to technical writing.
- Develop students' critical thinking skills.
- Provide more opportunities to develop their project and proposal writing skills.

UNIT I

Reading - Strategies for effective reading-Use glosses and footnotes to aid reading comprehension- Read and recognize different text types-Predicting content using photos and title **Writing**-Plan before writing- Develop a paragraph: topic sentence, supporting sentences, concluding sentence –Write a descriptive paragraph

UNIT II

Reading-Read for details-Use of graphic organizers to review and aid comprehension **Writing**-State reasons and examples to support ideas in writing- Write a paragraph with reasons and examples- Write an opinion paragraph

UNIT III

Reading- Understanding pronoun reference and use of connectors in a passage- speed reading techniques-**Writing-** Elements of a good essay-Types of essays- descriptive-narrative- issue-based-argumentative-analytical.

UNIT IV

Reading- Genre and Organization of Ideas- **Writing-** Email writing- visumes – Job application-project writing-writing convincing proposals.

UNIT V

Reading- Critical reading and thinking- understanding how the text positions the reader- identify **Writing**- Statement of Purpose- letter of recommendation- Vision statement

TOTAL: 30 PERIODS

OUTCOMES: At the end of the course Learners will be able to:

- Write different types of essays.
- Write winning job applications.
- Read and evaluate texts critically.
- Display critical thinking in various professional contexts.

TEXT BOOKS:

1. Gramer F. Margot and Colin S. Ward **Reading and Writing (Level 3)** Oxford University Press: Oxford, 2011.
2. Debra Daise, CharlNorloff, and Paul Carne **Reading and Writing (Level 4)** Oxford University Press: Oxford, 2011.

REFERENCES:

1. Davis, Jason and Rhonda LIss.**Effective Academic Writing (Level 3)** Oxford University Press: Oxford, 2006

2. E. Suresh Kumar and et al. **Enriching Speaking and Writing Skills.** Second Edition. Orient Black swan: Hyderabad, 2012
3. Withrow, Jeans and et al**. Inspired to Write. Readings and Tasks to develop writing skills.** Cambridge University Press: Cambridge, 2004
4. Goatly, Andrew**. Critical Reading and Writing.** Routledge: United States of America, 2000
5. Petelin, Roslyn and Marsh Durham**. The Professional Writing Guide: Knowing Well and Knowing Why.** Business & Professional Publishing: Australia, 2004

BT8691 APPLIED CHEMICAL REACTION ENGINEERING L T P C
3 0 0 3

OBJECTIVES:

- To provide the basic concepts of types of reactions, variable affecting the rate of reaction, predicting the rate equations for different types of reactions.
- To provide the information about different reactor systems, deriving the performance equations and predicting the rate equations in chemical reaction engineering system.

UNIT I SCOPE OF CHEMICAL KINETICS & CHEMICAL REACTION ENGINEERING 9

Broad outline of chemical reactors; rate equations; concentration and temperature dependence; development of rate equations for different homogeneous reactions. Industrial scale reactors.

UNIT II IDEAL REACTORS 9

Isothermal batch, flow, semi-batch reactors; performance equations for single reactors; multiple reactor systems; multiple reactions.

UNIT III NON IDEAL REACTORS 9

RTD in non-ideal flow; non-ideal flow models; reactor performance with non-ideal flow.

UNIT IV GAS-SOLID, GAS-LIQUID REACTIONS 9

Resistances and rate equations; heterogeneous catalysis; reactions steps; resistances and rate equations.

UNIT V FIXED BED AND FLUID BED REACTORS 9

G/L reactions on solid catalysis; trickle bed, slurry reactors; three phase-fluidized beds; reactors for fluid-fluid reactions; tank reactors.

TOTAL: 45 PERIODS

OUTCOMES:

The student will be able to

- Write the rate equation for any type of reaction.
- Design reactors for heterogeneous reactions and optimize operating conditions.
- Relate and calculate the conversions, concentrations and rates in a reaction and identify, formulate and solve chemical engineering problems.

TEXT BOOKS:

1. Levenspiel O. Chemical Reaction Engineering. IIIrd Edition. John Wiley.2006.
2. Fogler H.S. Elements Of Chemical Reaction Engineering. Prentice Hall India.2002

REFERENCES:

1. Missen R.W., Mims C.A., Saville B.A. Introduction to Chemical Reaction Engineering and Kinetics. John Wiley.1999

2. Dawande, S.D., “Principles of Reaction Engineering”, Ist Edition, Central Techno Publications, 2001.
3. Richardson, J.F. and Peacock, D.G., “Coulson Richardson - Chemical Engineering”, Vol.III, IIIrd Edition, Butterworth- Heinemann- Elsevier, 2006.

PY8501 MEDICINAL CHEMISTRY L T P C
4 0 0 4

OBJECTIVES:

- To impart comprehensive understanding of the chemical basis of drug action including physicochemical and steric properties of drug.
- To study the classification, chemical nomenclature, generic names and synthesis of various medicinal agents.
- To understand the structure activity relationship, biochemical/molecular basis of mechanism of action and uses of drug.

UNIT I PRINCIPLES OF MEDICINAL CHEMISTRY 12

Physicochemical properties in relation to biological action: Ionization, Drug distribution and pKa values and their relation to drug transport, hydrogen bonding, redox potential, surface activity and chelation. Steric properties of drugs: optical and geometrical isomerism. Functional group and their effects of on drug action: steric effect, concept of isosterism, bioisosterism, homologs and analogs.

UNIT II DRUGS ACTING ON SYNAPTIC AND NEURO-EFFECTOR JUNCTION SITES 12

Classification, biochemical/molecular basis of mechanism of action, structure activity relationship including stereo chemical aspects, physiochemical properties and synthesis of selected drugs belonging to the class of Cholinergics, Anticholinergics, Anticholinesterases and Adrenergics.

UNIT III DRUGS ACTING ON THE CENTRAL NERVOUS SYSTEM 12

Classification, molecular basis of mechanism of action, structure activity relationship and synthesis of Hypnotics and Sedatives, Opioid analgesics, Anticonvulsants and Psychopharmacological agents (neuroleptics, antidepressants, anxiolytics).

UNIT IV DRUGS ACTING ON CARDIOVASCULAR SYSTEM 12

Structural basis of mechanism of action, structure activity relationship including physiochemical properties, and synthesis of selected drugs belonging to the class of anti-anginal, vasodilators, calcium channel blockers and cardiac glycosides.

UNIT V AUTOCOIDS 12

Synthetic procedures, uses, structure activity relationship including physicochemical properties of the following classes of drugs Antihistamines, Eicosanoids, Analgesic-antipyretics, Anti - inflammatory (non-steroidal) agents.

TOTAL: 60 PERIODS

OUTCOMES:

The student will be able to

- Gain an appreciation of importance of the physical properties of drugs with respect to the ionization, solubility and efficacy of drugs, understand how changes in the chemical structure of drugs affect efficacy.
- Obtain a working knowledge of chemical structures and nomenclature, to develop the ability to suggest suitable techniques to synthesis different drug molecules.

- Understand how current drugs were developed and demonstrate the importance of chemistry in the development and application of therapeutic drugs.

TEXT BOOKS:

1. Ashutosh Kar, Medicinal Chemistry, 6th Edition, New Age International (P) Ltd. Publishers, New Delhi 2015.
2. Graham L. Patrick, An introduction to Medicinal Chemistry ,6th Edition, Oxford University Press, 2017.
3. Ilango, K. and Valentina, P., "Text book of Medicinal Chemistry", Vol.1, 1st edition, Keerthi Publishers,2007.

REFERENCES:

1. Donald J. Abraham, Burger's Medicinal Chemistry and Drug Discovery, Vol V, 6th Edition, John Wiley and Sons, Inc., 2003.
2. William O Foye, Thomas L Lemke, David A Williams Foye's Principles of Medicinal Chemistry, 7th Edition, Wolters Kluwer Health Adis (ESP) Publisher, 2012.
3. Indian Pharmacopoeia, Vol-I,7th Edition, Published by Indian Pharmacopoeia Commission India, 2014.

PY8502 PHARMACOLOGY AND CHEMOTHERAPY L T P C
4 0 0 4

OBJECTIVES:

- To provide the general pharmacological principles.
- To make understand the pharmacology of different types of drugs acting on various physiological systems.

UNIT I GENERAL PHARMACOLOGY 12

Routes of administration, Pharmacokinetics, Pharmacodynamics, Factors modifying drug action, adverse drug reaction, drug interactions, Bioassay of drugs, drug discovery and development.

UNIT II PERIPHERAL AND CENTRAL NERVOUS SYSTEM 12

Mechanism of action, Pharmacology of parasympathomimetics, parasympatholytics, sympathomimetics, sympatholytics, neuromuscular blocking agents, general anaesthetics, antipsychotics, antidepressants, antiepileptic, analgesics, antipyretic, anti-inflammatory (NSAIDS) and CNS stimulants.

UNIT III CARDIOVASCULAR PHARMACOLOGY 12

Classification, Mechanism of action, Pharmacology of cardiac glycosides, antianginal, antihypertensive agents, vasodilators including calcium channel blockers, antiarrhythmic and anti-hyperlipidemic agents.

UNIT IV GASTROINTESTINAL PHARMACOLOGY 10

Classification, Mechanism of action, Antacids, antiulcer drugs, laxatives, antidiarrhoeal, emetics, antiemetics, appetite stimulants and suppressants.

UNIT V CHEMOTHERAPY AND ANTIMICROBIAL AGENTS 14

General principles of chemotherapy, sulphonamides, antibiotics – penicillins, cephalosporins, chloramphenicol, macrolides, fluoroquinolones. Chemotherapy of tuberculosis, leprosy, fungal, viral diseases, malignancy and immunosuppressive agents.

TOTAL: 60 PERIODS

OUTCOMES:

The student will be able to

- Understand the various principles of general pharmacology.
- Understand the pharmacology of various categories of drugs acting on nervous, cardiovascular and gastrointestinal systems.
- Understand the principles of chemotherapy and pharmacology of antimicrobial agents.

TEXT BOOKS:

1. Tripathi, K.D., “Essentials of Medical Pharmacology”, 7th Edition, Jaypee Brothers Medical Publishers (P) Ltd, 2015.
2. Satoskar, R.S., Bhandarkar, S.D. and Rege, N., “Pharmacology and Pharmacotherapeutics”, 24th edition, Popular Prakashan (P) Ltd., 2015.
3. H. L. Sharma, K. K. Sharma, Principles of Pharmacology, Paras Medical Publishers, 3rd Edition, 2017.

REFERENCES:

1. Laurence L. Brunton, Bjorn C. Knollmann, RandaHilal-Dandan, " Goodman and Gilman S “The Pharmacological Basis of Therapeutics", 13thedition, McGraw-Hill Education / Medical, 2017.
2. Humphrey P. Rang,Maureen M .Dale ,James M .Ritter ,Rod J. Flower, Graeme Henderson, "Rang &Dale's Pharmacology", 8th edition, Churchill Livingstone, 2015.
3. Katzung, B.G., Trevor AJ. Basic and Clinical Pharmacology, McGraw-Hill Education, 13th Edition, 2015.

FD8491 FUNDAMENTALS OF HEAT AND MASS TRANSFER L T P C

3 2 0 4

OBJECTIVE:

- To understand the principles and applications of heat and mass transfer operations.

UNIT I HEAT TRANSFER – CONDUCTION 9+6

Basic transfer processes – heat, mass and momentum – heat transfer process - conductors and insulators - conduction – Fourier’s fundamental equation – thermal conductivity and thermal resistance - linear heat flow – heat transfer through homogenous wall, composite walls, radial heat flow through cylinders and sphere – extended surfaces (fins) –– solving problems in heat transfer by conduction.

UNIT II HEAT TRANSFER - CONVECTION 9+6

Newton Rikhman’s law – film coefficient of heat transfer - convection – free and forced convection - dimensional analysis and its application – factors affecting the heat transfer coefficient in free and forced convection heat transfer – overall heat transfer coefficient - solving problems in heat transfer by convection.

UNIT III HEAT TRANSFER – HEAT EXCHANGER 9+6

Heat exchangers – parallel, counter and cross flow – evaporator and condensers - Logarithmic Mean Temperature Difference – overall coefficient of heat transfer – tube in tube heat exchanger, shell and tube heat exchanger, plate heat exchanger – applications of heat exchangers - solving problems in heat exchangers.

UNIT IV HEAT TRANSFER: RADIATION 9+6

Radiation heat transfer – concept of black and grey body - monochromatic total emissive power – Kirchoff's law – Planck's law - Stefan-Boltzman's law – heat exchange through non-absorbing media - solving problems in heat transfer by radiation.

UNIT V MASS TRANSFER 9+6

Mass transfer – introduction – Fick's law for molecular diffusion - molecular diffusion in gases – equimolar counters diffusion in gases and diffusion of gas A through non diffusing or stagnant B - diffusion through a varying cross sectional area and diffusion coefficients for gases - molecular diffusion in liquids, biological solutions and gels.

TOTAL: 75 PERIODS

OUTCOME:

- To understand and apply the principles in heat transfer phenomena To understand and apply the principles in mass transfer phenomena To design heat and mass transfer equipments.

TEXT BOOKS:

1. Bellaney, P.L. "Thermal Engineering". Khanna Publishers, New Delhi, 2001
2. Geankoplis C.J. "Transport Process and Unit Operations". Prentice-Hall of India Private Limited, New Delhi, 1999

REFERENCES:

1. Jacob and Hawkins. "Elements of Heat Transfer".John Willey and Sons Inc. New York, 1983
2. EcKert, E.R.G. "Heat and Mass Transfer". McGraw Hill Book Co., New York, 1981
3. Holman, E.P. "Heat Transfer". McGraw-Hill Publishing Co. New Delhi, 2001
4. Coulson, J.M. and etal. "Coulson & Richardson's Chemical Engineering", 6th Edition, Vol. I & II, Butterworth – Heinman (an imprint of Elsevier), 2004
5. McCabe, W.L., J.C. Smith and P.Harriot "Unit Operations of Chemical Engineering", 6th Edition, McGraw Hill, 2003.

PY8511 PHYSIOLOGY AND PHARMACOLOGY LABORATORY L T P C
0 0 4 2

OBJECTIVES:

- To learn the gross histology, structure and functions of various organs of the human body
- To perform the physiological tests and appreciate the interlinked mechanisms in the maintenance of normal functioning of human body.
- Communicate clearly and in a way that reflects knowledge and understanding of the human body and demonstrates the ability to adapt information to different audiences and applications.

PHYSIOLOGY EXPERIMENTS

1. Microscopical examination of tissue samples and endocrine glands.
2. Measurements of enzyme activity (Glucose, amino acids, cholesterol, etc in biological specimens)
3. Determination of bleeding time and clotting time
4. Estimation of Haemoglobin.
5. RBC estimation, WBC total count and differential count

6. Erythrocyte sedimentation rate determination.
7. Determination of pulse, heart rate, BP and recording of ECG.
8. Determination of vital capacity.
9. Study of nervous system through reflex arcs and jerks.

PHARMACOLOGY EXPERIMENTS

1. Practical &/ Online demonstration of laboratory animals handling and various routes of drug administration.
2. Virtual study of use of anaesthetics in various laboratory animals.
3. Virtual demonstration of determination of toxicity. LD 50 .
4. To demonstrate the bioassay of Ach using isolated ileum /rectus abdominis muscle preparation using online videos.
5. Bioassay of 5-HT using rat fundus strip or Bioassay of oxytocin using rat uterus using simulation software's / online gadgets.
6. Computer assisted demonstration of estimation of pA 2 value on isolated tissues.
7. Study of alternative methods for drug evaluation.

TOTAL:60 PERIODS

LIST OF EQUIPMENTS FOR BATCH OF 30 STUDENTS

1. Microscope
2. Haemocytometer
3. B.P Apparatus
4. Haemoglobinometer
5. ECG machine with recorder
6. Glucometer
7. Kymograph with organ bath
8. Spirometer/respirometer
9. Spectrophotometer/calorimeter

OUTCOMES:

The students will be able to

- Perform basic physiological and pharmacological experiments and to record and interpret the results for its clinical significance.
- Demonstrate laboratory procedures used to examine anatomical structures and evaluate physiological functions of each organ system.
- Interpret graphs of anatomical and physiological data.

REFERENCE BOOKS:

1. Instructor's Manual for the Laboratory Guide to accompany Human Physiology, ninth edition, by Laurence G. Thouin, Jr. (ISBN 0–697–34221–2)
2. Laboratory Atlas of Anatomy and Physiology, Fifth edition, by J. Ederand John W.Bertram, 2005.

PY8512 MEDICINAL CHEMISTRY LABORATORY L T P C
0 0 4 2

OBJECTIVES:

- To provide students with the practical laboratory skills of medicinal chemistry
- To demonstrate the effect of the different synthetic methodology.
- To clarify theoretical concepts of chemical synthesis of drug molecules.

LIST OF EXPERIMENTS: (Minimum of 10 experiments shall be conducted)

1. Determination of melting point.
2. Determination of pKa.
3. Determination of partition coefficient of any medicinal compound by shake flask method.
4. Synthesis and characterization of the following drugs:
   a. Phenacetin
   b. Antipyrin
   c. Benzocaine
   d. Uramil
   e. Tolbutamide
   f. Phenothiazine
   g. Isoniazid
   h. Sulphasalazine
   i. Aspirin from salicylic acid
   j. Paracetamol from p-aminophenol
   k. Benzotriazole
   l. 2-Phenyl Indole
   m. 7-hydroxy-4methyl coumarin
5. Any other relevant experiments based on theory.

TOTAL:60 PERIODS

LIST OF EQUIPMENTS REQUIRED FOR 30 STUDENTS

- Water bath
- Hot air oven
- Vacuum filtration unit

OUTCOMES:

The students will be able to

- develop the ability to suggest suitable techniques to synthesis different drug molecules
- master a variety of synthetic techniques including purification methods and should gain the ability to design a synthetic scheme for a proposed drug molecule.
- Demonstrate how to conduct chemical reactions within medicinal chemistry context and scientific report.

REFERENCES:

1. K.Yogananda Reddy, Dr.K.N. Jayaveera & Dr.S.Subramanyam, Practical Medicinal Chemistry, S.Chan Publishing, 2013.
2. Vogel's Textbook of Practical Organic Chemistry, 5th edition, Pearson Publisher, 2003.
3. Mann & Saunders, Practical Organic Chemistry, 4th edition, Pearson Publisher, 2009.

HS8581	PROFESSIONAL COMMUNICATION	L	T	P	C
		0	0	2	1

OBJECTIVES:

The couse aims to:

- Enhance the Employability and Career Skills of students
- Orient the students towards grooming as a professional
- Make them Employable Graduates
- Develop their confidence and help them attend interviews successfully

UNIT I

Introduction to Soft Skills-- Hard skills & soft skills - employability and career Skills—Grooming as

a professional with values—Time Management—General awareness of Current Affairs

UNIT II

Self-Introduction-organizing the material - Introducing oneself to the audience – introducing the topic – answering questions – individual presentation practice— presenting the visuals effectively – 5 minute presentations

UNIT III

Introduction to Group Discussion— Participating in group discussions – understanding group dynamics - brainstorming the topic -– questioning and clarifying –GD strategies- activities to improve GD skills

UNIT IV

Interview etiquette – dress code – body language – attending job interviews– telephone/skype interview -one to one interview &panel interview – FAQs related to job interviews

UNIT V

Recognizing differences between groups and teams- managing time-managing stress- networking professionally- respecting social protocols-understanding career management-developing a long-term career plan-making career changes

TOTLA: 30 PERIODS

OUTCOMES:

At the end of the course Learners will be able to:

- Make effective presentations
- Participate confidently in Group Discussions.
- Attend job interviews and be successful in them.
- Develop adequate Soft Skills required for the workplace

Recommended Software

1. Globearena
2. Win English

REFERENCES:

1. Butterfield, Jeff **Soft Skills for Everyone.** Cengage Learning: New Delhi, 2015
2. **Interact** English Lab Manual for Undergraduate Students,. OrientBalckSwan: Hyderabad, 2016.
3. E. Suresh Kumar et al. **Communication for Professional Success.** Orient Blackswan: Hyderabad, 2015
4. Raman, Meenakshi and Sangeeta Sharma. **Professional Communication**. Oxford University Press: Oxford, 2014
5. S. Hariharanetal. **Soft Skills**. MJP Publishers: Chennai, 2010.

GE8077	TOTAL QUALITY MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVE:

- To facilitate the understanding of Quality Management principles and process.

UNIT I INTRODUCTION **9**

Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM - TQM Framework - Contributions of Deming, Juran and Crosby - Barriers to TQM - Customer focus - Customer orientation, Customer satisfaction, Customer complaints, Customer retention.

UNIT II TQM PRINCIPLES 9

Leadership - Quality Statements, Strategic quality planning, Quality Councils - Employee involvement - Motivation, Empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal - Continuous process improvement - PDCA cycle, 5S, Kaizen - Supplier partnership - Partnering, Supplier selection, Supplier Rating.

UNIT III TQM TOOLS AND TECHNIQUES I 9

The seven traditional tools of quality - New management tools - Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT - Bench marking - Reason to bench mark, Bench marking process - FMEA - Stages, Types.

UNIT IV TQM TOOLS AND TECHNIQUES II 9

Quality Circles - Cost of Quality - Quality Function Deployment (QFD) - Taguchi quality loss function - TPM - Concepts, improvement needs - Performance measures.

UNIT V QUALITY MANAGEMENT SYSTEM 9

Introduction—Benefits of ISO Registration—ISO 9000 Series of Standards—Sector-Specific Standards—AS 9100, TS16949 and TL 9000-- ISO 9001 Requirements—Implementation—Documentation—Internal Audits—Registration--**ENVIRONMENTAL MANAGEMENT SYSTEM:** Introduction—ISO 14000 Series Standards—Concepts of ISO 14001—Requirements of ISO 14001—Benefits of EMS.

TOTAL: 45 PERIODS

OUTCOME:

- The student would be able to apply the tools and techniques of quality management to manufacturing and services processes.

TEXT BOOK:

1. Dale H.Besterfiled, Carol B.Michna,Glen H. Besterfield,Mary B.Sacre,Hemant Urdhwareshe and Rashmi Urdhwareshe, “Total Quality Management”, Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression, 2013.

REFERENCES:

1. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, First Indian Edition, Cengage Learning, 2012.
2. Janakiraman. B and Gopal .R.K., "Total Quality Management - Text and Cases", Prentice Hall (India) Pvt. Ltd., 2006.
3. Suganthi.L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006.
4. ISO9001-2015 standards

BT8591 BIOPROCESS ENGINEERING L T P C
3 0 0 3

OBJECTIVES:

- To provide the students with the basics of bioreactor engineering.
- To develop bioengineering skills for the production of biochemical product using integrated biochemical processes.

UNIT I CONFIGURATION OF BIOREACTORS 9

Ideal reactors and its characteristicsFed batch cultivation, Cell recycle cultivation, Cell recycle cultivation in waste water treatment, two stage cultivation Packed bed reactor, airlift reactor, introduction to fluidized bed reactor bubble column reactors

UNIT II BIOREACTOR SCALE – UP 9

Regime analysis of bioreactor processes, oxygen mass transfer in bioreactors – microbial oxygen demands; methods for the determination of mass transfer coefficients; mass transfer correlations. Scale up criteria for bioreactors based on oxygen transfer, power consumption and impeller tip speed.

UNIT III BIOREACTOR CONSIDERATION IN ENZYME SYSTEMS 9

Analysis of film and pore diffusion effects on kinetics of immobilized enzyme reactions; formulation of dimensionless groups and calculation of effectiveness factors. Design of immobilized enzyme reactors – packed bed, fluidized bed and membrane reactors

UNIT IV MODELLING AND SIMULATION OF BIOPROCESSES 9

Study of structured models for analysis of various bioprocess – compartmental models, models of cellular energetics and metabolism, single cell models, plasmid replication and plasmid stability model. Dynamic simulation of batch, fed batch, steady and transient culture metabolism.

UNIT V RECOMBINANT CELL CULTIVATION 9

Different host vector system for recombinant cell cultivation strategies and advantages. E.coli, yeast Pichia pastoris / Saccharomyces cereviseae, Animal cell cultivation, plant cell cultivation, Insect cell cultivation. High cell density cultivation, process strategies, reactor considerations in the above system

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of Bioprocess Engineering course graduates will be able to

- Select appropriate bioreactor configurations and operation modes based upon the nature of bioproducts and cell lines and other process criteria.
- Apply modeling and simulation of bioprocesses so as to reduce costs and to enhance the quality of products and systems.
- Plan a research career or to work in the biotechnology industry with strong foundation about bioreactor design and scale-up.
- Integrate research lab and Industry; identify problems and seek practical solutions for large scale implementation of Biotechnology.

TEXT BOOKS:

1. Michael L. Shuler and Fikret Kargi, Bioprocess Engineering, Basic Concept, 2nd Edition Prentice Hall PTR, 2002.
2. Pauline Doran, Bioprocess Engineering Calculation, Blackwell Scientific Publications

REFERENCES

1. Anton Moser, “Bioprocess Technology, Kinetics and Reactors”, , Springer Verlag.
2. James E. Bailey & David F. Ollis, Biochemical Engineering Fundamentals, McGraw Hill.
3. James M. Lee, Biochemical Engineering, PHI, USA.
4. Atkinson, Handbook of Bioreactors,Harvey W. Blanch, Douglas S. Clark, Biochemical Engineering, Marcel Decker Inc.

5. Harvey W. Blanch, Douglas S. Clark, Biochemical Engineering, Marcel Dekker, Inc

PY8601 TECHNOLOGY OF SOLID DOSAGE FORMS L T P C
4 0 0 4

OBJECTIVE:

- To provide the concepts of various parameters involved in the formulation and development of various solid dosage forms.

UNIT I POWDERS AND GRANULES 12

Advantages and disadvantages of powdered and granulated products, Mixing and dividing of powders, Problems in manufacturing powders, Effervescent granules, Reasons for granulation, Granulation mechanisms, Pharmaceutical granulation equipments.

UNIT II TABLETS AND COATING 12

Types of tablets, Formulation, Manufacturing of tablets, Tableting problems, Evaluation of Tablets, Tablet coating,Film coating, Sugar Coating, Enteric coating, Evaluation of coated tablets, Applications, Large Scale Manufacture.

UNIT III CAPSULES 12

Classification, Hard gelatin capsules, Composition and size, Materials and methods for production of hard gelatin capsule, Formulation and filling of capsules, Soft gelatin capsules, Rationale, Manufacturing and formulation of soft gelatin capsules,Evaluation of capsules.

UNIT IV MICROENCAPSULATION 12

Types of microcapsules, Application of microencapsulation in pharmaceutical sciences, Microencapsulation by coacervation, Phase separation, Multi-orifice centrifugation, Spray congealing, Polymerization,Air suspension technique, Pan coating and other techniques,Evaluation of microcapsules.

UNIT V ADVANCES IN TABLETING TECHNIQUES 12

Sustained release dosage forms,controlled release dosage forms-Compression coating – Inlay tablets, Layer tablets, Mouth dissolving tablet, Tablets in tablets.

TOTAL: 60 PERIODS

OUTCOMES:

The student will be able to

- Comprehend the factors influencing the development of various solid dosage forms.
- Recognize the formulation concepts and evaluate different dosage forms to meet out the compendial requirements.
- Apprehend the advances in solid dosage forms

TEXT BOOKS:

1. Aulton, M.E., “Pharmaceutics – The Science of Dosage form Design”, 2nd Edition, ELBS Publications, 2002.
2. Indian Pharmacopoeia, Indian Pharmacopoeia commission, Ghaziabad, 2016
3. Cooper and Gunn's “Dispensing for Pharmaceutical Students”, Edited by S J Carter,CBS Publishers, New Delhi, 2008.

REFERENCES:

1. Liberman, H.A., Lachman, L. and Schwartz, J.B., “Pharmaceutical Dosage Form: Tablets”, 2nd Edition, Volume II, Mercel Dekker, 1999.
2. Gennaro, A.R., “Remington: The Science and Practice of Pharmacy”, Vol. I and II,21st Edition, Lippincott Williams and Willkins, 2005.
3. Banker, G.S. and Rhodes, C.T., “Modern Pharmaceutics”, 4th Edition, Informa Health Care, 2002.

PY8611 BIOPROCESS ENGINEERING LABORATORY L T P C
0 0 4 2

OBJECTIVES:

- The course provides the basics of bioprocess engineering.
- To offer a thorough foundation for more advanced studies in microbiology, biotechnology and environmental engineering.
- To introduce the engineering principles of bioprocesses including characteristics of different microbial cells, enzymes, microbial kinetics, and design considerations.

EXPERIMENTS:

1. Batch sterilization kinetics.
2. Medium optimization of growth conditions – Physical and Chemical parameters
   (a) Placket burman design. (b) Response surface methodology
3. Growth Kinetics study of Bacteria and Yeast (Estimation of biomass, calculation of specific growth rate and yield coefficient).
4. Residence time distribution.
5. Calculation of Oxygen Transfer Coefficient – Dynamic Gassing-out method and Sulphite Oxidation Method.
6. Enzyme Purification by Ammonium Sulfate Precipitation.
7. Enzyme kinetics – Michelis-Menton parameter, effect of temperature and pH and Enzyme inhibition kinetics.
8. Immobilized Enzyme Kinetics in batch reactor - matrix entrapment, ionic and cross linking.

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

- Bioreactor (Fermentor lab scale)
- Microbial shaker incubator
- Cooling centrifuge
- Refrigerator
- Incubator

OUTCOMES:

After completing this course, the student will be able to

- Describe the fundamental concepts of bioprocessing, Understand the difference between bioprocesses and chemical processes, Bioprocess design and operation and would be able to select the bioreactor
- Demonstrate bioprocesses in a bacterium, fungi or yeast, and their energy metabolism and carbon sources through various parameters.
- Eva luate and optimize the nutritional requirements.

REFERENCES:

1. K.R. Aneja, "Experiments in Microbiology, Plant Pathology & Biotechnology", 4th Edition, New Age International (P) Ltd. Publisher, New Delhi,2013.
2. Sadasivam S, Manickam A Biochemical method. 3rd Edition, New Age International (P) Ltd. Publisher, New Delhi, 2016.
3. Söylemez, Z. and Fadıloğlu, S., 1996. Laboratory Manual on Enzyme Purification and Immobilization. 1996.

PY8612 TECHNOLOGY OF DOSAGE FORMS LABORATORY L T P C
0 0 4 2

OBJECTIVE:

- To study, the basic principles in formulating liquid, semisolid, solid and parentral dosage forms and their evaluations.

LIST OF EXPERIMENTS

1. Preparation of solutions
2. Preparation of creams
3. Evaluation of creams
4. Preparation of ointments
5. Evaluation of ointments
6. Preformulation studies on prepared granules
7. Manufacture and evaluation of granules - wet granulation and dry granulation methods
8. Preparation of tablets
    a. Tablets prepared from wet and dry granules
    b. Tablets prepared by direct compression
9. Formulation and filling of hard gelatin capsules
10. Preparation and evaluation of parenterals
    a. Ascorbic acid injection
    b. Calcium gluconate injection
    c. Sodium chloride injection

TOTAL: 60 PERIODS

OUTCOMES:

The students will be able to

- Acquire knowledge to prepare and evaluate various liquid, semi solid dosage forms
- Acquire knowledge to prepare and evaluate solid dosage forms and parenteral dosage forms
- Apply the knowledge to formulate new dosage forms.

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

1. Tablet punching machine – Mini press
2. Automatic capsule filling machine
3. pH meter
4. Dissolution apparatus
5. Liquid filling Machine

TEXT BOOKS:

1. Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems, Jaypee medical publishers,Ninth edition, 2010.
2. Indian Pharmacopoeia, Indian Pharmacopoeia commission, Ghaziabad, 2016.

3. Cooper and Gunn's Dispensing for Pharmaceutical Students, Edited by S J Carter,CBS Publishers, New Delhi, 2008.

REFERENCES:

1. Handbook of Pharmaceutical Manufacturing Formulations, Second Edition,Sarfaraz K. NiaziMack Pub. Co., CRC Press, 2009.
2. Hard capsules, development and technology. Edited by K. Ridgway. The Pharmaceutical Press: London, UK. 1987. 320.
3. Pharmaceutical Dosage Forms: Parenteral Medications, Volume I, Kenneth E. Avis, Herbert A. Lieberman (Editor), Leon Lachman (Editor) Informa Healthcare, 1993.

PY8701 BIOPHARMACEUTICS AND PHARMACOKINETICS L T P C
3 0 0 3

OBJECTIVES:

- To learn important parameters involved in drug disposition and its principles in living systems.
- To make the students to understand how the drug disposition takes place in the *in vitro* and *in vivo* conditions.
- To understand the concepts of bioavailability and bioequivalence of drug products and their significance

UNIT I DRUG ABSORPTION AND DISTRIBUTION 9

Mechanisms of drug absorption through GIT, factors influencing drug absorption though GIT, absorption of drug from Non-per oral extra-vascular routes, Distribution of drugs, Tissue permeability of drugs, binding of drugs, apparent volume of drug distribution, plasma and tissue protein binding of drugs, factors affecting protein-drug binding. Kinetics of protein binding, Clinical significance of protein binding of drugs.

UNIT II ELIMINATION 9

Drug metabolism, metabolic pathways, factors affecting metabolism, renal excretion of drugs, factors affecting renal excretion of drugs, renal clearance, Non- renal routes of drug excretion of drugs

UNIT III BIOAVAILABILITY AND BIOEQUIVALENCE 9

Definition and Objectives of bioavailability, absolute and relative bioavailability, measurement of bioavailability, *in-vitro* drug dissolution models, *in-vitro-in-vivo* correlations, bioequivalence studies, methods to enhance the dissolution rates and bioavailability of poorly soluble drugs.

UINT IV PHARMACOKINETICS 9

Introduction to Pharmacokinetics, Pharmacokinetic models, One compartment open model- Intravenous Bolus Injection – Intravenous infusion - Extra vascular administrations. Determination of pharmacokinetics parameters and their significance - Absorption Rate Constant (ka), Elimination Rate Constant (K) & Elimination Hal- life ($t_{½}$), AUC, $C_{max,}$ and t_{max}. Apparent Volume of Distribution (V_d) & Renal Clearance (Q).

UNIT V MULTIPLE DOSAGE REGIMENS AND NONLINEAR PHARMACOKINETICS 9

Concept, Accumulation, Persistent and elimination factors. Calculation of dosage regimen following repetitive IV and oral administration.Nonlinear Pharmacokinetics **-** Introduction, factors causing Non-linearity, Michaelis-menton method of estimating pharmacokinetic parameters.

TOTAL: 45 PERIODS

OUTCOMES:

The student will be able to

- Explain the various factors influencing the drug disposition, various pharmacokinetic parameters**.**
- Design and interpret the bioavailability and bioequivalence of dosage forms.
- Identify the factors affecting the rate of drug absorption.

TEXT BOOKS:

1. Rosenbaum, S. E. "Basic Pharmacokinetics and Pharmacodynamics: An Integrated Textbook and Computer Simulations", 2nd Edition, John Wiley & Sons, 2016.
2. Brahmankar, D.M. and Jaiswal, S.B. "Biopharmaceutics and Pharmacokinetics: a Treatise" ,3rd Edition, Vallabh Prakashan, 2015.
3. Chatwal, G.R. "Biopharmaceutics and Pharmacokinetics", 2nd Edition, Himalaya Publishing House, 2014.

REFERENCES:

1. Shargel,L and Andrew, B.C. Yu. "Applied Biopharmaceutics & Pharmacokinetics",7th Edition, The McGraw-Hill Companies, Inc, 2016.
2. Gibaldi, M. "Biopharmaceutics & Clinical Pharmacokinetics", 4th Edition, Pharma Book Syndicate, 2016.
3. Jambhekar, S.S. and Philip, J. B. "Basic Pharmacokinetics" 2nd Edition, Pharmaceutical Press,2012.

PY8702 REGULATORY REQUIREMENTS IN PHARMACEUTICAL INDUSTRIES L T P C
3 0 0 3

OBJECTIVE:

- To acquire the knowledge of pharmaceutical industry regulations and research

UNIT I REGULATORY CONCEPTS 9

Quality assurance – Quality control – Practice of cGMP – Schedule M – USFDA.

UNIT II REGULATORY ASPECTS 9

Pharmaceuticals: Bulk drug manufacture; Personnel, Buildings and Facilities, Process Equipment, Documentation and Records, Materials Management, Production and In-Process Controls, Packaging and Identification Labelling of API's and Intermediates, Storage and distribution, – Biotechnology derived products; Principles, Personnel, Premises and equipments, Animal quarters and care, production, labelling, Lot processing records and distribution records, quality assurance and quality control.

UNIT III INTELLECTUAL PROPERTY RIGHTS 9

Patent system – Different types of patents – Filing process of application for patent – Infringement of patents – The patent rules 2003 as amended by the patents (amendment) rules 2016.

UNIT IV ICH GUIDELINES 9

Quality guidelines – Impurities in new drug substances (Q3A(R2)) – Impurities in newdrug products(Q3B(R2)) – Validation of analytical procedures text and methodology (Q2 (R1)).

UNIT V QUALITY AUDIT AND SELF INSPECTIONS 9

SOPs – Documentation – Loan license auditing – Common technical documentation (CTD) – Drug

master file (DMF)**.**

TOTAL: 45 PERIODS

OUTCOMES:

- To be familiarise with the pharmaceutical industry manufacturing practices and regulatory aspects of pharmacy products.
- To know the process of patenting activities.
- To know the quality guidelines followed for pharmaceutical products and few of the aspects involved in document preparation for pharmaceutical product registration.

TEXT BOOKS:

1. C.V.SSubbrahmanyam & J.Thimmasetty, Pharmaceutical regulatory affairs, 1st Edn., vallabhPrakashan, New Delhi, 2012.
2. Willig, H., Tuckeman, M.M. and Hitchings, W.S., "Good Manufacturing Practices for Pharmaceuticals", 5th Edition, Marcel Dekker Drugs and the Pharmaceutical Sciences, by CRC Press, New York, 2000.
3. N Udupa, Krishnamurthy Bhat, A Concise Textbook of Drug Regulatory Affairs, Manipal University Press (MUP); First Edition, 2015.

REFERENCES:

1. Ira R. Berry,The Pharmaceutical Regulatory Process, marcel dekker Series: Drugs and the Pharmaceutical Sciences, by CRC Press, Newyork, 2004.
2. Mindy J. Allport-Settle, Current Good Manufacturing Practices: Pharmaceutical, Biologics, and Medical Device Regulations and Guidance Documents Concise Reference, Pharmalogika Inc., USA, 2009.
3. Sharma, P.P., "How to Practice GMPs", 3rd Edition, Vandana Publications, 2006.

PY8703 CHEMISTRY OF NATURAL PRODUCTS L T P C
3 0 0 3

OBJECTIVE:

- To provide knowledge on isolation, characterization and biological significance of natural products and their active substances.

UNIT I STRUCTURAL CHARACTERISATION OF NATURAL PRODUCTS 9

Chemical and spectral approaches to simple molecules of natural origin. Identification of natural products by chromatographic and spectroscopic methods and application of I.R., N.M.R. and Mass spectroscopy in the structural elucidation of organic compounds.

UNIT II GLYCOSIDES 9

Classification, biosynthetic studies and basic metabolic pathways, introduction to biogenesis of secondary metabolites, chemistry, general methods of extraction, isolation, chemical tests, medicinal properties and structural elucidation of sennosides, cardenolides and bufadienolides, digoxin and digitoxin, scillaren A and ouabain.

UNIT III ALKALOIDS 9

Classification, chemistry, general methods of extraction, isolation, chemical tests, and structural elucidation of pyridine alkaloids, tropane alkaloids, quinoline and iso-quinoline alkaloids, phenanthrene alkaloids, indole alkaloids, imidazole alkaloids, alkaloid amines, glycoalkaloids and xanthene alkaloids.

UNIT IV TERPENES AND FLAVONOIDS 9

Classification, biosynthetic studies and basic metabolic pathways, introduction to biogenesis of secondary metabolites, chemistry, general methods of extraction, isolation, chemical tests, medicinal properties and structural elucidation of flavonoids, quercetin; Terpenes–special isoprene rule, mono, diterpenes, triterpenoids and sesquiterpenes and structural elucidation of citral, carvone, menthol and camphor; Steroids – cholesterol, colour reactions of steroids, stigmasterol, β-sitosterol, bile acids, ergosterol, diosgenin, solasodine and hecogenin.

UNIT V PHARMACEUTICALLY IMPORTANT NATURAL PRODUCTS 9

Structure, stereochemistry, synthesis, biogenesis and biological activity of azadirachtin, forskolin, taxanes, camptothecin, artemisinin, podophyllotoxin, estrone and mifepristone.

TOTAL: 45 PERIODS

OUTCOMES:

The students will be able

- To understand and apply the concept of extraction, isolation and characterization of the natural products.
- To explain the classification, metabolic pathways, metabolites and structural elucidation of plant secondary metabolites.
- To acquire knowledge on structure, synthesis, biogenesis and biological activity of some of the pharmaceutically important natural products.

TEXT BOOKS:

1. O.P. Agarwal, Chemistry of Natural Products (Vol.-1 & 2), 41st edition, GoelpublishingHouse, 2014.
2. Gurdeep Chatwal, Organic Chemistry of Natural Products (Vol. 1 & 2), Himalaya Publishing House, 2015.
3. I.L.Finar, “Organic chemistry” Volume 2, 5th edition, Published by Pearson India, 2012.

REFERENCES:

1. Varro E. Tyler, Lynn R. Brady, James E. Robbers, Pharmacognosy, 9th edition, Published by Lea & Febiger, 2011.
2. Trease, G. E. and Evans, W.C. Pharmacognosy, 16th edition, Published by Elsevier, 2009.
3. Wallis, T.E. Textbook of Pharmacognosy, 5th Edition, CBS Publishers, 2005.

PY8711 BIOPHARMACEUTICS AND PHARMACOKINETICS LABORATORY L T P C

0 0 4 2

OBJECTIVE:

- To impart the knowledge of the rate and extent of drug absorption and distribution.

LIST OF EXPERIMENTS

1. *In-vitro* dissolution study of the given sustained release dosage form using various dissolution media.
2. Study the effect of formulation on drug release (Tablet, Solution, suspension etc.).
3. Determination of effect of pH on the partition co-efficient of drug(s)
4. Determination of protein binding of the given drug(s) and the effect of protein binding on drug bioavailability.
5. *In-vitro* drug absorption study using everted small intestine sac technique.

6. To calculate the various Pharmacokinetic parameters from the given blood data of I.Vbolus injection (one compartment model).
7. 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).
8. To determine the various Pharmacokinetic parameters from the given blood data of oral dosage form.

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

- pH Meter
- Dissolution test apparatus
- Cooling Centrifuge
- Ultra Violet Spectrophotometer
- HPLC

OUTCOMES:

On completion of the course the students able to

- Perform dissolution studies for the modified dosage forms.
- Estimate various pharmacokinetic parameters using plasma and urine drug level data.
- Predict the effects of dosage form design and routes of drug administration on drug levels in body.

REFERENCES:

1. Vijaya Raghavan, C and Judith Justin. Experimental Biopharmaceutics and Pharmacokinetics, New century book house (P) Ltd., 2006
2. Burton, M.E. “Applied Pharmacokinetics & Pharmocodynamics: Principles of Therapeutics” 4th Edition, Lippincott Williams Wilkins, 2006.
3. Brahmankar, D.M. and Jaiswal, S.B. “Biopharmaceutics and Pharmacokinetics: a Treatise” 3rd Edition, Vallabh Prakashan, 2015.

PY8712 CHEMISTRY OF NATURAL PRODUCTS LABORATORY L T P C
0 0 4 2

OBJECTIVE:

- The lab course is to make the students learn, understand and perform various standardisation techniques of natural products as per WHO guidelines.

LIST OF EXPERIMENTS

Standardisation techniques of medicinal plants as per WHO guidelines.

1. Morphology, microscopy and quantitative microscopy of medicinal plants: Macroscopic and microscopic identification of 4-5 commonly used medicinal plants.
2. Physical constants like: specific gravity, swelling factor, ash values, extractive values,refractive index, optical rotation of selected plant materials.
3. Phytochemical methods, identification tests for various classes of phytoconstituents.
4. Extraction and isolation of active principles such as alkaloids, flavonoids, glycosides, tannins, carbohydrates, essential oils and terpenes from natural drugs (5-6 drugs).
5. Quantification of phytochemicals in plant extracts by chromatography and spectroscopy.

TOTAL: 60 PERIODS

EQUIPMENTS REQUIRED

- Microscope, polarimeter, soxhlet apparatus, water bath, hot air oven, rotary vacuum evaporator, camera lucida, phytochemical reagents, Chromatographic plates, UV spectrophotometer, HPLC, HPTLC.

OUTCOMES:

The students will be able to

- Perform standardisation of medicinal plant products.
- Identify different types of medicinal plants and its products by morphology, physical and chemical characteristics.
- Carry out chromatographic and spectroscopic analysis of medicinal plant products.

REFERENCES:

1. Kokate, C.K. “Practical Pharmacognosy”, 5th Edition, Vallabh Prakashan, 2014.
2. Ayurvedic pharmacopoeia. Volume I & II, First edition, Department of AYUSH, New Delhi, 2008.
3. Pulok K. Mukherjee, Quality Control of Herbal Drugs: An Approach to Evaluation of Botanicals, Business Horizons Ltd., New Delhi, 2002.

PY8001 BASIC LABORATORY ANIMAL SCIENCE L T P C

3 0 0 3

OBJECTIVES:

- The objective of this course is to present basic facts and principles that are essential for the humane use and care of laboratory animals and for the quality of research.
- The objective of these courses is to present basic and appropriate biology, care, health and management of animals, recognition of pain, suffering and distress in these animals and minimally invasive procedures without anaesthesia to be applied on these animals.
- This course meets the standards for the species-specific education and training requirements for persons designing projects and procedures for these specific animals.

UNIT I FUNDAMENTALS OF LABORATORY ANIMAL SCIENCE 9

Contribution of Laboratory animals to Medical Progress: Past, Present and Future. Overview of ethics of animal research.

UNIT II LABORATORY ANIMAL CARE 9

Animal accommodation, animal care routines, animal health and hygiene, diets, feeding and drinking, reproduction, breeding and heredity.

UNIT III GLOBAL REGULATIONS 9

An overview of global and Indian legislation, regulation and policies about experimentation on laboratory animals.

UNIT IV PRE-CLINICAL RESEARCH 9

Animal models, concepts, classification of animal models and disease models, extrapolation from animals to humans, model body size and scaling.

UNIT V ALTERNATIVES TO ANIMAL TESTING 9

Alternatives to animal models,refinement, reduction, and replacement of animal uses in the life sciences.

TOTAL: 45 PERIODS

OUTCOMES:

The student would able to

- Describe the requirements of various legislation concerning scientific use of animals.
- Identify ethical issues in human-animal interaction, including replacement, reduction and refinement.
- Describe normal behaviour of rodents and lagomorphs, handling, husbandry needs, and enrichment and also could be able to describe the need for hygiene in animal housing and experimental work.

TEXT BOOKS:

1. Introduction to Laboratory Animal Science and Technology J. K. INGLIS. Pergamon Press, Elsevier; 2013.
2. Hau, Jann, and Steven J. Schapiro, eds. Handbook of laboratory animal science: essential principles and practices. Vol. 1. CRC press, 2002
3. Fundamentals of Laboratory Animal Science, Anqi Li, Jianglin Fan, CRC press,2017.

REFERENCES:

1. Handbook of Laboratory Animal Science 2nd Edition, Edited by Jann Hau and Gerald L.Van Hoosier Jr. Vol, I, II, III. 2004.
2. Management of laboratory animal care and use programs. Edited by Mark A. Suckow, Fred A Douglas, Robert H Weichbrod, 2001.
3. Conn, P.M., Animal models for the study of human disease. Academic Press, 2017.

PY8002 FUNDAMENTALS OF MATERIAL SCIENCE AND ENGINEERING L T P C

3 0 0 3

OBJECTIVE:

- To provide a comprehensive understanding of various material, its properties and their application.

UNIT I STRUCTURE OF SOLIDS 9

Introduction – material classification of materials – structure- property relationship – atomic Structure - space lattice and crystal structure- Miller indices, crystal planes – symmetry – crystal imperfections – point, line, surface, volume – solid solutions - ceramic crystal structures - structure and crystallinity of long chain polymers.

UNIT II PHASE DIAGRAMS 9

Gibb's Phase rule – thermodynamic criteria for phase stability – phase diagrams - single, binary and ternary phase diagrams – lever rule – applications of phase diagrams.

UNIT III MECHANICAL PROPERTIES 9

Elastic behaviour – plastic deformation by slip – dislocation movement – effect of stress and temperature – work hardening – creep – fracture, modes of fracture - fracture toughness – hardness – wear - corrosion.

UNIT IV ELECTRICAL AND ELECTRONIC PROPERTIES 9

Classification of materials using free electron theory and band theory -conductivity of metals – Matheisen's Rule – concentration and mobility of charge carriers and their variation with temperature .– energy gap in solids – dielectric materials - types of polarizations – polarization calculations – polymer dielectrics – Fast ionic conductors – ionic conduction in zirconia and other systems - dipole moment – static permittivity – dielectric constant – dielectric loss – dielectric breakdown – superconductivity – semiconducting materials

UNIT V MAGNETIC, THERMAL AND OPTICAL PROPERTIES 9

Introduction – types of magnetic materials - Classification of dia- para -ferro- antiferro and ferri magnetic materials – magnetic semiconductors – specific heat capacity – thermal conductivity – measurement by Laser Flash and other methods - thermal expansion – Light Interaction with solids – optical properties of metals and non- metals – refraction, reflection, absorption, transmission, color, opacity, translucency - applications.

TOTAL: 45 PERIODS

OUTCOMES:

The students will be able to

- Understand basic and the mechanical behaviour of the materials.
- Understand phase diagrams and phase transformations of materials.
- Understand the basic concepts of nano- materials

TEXT BOOKS:

1. Raghavan V, Materials and Engineering, Prentice Hall of India, New Delhi, 2006.
2. I P Singh, Materials Science and Engineering, Jain Brothers, Delhi, 2010.
3. William D Callister.Jr, Materials Science &Engineering, John Wiley & Sons, 2000.

REFERENCES:

1. Fahrner W R, Nanotechnology and Nanoeletronics, Springer International edition 2005.
2. Arumugam M, Material Science, Anuradha technical book publishers, 1997.
3. Budinsky K G and Budinsky K M, Engineering materials- Properties and Selection, Prentice Hall of India, 2002.

GE8071 DISASTER MANAGEMENT L T P C

3 0 0 3

OBJECTIVES:

- To provide students an exposure to disasters, their significance and types.
- To ensure that students begin to understand the relationship between vulnerability, disasters, disaster prevention and risk reduction
- To gain a preliminary understanding of approaches of Disaster Risk Reduction (DRR)
- To enhance awareness of institutional processes in the country and
- To develop rudimentary ability to respond to their surroundings with potential disaster response in areas where they live, with due sensitivity

UNIT I INTRODUCTION TO DISASTERS 9

Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Disasters: Types of disasters – Earthquake, Landslide, Flood, Drought, Fire etc - Classification, Causes, Impacts including social, economic, political, environmental, health, psychosocial, etc.- Differential impacts- in terms of caste, class, gender, age, location, disability - Global trends in disasters: urban disasters, pandemics, complex emergencies, Climate change- Dos and Don'ts during various types of Disasters.

UNIT II APPROACHES TO DISASTER RISK REDUCTION (DRR) 9

Disaster cycle - Phases, Culture of safety, prevention, mitigation and preparedness community based DRR, Structural- nonstructural measures, Roles and responsibilities of- community, Panchayati Raj

Institutions/Urban Local Bodies (PRIs/ULBs), States, Centre, and other stake-holders- Institutional Processess and Framework at State and Central Level- State Disaster Management Authority(SDMA) – Early Warning System – Advisories from Appropriate Agencies.

UNIT III INTER-RELATIONSHIP BETWEEN DISASTERS AND DEVELOPMENT 9

Factors affecting Vulnerabilities, differential impacts, impact of Development projects such as dams, embankments, changes in Land-use etc.- Climate Change Adaptation- IPCC Scenario and Scenarios in the context of India - Relevance of indigenous knowledge, appropriate technology and local resources.

UNIT IV DISASTER RISK MANAGEMENT IN INDIA 9

Hazard and Vulnerability profile of India, Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness, Disaster Management Act and Policy - Other related policies, plans, programmes and legislation – Role of GIS and Information Technology Components in Preparedness, Risk Assessment, Response and Recovery Phases of Disaster – Disaster Damage Assessment.

UNIT V DISASTER MANAGEMENT: APPLICATIONS AND CASE STUDIES AND FIELD WORKS 9

Landslide Hazard Zonation: Case Studies, Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management.

TOTAL: 45 PERIODS

OUTCOMES:

The students will be able to

- Differentiate the types of disasters, causes and their impact on environment and society
- Assess vulnerability and various methods of risk reduction measures as well as mitigation.
- Draw the hazard and vulnerability profile of India, Scenarious in the Indian context, Disaster damage assessment and management.

TEXT BOOKS:

1. Singhal J.P. “Disaster Management”, Laxmi Publications, 2010. ISBN-10: 9380386427 ISBN-13: 978-9380386423
2. Tushar Bhattacharya, “Disaster Science and Management”, McGraw Hill India Education Pvt. Ltd., 2012. **ISBN-10:** 1259007367, **ISBN-13:** 978-1259007361]
3. Gupta Anil K, Sreeja S. Nair. Environmental Knowledge for Disaster Risk Management, NIDM, New Delhi, 2011
4. Kapur Anu Vulnerable India: A Geographical Study of Disasters, IIAS and Sage Publishers, New Delhi, 2010.

REFERENCES:

1. Govt. of India: Disaster Management Act , Government of India, New Delhi, 2005
2. Government of India, National Disaster Management Policy,2009.

PY8003 TECHNOLOGY OF SEMISOLID DOSAGE FORMS L T P C
3 0 0 3

OBJECTIVE:

- To impart the knowledge of the various semisolid dosage forms and its implications in pharmaceutical technology.

UNIT I INTRODUCTION 9

Ideal properties of semisolid dosage forms - various types - advantages and disadvantages. Semi solid bases and their selection – preservatives - drug penetration through skin – mechanism - penetration enhancers.

UNIT II OINTMENTS 9

Preparation - various classes of materials for preparation - manufacturing method. Compendial Requirements for ointments - characterization, applications

UNIT III PASTES AND GELS 9

Introduction to Pastes – additives – manufacturing methods - containers and closures - characterisation. Gels – materials - manufacturing – characterisation - applications.

UNIT IV SUPPOSITORIES AND PESSARIES 9

Ideal requirements - bases used - manufacturing procedure - displacement value - packaging and evaluation – storage – packaging - stability studies.

UNIT V COSMETOLOGY AND COSMETIC PREPARATIONS 9

Raw materials used in Cosmetics - Skin Cream – Types – materials - preparation – characterization - applications. Lipstick – materials – preparation – characterization - applications.

TOTAL: 45 PERIODS

OUTCOMES:

- Understands the principles of various semisolid dosage forms
- Understands basic process used in different preparation of semisolid formulation
- Able to know formulation, labeling, and packing of different types semisolid products.

TEXT BOOKS:

1. Loyd V. Allen, Howard C. Ansel, Pharmaceutical Dosage Forms and Drug Delivery Systems, 10th Edition, Wolters Kluwer Health, 2013.
2. SP Vyas, AK Goyal and G Rath, Handbook of Pharmaceutical Dosage Forms, First Edition, Vallabh Prakashan, New Delhi, 2011.
3. Roop K. Khar, SP. Vyas “Lachman/Liebermans: The Theory and Practice of Industrial Pharmacy”, 4th Edition CBS Publishers and Distributors, 2013.

REFERENCES:

1. Gabriella Baki, Kenneth S. Alexander, “Introduction to Cosmetic Formulation and Technology” First Edition John Wiley, First edition , 2015.
2. Ram I. Mahato, Ajit S. Narang “Pharmaceutical Dosage Forms and Drug Delivery, Second Edition” 2nd Edition, CRC Press, 2012.
3. James Swarbrick “Encyclopedia of Pharmaceutical Science and Technology”,4th Edition, CRC Press, 2012.

BT8071 BIOLOGICAL SPECTROSCOPY L T P C
3 0 0 3

OBJECTIVES:

- To deliver the knowledge of spectroscopic techniques and its functions
- To provide the technical information of spectroscopy for biological applications

UNIT I OPTICAL ROTATORY DISPERSION 9

Polarized light – optical rotation – circular dichroism – circular dichroism of nucleic acids and proteins.

UNIT II TYPES OF NUCLEAR MAGNETIC RESONANCE 9

Chemical shifts – spin – spin coupling – relaxation mechanisms – nuclear overhauser effect – ESR multidimensional nmr spectroscopy – determination of macromolecular structure by NMR – magnetic resonance imaging.

UNIT III TYPES OF MASS SPECTROMETRY 9

Ion sources sample introduction – mass analyzers and ion detectors – bimolecular mass spectrometry – peptide and protein analysis – carbohydrates and small molecules – specific applications.

UNIT IV X-RAY DIFFRACTION 9

Scattering by x- rays – diffraction by a crystal – measuring diffraction pattern – Bragg reflection – unit cell – phase problem – anomalous diffraction – determination of crystal structure – electron and neutron diffraction.

UNIT V SPECIAL TOPICS AND APPLICATIONS 9

Electron microscopy – transmission and scanning electron microscopy – scanning tunnelling and atomic force microscopy – combinatorial chemistry and high throughput screening methods.

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of this course, the student would be able to understand and apply

- Basics of optical rotary dispersion methods and nuclear magnetic resonance
- Principles and applications of mass spectrometry and X-ray diffraction
- Microscopic techniques and its applications
- Spectroscopic techniques for various biological applications

TEXT BOOKS:

1. Banwell, Colin N. and E.M. McCash. “Fundamentals of Molecular Spectroscopy” IVth Edition, Tata McGraw-Hill, 2017.
2. Aruldas, G. “Molecular Structure and Spectroscopy”. IInd Edition, Prentice Hall of India, 2007.
3. Pavia, D.L., G.M. Lampman and G.S. Kriz. “ Introduction to Spectroscopy:” IIIrd Edition, Thomson, Brooks/ Cole, 2001.
4. Williams, Dudley H. and Ian Fleming. ”Spectroscopic Methods in Organic Chemistry”. VIth Edition, Tata McGraw-Hill, 2007.

REFERENCES:

1. Siuzdak, Gary. “Mass Spectrometry for Biotechnology ”. Academic Press / Elsevier,1996.
2. Hammes, Gordon G. “Spectroscopy for the Biological Sciences”. John Wiley, 2005.

3. Campbell I.D and Dwek R.A., " Biological Spectroscopy ", Benjamin Cummins and Company, 1986.
4. Atkins P.W., "Physical Chemistry ",10th Edition, Oxford University Press India, 2014.

PY8004 FUNDAMENTALS OF POLYMER SCIENCE AND ENGINEERING L T P C
3 0 0 3

OBJECTIVES:

- To provide the basic knowledge of polymers and its classification.
- To make aware of characterization of polymers and its application.

UNIT I BASICS OF POLYMERS 9

Basics–polymer classifications based on occurrence, types, process and uses. Kinetics and mechanism of free radical, cationic, anionic, living polymers and coordination polymerization–Ziegler Natta catalysts-monometallic mechanism–stereo regular polymerization–chain transfer reaction and constant.

UNIT II WATER SOLUBLE POLYMERS 9

Synthetic water-soluble polymers, preparation, properties and applications of polyvinyl alcohol – polyvinylpyrrolidone – polyacrylic acid and its homolog's – polyacrylamide – polyethylene oxide – polyethylene mine.

UNIT III BIO AND INORGANIC POLYMERS 9

Naturally occurring polymers –starch, proteins, cellulose – Derivatives of cellulose polymers – rayon, cellophane, cellulose acetate, butyrate and nitrate – ethyl cellulose –carboxy methyl cellulose- preparation, properties- application organometallic polymers – co-ordination polymers– polyamides- Inorganic polymers - phosphorous and nitrogen containing polymers –silicones – hybrid polymers – iniferters.

UNIT IV TESTING OF POLYMERS 9

Elemental and Chemical Analysis, Compositional Analysis, Thermal Analysis, Physical Properties

UNIT V APPLICATION OF POLYMERS 9

Overview on application of polymers in Automotive, Aerospace, Building, Consumer Goods and Packaging. Detailed study on application of polymers in pharmaceutical formulations- solid dosage form-transdermal drug delivery – targeted drug delivery – nanoformulations and cosmetics.

TOTAL: 45 PERIODS

OUTCOMES:

The students will be able to

- Understand the basic of polymers.
- Acquire knowledge on different classification of polymers.
- Develop capacity to characterize polymers and its applications.

TEXT BOOKS:

1. Fundamentals of Polymer Engineering, Revised and Expanded. 2nd Ed. Anil Kumar, Rakesh K. Gupta, Marcell Dekker, USA, 2003.
2. Fundamentals of Polymer Science for Engineers. StoykoFakirov,. ISBN: 978-3-527-34131-3 Wiley, 2017.
3. F.W. Billmayer, Text Book of Polymer Science, 3rd ed., John Wiley and sons, New York, 2002.

REFERENCES:

1. Polymer Science and Technology. Premamoy Ghosh, 2nd ed., McGraw-Hill Publishing Company Limited, New Delhi, 2003.
2. Polymer Science. V.R. Gowarikar, New Age International Pvt. Ltd Publishers, 2010.
3. Polymer Chemistry – An Introduction. R.B. Seymour and C.E.Carraher, Jr., Marcel Dekker Inc., New York, 2010.

PY8005 VALIDATION IN PHARMACEUTICAL INDUSTRIES L T P C
3 0 0 3

OBJECTIVES:

- To provide the information on GMP/GLP regulation involved in the manufacturing Of API and biological products.
- To provide the importance of impurity profile and stability testing of drugs.

UNITI DRUGS ANDCOSMETICSACTANDGMPFORAPI 9

Drugs and cosmetics act-1948–Organization and personnel –Buildings and facilities –Equipment –Documentation and records–Material management–Production and in process control–Packaging and labelling–Storage Distribution.

UNITII IMPURITIES IN DRUG SUBSTANCES AND DRUG PRODUCTS 9

Definition of impurities–Validation and impurity issue related to manufacturing –Processing of drug substances –Enantiomers as impurities –Polymorphs as unwanted components.

UNIT III CLEANING PROCEDURE INAPIMANUFACTURINGFACILITIES 9

Regulatory requirements–Multiple vs dedicated equipment– Unique nature of API–Multiple level approach to cleaning–Nature of contaminants–Selection of a worst case–Cleaning techniques – Sampling – Analytical methods – Limits and acceptance criteria, documentation.

UNIT IV STABILITY TESTING 9

Reasons for stability testing–Modes of degradation –Shelflives and expiration dates– Possible strategies to improve shelflives–Stability testing of new drug substances andproducts(Q1A)–Photostability testing of new substances and products(Q1B)–Validation on analytical procedures(Q2A).

UNIT V PROCESS VALIDATION 9

Process validation as a quality assurance tool-General QA tools, purpose of process validation, Qualification activities, Process validation activities. Prospective process validation-Organization, documentation, product development, development of manufacturing capability, full scale production development, defining experimental programs, experimental design and analysis.

TOTAL: 45 PERIODS

OUTCOMES:

The students will be able to

- Understand regulatory practices and administrative functions adopted in the Pharmaceutical organizations.
- Understand the importance of impurity and the procedure for determination of expiry date.
- Understand the role of cleanliness in manufacturing high purity products and reducing adverse products

TEXT BOOKS:

1. R.A. Nash, A.H. Wachter, "Pharmaceutical Process Validation", 3rd ed., CRC Press, Taylor & Francis Group, 2003.
2. Y. Anjaneyulu,R.Maraya, "Quality Assurance and Quality Management in PharmaceuticalIndustry",PharmaBookSyndicate,2005.
3. J. P. Agalloco,F.J. Carleton, "Validation of Pharmaceutical Processes", 3rd ed., Informa Healthcare, NY, USA, 2007.

REFERENCES:

1. Willig,S.H., "Good Manufacturing Practice for Pharmaceuticals", 5th Edition, MarcelDekker,2005.
2. A.A. Signore, T. Jacobs, "Good Design Practices for GMP Pharmaceutical Facilities" 1st ed., CBS Publishers & Distributors Pvt. Ltd., 2009.
3. S.C. Chow, "Statistical Design and Analysis of Stability Studies" Chapman and Hall/CRC, 2007.

CH8791 TRANSPORT PHENOMENA L T P C
3 0 0 3

OBJECTIVE:

- To develop a fundamental knowledge of the physical principles that govern the transport of momentum, energy and mass, with emphasis on the mathematical formulation of the conservation principles.

UNIT I TRANSPORT PHENOMENA BY MOLECULAR MOTION 9

Vectors/Tensors, Newton's law of viscosity, Newtonian & Non-Newtonian fluids, rheological models, Temperature, pressure and composition dependence of viscosity, Kinetic theory of viscosity, Fourier's law of heat conduction, Temperature, pressure and composition dependence of thermal conductivity, Kinetic theory of thermal conductivity, Fick's law of diffusion, Temperature, pressure and composition dependence of diffusivity, Kinetic theory of diffusivity.

UNITII ONE DIMENSIONAL MOMENTUM TRANSPORT 9

Shell Momentum balances, boundary conditions, velocity profiles, average velocity, momentum flux at the surfaces, of Newtonian and non-Newtonian for flow of a falling film, flow through circular tube, slits, flow through an Annulus, Adjacent flow of two Immiscible fluids. Equations of Change (Isothermal), equation of continuity, equation of motion, equation of energy (isothermal) their applications in fluid flow problems.

UNIT III ONE DIMENSIONAL HEAT TRANSPORT 9

Shell energy balances, boundary conditions, temperature profiles, average temperature, energy fluxes at surfaces for different types of heat sources such as electrical, nuclear viscous and chemical, Equations ofchange (non-isothermal), equation of motion for forced and free convection, equationof energy (non-isothermal).

UNIT IV ONE DIMENSIONAL MASS TRANSPORT 9

Shell mass balances, boundary conditions, concentration profiles, average concentration, mass flux at surfaces for Diffusion through stagnant gas film, Diffusion with homogeneous and heterogeneouschemical reaction, Diffusion in to a falling liquid film, Diffusion and chemical

reaction in porous catalystand the effectiveness factor,equation of continuity for binary mixtures, equation of change to set updiffusion problems for simultaneous heat and mass transfer.

UNITV TRANSPORT IN TURBULENT AND BOUNDARY LAYER FLOW 9

Turbulence phenomena; phenomenological relations for transfer fluxes; time smoothed equations of change and their applications for turbulent flow in pipes; boundary layer theory; laminar and turbulent hydrodynamics thermal and concentration boundary layer and their thicknesses; analysis of flow over flat surface. Introduction to macroscopic balances for isothermal flow systems, non-isothermal systems and multicomponent systems.

TOTAL: 45 PERIODS

OUTCOMES:

- Students would gain the knowledge of fundamental connections between the conservation laws in heat, mass, and momentum in terms of vector and tensor fluxes.
- The students would be able to understand the mechanism of fluids in motion under different conditions.

TEXT BOOKS:

1. R. B. Bird, W.E. Stewart, E.W. Lightfoot, Transport Phenomena, 2nd RevisedEdition, John Wiley, 2007
2. Robert, S Brodkey, Harry C. Hershey, “Transport Phenomena A Unified Approach”, Brodkey Publishing 2003.

REFERENCES:

1. C. J. Geankoplis, Transport Processes and Separation Process Principles, Prentice- Hall Inc., 4th Edition 2003.
2. C. O. Bennett, J. O. Myers, Momentum, Heat and Mass Transfer, 2nd International Student Edition Mc-Graw Hill, 1983.
3. R. Welty, R.W. Wilson, and C.W.Wicks, Rorer G.E, Wilson R.W. “Fundamentals of Momentum Heat and Mass Transfer”, 5th Edition, John Wiley, New York, 2007.

GE8073 FUNDAMENTALS OF NANOSCIENCE L T P C

3 0 0 3

OBJECTIVE:

- To learn about basis of nanomaterial science, preparation method, types and application

UNIT I INTRODUCTION 8

Nanoscale Science and Technology- Implications for Physics, Chemistry, Biology and Engineering-Classifications of nanostructured materials- nano particles- quantum dots, nanowires-ultra-thinfilms-multilayered materials. Length Scales involved and effect on properties: Mechanical, Electronic, Optical, Magnetic and Thermal properties. Introduction to properties and motivation for study (qualitative only).

UNIT II GENERAL METHODS OF PREPARATION 9

Bottom-up Synthesis-Top-down Approach: Co-Precipitation, Ultrasonication, Mechanical Milling, Colloidal routes, Self-assembly, Vapour phase deposition, MOCVD, Sputtering, Evaporation, Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE.

UNIT III NANOMATERIALS 12

Nanoforms of Carbon - Buckminster fullerene- graphene and carbon nanotube, Single wall carbon Nanotubes (SWCNT) and Multi wall carbon nanotubes (MWCNT)- methods of synthesis(arc-growth, laser ablation, CVD routes, Plasma CVD), structure-property Relationships applications-Nanometal oxides-ZnO, TiO2,MgO, ZrO2, NiO, nanoalumina, CaO, AgTiO2, Ferrites, Nanoclays-functionalization and applications-Quantum wires, Quantum dots-preparation, properties and applications.

UNIT IV CHARACTERIZATION TECHNIQUES 9

X-ray diffraction technique, Scanning Electron Microscopy - environmental techniques, Transmission Electron Microscopy including high-resolution imaging, Surface Analysis techniques-AFM, SPM, STM, SNOM, ESCA, SIMS-Nanoindentation.

UNIT V APPLICATIONS 7

NanoInfoTech: Information storage- nanocomputer, molecular switch, super chip, nanocrystal, Nanobiotechlogy: nanoprobes in medical diagnostics and biotechnology, Nano medicines, Targetted drug delivery, Bioimaging - Micro Electro Mechanical Systems (MEMS), Nano Electro Mechanical Systems (NEMS)- Nanosensors, nano crystalline silver for bacterial inhibition, Nanoparticles for sunbarrier products - In Photostat, printing, solar cell, battery.

TOTAL: 45 PERIODS

OUTCOMES:

- Will familiarize about the science of nanomaterials
- Will demonstrate the preparation of nanomaterials
- Will develop knowledge in characteristic nanomaterial

TEXT BOOKS:

1. A.S. Edelstein and R.C. Cammearata, eds., “Nanomaterials: Synthesis, Properties and Applications”, Institute of Physics Publishing, Bristol and Philadelphia, 1996.
2. N John Dinardo, “Nanoscale Charecterisation of surfaces & Interfaces”, 2nd edition, Weinheim Cambridge, Wiley-VCH, 2000.

REFERENCES:

1. G Timp, “Nanotechnology”, AIP press/Springer, 1999.
2. Akhlesh Lakhtakia,“The Hand Book of Nano Technology, Nanometer Structure, Theory, Modeling and Simulations”. Prentice-Hall of India (P) Ltd, New Delhi, 2007.

PY8006 HERBAL TECHNOLOGY L T P C

3 0 0 3

OBJECTIVES:

- To acquire the basic knowledge of Indian system of medicines and to know the fundamentals, standardisation procedure and screening methodology for herbal drugs.
- To enablethe students to know about the plant tissue culture techniques and also learn about the sophisticated instruments used in the extraction, isolation, purification and identification of herbal drugs.

UNIT I INDIAN SYSTEMS OF MEDICINE 9

Introduction, basic principles and treatment modalities of Ayurveda – Unani – Homeopathy – Siddha –naturopathy- Introduction and streams of Yoga. Asanas, Pranayama, Meditations and relaxation techniques. Classification of herbs - Harvesting – Post harvesting – Conditions of storage.-seasonal and geographical variation.

UNIT II ***In-vitro*** **CULTURE OF MEDICINAL PLANTS** **9**

Requirements – Setting up a tissue culture lab – Basic laboratory procedure – Processing of plat tissue culture – Growth profile – Growth measurement – Plant tissue culture methods – Callus culture – Types of tissue culture – Tissue culture of medicinal plants – Applications of plant tissue culture.

UNIT III **EXTRACTION, ISOLATION AND ANALYSIS OF PHYTO PHARMACEUTICALS** **9**

Traditional and modern extraction techniques: Successive solvent extraction- Super critical fluid extraction – Steam distillation – Head space techniques – Sepbox –General extraction process: Carbohydrates – Proteins – Alkaloids –Glycosides. Isolation and purification of phytochemicals: Quinine from cinchona, vincristine from Vinca, sennoside from senna, Euginol from clove oil.

UNIT IV **SCREENING METHODS FOR HERBAL DRUGS** **9**

Screening methods for anti-fertility agents – Antidiabetic drugs – Anti anginal drugs – Diuretic – Analgesic activity – Antipyretic activity – Anti cancer activity –Evaluation of hepatoprotective agents – anticonvulsive- Anti ulcer drugs.

UNIT V **STANDARDIZATION AND CONSERVATION OF HERBAL DRUGS** **9**

Importance of standardization – Problems involved in the standardization of herbs- Standardization of single drugs and compound formulations – WHO guidelines for the quality assessment herbal drugs– Estimation of parameter limits used for standardization – Conservation strategies of medicinal plants – Conservation types – Government policies for protecting the traditional knowledge.

TOTAL: 45 PERIODS

OUTCOMES:

The student will be able to

- Understand the basic principle, design, control and processing techniques of medicinal plants and their derivatives. They also able to know the identification and isolation of medicinally important phytochemicals.
- Describe the biological effects of medicinal plantswith legislation and governmental policies for conserving medicinal plants.
- Gather and interpret data for the solution of problems, including social, scientific and ethical issues connected with the use of medicinal plants in the different field of applications.

TEXT BOOKS:

1. Agarwal, S.S. and Paridhavi, M., “Herbal Drug Technology” Universities Press (India)Private Limited, 2007.
2. Wallis, T.E., “Textbook of Pharmacognosy” 5th Edition, CBS Publishers and Distributors,2005.
3. Indian System of Medicine and Homeopathy in India, Planning and Evaluation Cell, Govt.of India, New Delhi, 2001.
4. Yoga- The Science of Holistic Living by V.K.Yoga, Vivekananda Yoga Prakashna Publishing, Bangalore, 2005.
5. Quality Control Methods for medicinal plant material, WHO Geneva, 1998.

REFERENCES:

1. Evans, W.C., “Trease and Evans Pharmacognosy” 15th Edition, Elsevier Health Sciences, 2001.

2. Pulok K. Mukherjee., “Quality control of Herbal Drugs”Reprintedn, Business Horizons, New Delhi, 2012.
3. Daniel, M., “Herbal Technology: Concepts and Advances” Satish Serial Publishing House, 2008.

PY8007 REGULATORY TOXICOLOGY L T P C
3 0 0 3

OBJECTIVES:

- The objective of the course is to provide up-to-date information of the international, and national regulatory processes concerning chemical risk assessment in humans, biomaterials and medical devices.
- Also to develop awareness of how toxicology is applied in real world regulatory situations and to develop knowledge of the complexities and competing interests that are part of the regulatory decision making
- Overview of the methods used to evaluate risk and produce safety guidelines, including laboratory testing, epidemiological studies and evaluation of the literature and of the online resources available to gather this information.

UNIT I INTRODUCTION 8

Regulatory aspects and strategy in medical device and biomaterials safety evaluation. Regulations affecting cosmetic and over-the- counter drug products.

UNIT II REGULATIONS GOVERNING TOXICOLOGY 8

Aim and mission, working areas, regulatory process in toxicology, quality assurance in regulatory toxicology, toxicological risk assessment.

UNIT III TOXICOLOGY AND DRUG PRODUCT REGULATIONS 8

Introduction, aspects of the IND / NDA process, toxicology and other issues, paediatric drug products, drug combinations, excipients and reformulations, conclusions.

UNIT IV TOXICOGENEOMICS, GENETIC TOXICOLOGY AND REGLATORY POLICY 12

Microarrays in toxicology, proteomics and metabolomics, case examples, toxicogenomics in regulatory environment. Initiation of genetic toxicology testing, EPA GENE TOX (Phase I and II), ICPEMC, NTP, Genetic toxicology technologies and concepts. Influence of genetic toxicology research on regulatory policy, future role in safety testing strategies.

UNIT V ALTERNATIVES IN TOXICOLOGY 9

Introduction, Societal need for information about toxic chemicals, evolution of alternatives in toxicology, humane science and animal welfare, assessing alternatives, challenges and future.

TOTAL: 45 PERIODS

OUTCOMES:

The student can be able to

- Describe the general principles in toxicological risk assessment, both ecotoxicology and human toxicology, legal regulations and alternative options in toxicology.
- Understand the basic principles of and have current, cutting-edge knowledge in environmental and human health toxicology.
- Demonstrate an understanding of legal, regulatory, and ethical considerations relating to toxicology within the broader societal context

TEXT BOOKS:

1. Shayne C. Gad, Regulatory Toxicology, Second Edition,, CRC Press, 2001.
2. Regulatory Toxicology in the European Union, Ian Dewhurst, Royal Society of Chemistry, 2017
3. Regulatory Toxicology: Essentially Practical Aspects, Renuka Sengupta, Narosa Publishing House,2015

REFERENCES:

1. Shayne C. Gad. Taylor and Francis, Regulatory Toxicology, 2nd Edition, CRC Press,2001.
2. Toxicology and Regulatory Process. Sidney Green, CRC Press, 2006.
3. Regulatory Toxicology. Eds. Franz Xaver Reichl and Michael Schwenk. Springer, 2014.

BT8791 IMMUNOLOGY L T P C
3 0 0 3

OBJECTIVES:

- To discuss the structure, functions and integration of immune system.
- To explain the antigen-antibody interactions and how the immune system is protecting the body from foreign pathogens/germs.
- To explain various techniques of monoclonal and engineered antibodies (important therapeutic molecules) production, for treating most of the human diseases.

UNIT I INTRODUCTION TO IMMUNE SYSTEM 9

Organisation and classification of immune system – immune cells and organs; innate and acquired immunity; Toll receptors and responses, classification of antigens – chemical and molecular nature; haptens, adjuvants; cytokines; complement pathway, antigen presenting cells; major histocompatibility complex

UNIT II HUMORAL AND CELLULAR IMMUNITY 9

Development, maturation, activation, regulation, differentiation and classification of T-cells and B-cells, antigen processing and presentation, theory of clonal selection, TCR; antibodies: structure and functions; antibodies: genes and generation of diversity; antigen-antibody reactions

UNIT III IMMUNITY AGAINST PATHOGENS AND TUMORS 9

Inflammation; protective immune responses to virus, bacteria, fungi and parasites; tumor antigens, tumor immune response, tumor diagnosis, tumor immunotherapy

UNIT IV IMMUNE TOLERANCE AND HYPERSENSITIVITY 9

Immune tolerance, Immuno deficiencies; Transplantation – genetics of transplantation; laws of transplantation; Allergy and hypersensitivity – Types of hypersensitivity, Autoimmunity, Auto immune disorders and diagnosis

UNIT V APPLIED IMMUNOLOGY 9

Monoclonal antibodies, engineering of antibodies; Classification of Vaccines, methods of vaccine development, immunodiagnostic methods (Immuno diffusion ELISA, FACS), immune modulatory drugs

TOTAL: 45 PERIODS

OUTCOMES:

- The students after completing the course would be aware of immune system structure and functions.
- The students would be aware of immunity to various pathogens

- The students would be aware of the principles behind the production of therapeutic/ diagnostic molecules.
- The students would be aware of the concepts and mechanism behind tumour development, allergy and hypersensivity reactions.

TEXT BOOKS:

1. Peter J Delves, Seamus J Martin, Dennis R Burtn and Ivan M Roitt., Roitts Essential Immunology, 13th Edition, Wiley –Blackwell, 2016.
2. Judith a Owen, Jenni Punt and Sharon A Stranford, Kuby Immunology, Macmillan Internation, 7th Edition, 2012
3. Ashim K. Chakravarthy, Immunology, Tata McGraw-Hill, 2006.

REFERENCES:

1. Coico, Richard "Immunology: A Short Course" VIth Edition. John Wiley, 2008.
2. Khan, Fahim Halim "Elements of Immunology" Pearson Education, 2009.
3. Robert R Rich, Thomas A Fleisher, William T Shearer, Harry Schroeder, Anthony J Frew, and Cornelia M Weyand, Clinical Immunology – Principles and Practive, Elsevier, 4th Edition, 2013.
4. Maurice R, G O`Gorman, and Albert D Donnnenberg, Handbook of human Immunology, Second edition, CRC Press, 2008
5. Gerd – Rudiger Burmester, Antonio Pezzutto and Jurgen Wirth, Colour atlas of immunology, Thieme Medical ublishers, 1st edition, 2003.

BT8091 INSTRUMENTATION AND PROCESS CONTROL L T P C
3 0 0 3

AIM :

- To familiarize the students with concepts of process dynamics and control leading to control system design.

OBJECTIVE:

- To introduce dynamic response of open and closed loop systems, control loop components and stability of control systems along with instrumentation.

UNIT I INSTRUMENTATION 9

Principles of measurements and classification of process instruments, measurement of temperature, pressure, fluid flow, liquid weight and weight flow rate, viscosity, pH, concentration, electrical and thermal conductivity, humidity of gases.

UNIT II OPEN LOOP SYSTEMS 9

Laplace transformation, application to solve ODEs. Open-loop systems, first order systems and their transient response for standard input functions, first order systems in series, linearization and its application in process control, second order systems and their dynamics; transportation lag.

UNIT III CLOSED LOOP SYSTEMS 9

Closed loop control systems, development of block diagram for feed-back control systems servo and regulatory problems, transfer function for controllers and final control element, principles of pneumatic and electronic controllers, transient response of closed-loop control systems and their stability

UNIT IV FREQUENCY RESPONSE 9

Introduction to frequency response of closed-loop systems, control system design by frequency response techniques, Bode diagram, stability criterion, tuning of controller settings

UNIT V ADVANCED CONTROL SYSTEMS 9

Introduction to advanced control systems, cascade control, feed forward control, Smith predictor controller, control of distillation towers and heat exchangers, introduction to computer control of chemical processes

TOTAL: 45 PERIODS

OUTCOMES:

The students will be able to

Understand the response of various control systems

TEXT BOOKS:

1. Stephanopoulos, G., "Chemical Process Control", Prentice Hall of India, 2003.
2. Coughnowr, D., " Process Systems Analysis and Control ",. 3rd ed., McGraw Hill, 2008.

REFERENCES:

1. Marlin, T. E., " Process Control ", IInd Edn, McGraw Hill, New York, 2000.
2. Smith, C. A. and Corripio, A. B., "Principles and Practice of Automatic Process Control",IInd Edn., John Wiley, New York, 1997.

GE8076 PROFESSIONAL ETHICS IN ENGINEERING L T P C

3 0 0 3

OBJECTIVES:

- To enable the students to create an awareness on Engineering Ethics and Human Values, to instill Moral and Social Values and Loyalty and to appreciate the rights of others.

UNIT I HUMAN VALUES 10

Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.

UNIT II ENGINEERING ETHICS 9

Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories.

UNIT III ENGINEERING AS SOCIAL EXPERIMENTATION 9

Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law.

UNIT IV SAFETY, RESPONSIBILITIES AND RIGHTS 9

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.

UNIT V GLOBAL ISSUES 8

Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership –Code of Conduct – Corporate Social Responsibility.

TOTAL: 45 PERIODS

OUTCOMES:

- Upon completion of the course, the student should be able to apply ethics in society,
- Discuss the ethical issues related to engineering
- The students will be able to realize the responsibilities and rights in the society.

TEXT BOOKS:

1. Mike W. Martin and Roland Schinzinger, “Ethics in Engineering”, Tata McGraw Hill, New Delhi, 2003.
2. Govindarajan M, Natarajan S, Senthil Kumar V. S, “Engineering Ethics”, Prentice Hall of India, New Delhi, 2004.

REFERENCES:

1. Charles B. Fleddermann, “Engineering Ethics”, Pearson Prentice Hall, New Jersey, 2004.
2. Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, “Engineering Ethics – Concepts and Cases”, Cengage Learning, 2009.
3. John R Boatright, “Ethics and the Conduct of Business”, Pearson Education, New Delhi, 2003
4. Edmund G Seebauer and Robert L Barry, “Fundamentals of Ethics for Scientists and Engineers”, Oxford University Press, Oxford, 2001.
5. Laura P. Hartman and Joe Desjardins, “Business Ethics: Decision Making for Personal Integrity and Social Responsibility” Mc Graw Hill education, India Pvt. Ltd.,New Delhi, 2013.
6. World Community Service Centre, ‘ Value Education’, Vethathiri publications, Erode, 2011.

Web sources:

1. www.onlineethics.org
2. www.nspe.org
3. www.globalethics.org
4. www.ethics.org

BT8651 BIOINFORMATICS L T P C

3 2 0 4

OBJECTIVES:

- To improve the programming skills of the student
- To let the students know the recent evolution in biological science

UNIT I INTRODUCTION (9 + 6)

Introduction to Operating systems, Linux commands, File transfer protocols ftp and telnet, Introduction to Bioinformatics and Computational Biology, Biological sequences, Biological databases, Genome specific databases, Data file formats, Data life cycle, Database management system models, Basics of Structured Query Language (SQL).

UNIT II SEQUENCE ALIGNMENT (9 + 6)

Sequence Analysis, Pair wise alignment, Dynamic programming algorithms for computing edit distance, string similarity, shotgun DNA sequencing, end space free alignment. Multiple sequence

alignment, Algorithms for Multiple sequence alignment, Generating motifs and profiles, Local and Global alignment, Needleman and Wunsch algorithm, Smith Waterman algorithm, BLAST, PSIBLAST and PHIBLAST algorithms.

UNIT III PHYLOGENETIC METHODS (9 + 6)

Introduction to phylogenetics, Distance based trees UPGMA trees, Molecular clock theory, Ultrametric trees, Parsimonious trees, Neighbour joining trees, trees based on morphological traits, Bootstrapping. Protein Secondary structure and tertiary structure prediction methods, Homology modeling, abinitio approaches, Threading, Critical Assessment of Structure Prediction, Structural genomics.

UNIT IV PROTEIN STRUCTURE ANALYSIS (9 + 6)

Machine learning techniques: Artificial Neural Networks in protein secondary structure prediction, Hidden Markov Models for gene finding, Decision trees, Support Vector Machines. Introduction to Systems Biology and Synthetic Biology, Microarray analysis, DNA computing,Bioinformatics approaches for drug discovery, Applications of informatics techniques in genomics and proteomics: Assembling the genome, STS content mapping for clone contigs, Functional annotation, Peptide mass fingerprinting.

UNIT V PERL PROGRAMMING (9 + 6)

Basics of PERL programming for Bioinformatics: Data types: scalars and collections, operators, Program control flow constructs, Library Functions: String specific functions, User defined functions, File handling.

TOTAL: 75 PERIODS

OUTCOMES:

Upon completion of this course, students will be able to

- Develop bioinformatics tools with programming skills.
- Apply computational based solutions for biological perspectives.
- Pursue higher education in this field.
- Practice life-long learning of applied biological science.

TEXT BOOKS:

1. Introduction to Bioinformatics by Arthur K. Lesk , Oxford University Press.
2. Algorithms on Strings, Trees and Sequences by Dan Gusfield, Cambridge University Press.
3. Biological Sequence Analysis Probabilistic Models of proteins and nucleic acids by R.Durbin, S.Eddy, A.Krogh, G.Mitchison.
4. Bioinformatics Sequence and Genome Analysis by David W. Mount, Cold Spring Harbor Laboratory Press.
5. Beginning Perl for Bioinformatics: An introduction to Perl for Biologists by James Tindall, O'Reilley Media

REFERENCE:

1. Bioinformatics The Machine Learning Approach by Pierre Baldi and Soren Brunak.

PY8008 VACCINE TECHOLOGY L T P C

3 0 0 3

OBJECTIVES:

- To provide the knowledge on conventional to recent technology of vaccine production.

- To learn the types of vaccines, its immunological effects and regulatory guidelines.

UNIT I IMMUNOLOGICAL CONCEPTS IN VACCINOLOGY 9

Short history of vaccination, requirements for induction of immunity, Epitopes, linear and conformational epitopes, characterisation and location of APC, MHC and immunogenicity, Rationale vaccine design based on clinical requirements: Hypersensitivity, Immunity to Infection, Autoimmunity, immunodeficiency, mechanism of adjuvant action, Scope of future vaccine strategies.

UNIT II CLASSIFICATION OF VACCINES AND ITS PREPARATIONS 10

Active and passive immunization; Viral/bacterial/parasite vaccine differences, methods of vaccine preparation – Live, killed, attenuated, sub unit vaccines; Vaccine technology- Role and properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines, edible vaccines, reverse vaccinology, combination vaccines, therapeutic vaccines; Peptide vaccines, conjugate vaccines; Cell based vaccines.

UNIT III VACCINE RESEARCH AND DESIGN 9

Fundamental research to rational vaccine design. Antigen identification and delivery, T-Cell expression cloning for identification of vaccine targets for intracellular pathogens, Fundamentals of Immune recognition, implications for manipulating the T-Cell repertoire, Targeting Dendritic cells; a rational approach for Vaccine development, Cellular basis of T- Cell memory, Rational design of new vectors, CpG adjuvant activity, Transcutaneous immunisation, Vaccination studies and recent advances in Malaria, Tuberculosis, HIV.

UNIT IV COMPUTATIONAL TOOLS FOR VACCINE DESIGN 8

Antigen Sequence analysis, Epitope Mapping, Predictions of Immunogenic peptides of T-Cell and B-Cells. Prediction of HLA binding peptides, Comparative Genomics as a tool for vaccine design, introduction to online epitope databases.

UNIT V ANIMAL TESTING, COMMERCIALISATION, QUALITY CONTROL 9

Quality control and regulations in vaccine research, *In-vitro* experimental validations for predictions of vaccines by software, Animal testing, Rational design to clinical trials, Large scale production, Commercialisation, ethics.

TOTAL: 45 PERIODS

OUTCOMES:

The students after completing the course

- Aware of the strategies available for developing an innovative vaccine technology with different mode of vaccine delivery.
- Able to explain the significance of critical antigens, immunogens and adjuvants in developing effective vaccines.
- Aware of the regulatory issues, guidelines for the management of production of vaccine.

TEXT BOOKS:

1. Ronald W. Ellis, “New Vaccine Technologies”, Landes Bioscience, 2001.
2. Cheryl Barton, “Advances in Vaccine Technology and Delivery”, Espicom Business Intelligence, 2009.
3. Male, David et al., “Immunology”, 7th Edition, Mosby Publication, 2007.

REFERENCES:

1. Coico, R. etal., “Immunology: A Short Course”, 5th Edition, Wiley – Liss, 2003.
2. Parham, Peter “The Immune System”, 2nd Edition, Garland Science, 2005.

3. Abbas, A.K. etal., "The Cellular and Molecular Immunology", 6th Edition, Sanders / Elsevier, 2007.
4. Weir, D.M. and Stewart, John "Immunology", 8th Edition, Churchill Pvt. Ltd., 2000

PY8009 TECHNOLOGY OF FINE CHEMICALS AND BULK DRUGS L T P C
3 0 0 3

OBJECTIVE:

- To study about the plant design, production techniques and process chemistry involved in the fine chemicals and bulk drug industry.

UNIT I INTRODUCTION OF FINE CHEMICALS AND BULK DRUGS 9

Concept of fine and Bulk drugs and their salient features – Evolution of process – Process chemistry – Research and development strategies in pharmaceutical industries, Chemical process life cycle, Legislative requirements for safe process development and scale up.

UNIT II PRODUCTION, PLANNING AND CONTROL 9

Flow sheets – Types of flow sheets – Flow symbols – Line symbols – Concept of all purpose and multipurpose plants – Plant design – Layout –– Process economics – Materials of construction – Effluent treatment and solvent recovery for fine chemicals and bulk drugs.

UNIT III PROCESS DEVELOPMENT AND HAZARDS 9

Developing the best synthetic route; Selection of the best route for scale-up, Choice of raw materials and reagents, Development techniques for safe process design, Unit operations posing particular hazards during development, Strategies for chemical hazards assessment, Hazards of gas and vapor generation, Identification of highly-energetic materials.

UNIT IV BASE CHEMICALS, DRUG INTERMEDIATES AND FINE CHEMICAL PRODUCTION 9

Manufacture of following chemicals and their applications – Sulphuric acid – Caustic soda – Ammonia – Phenol – Industrial alcohol - Urea – Acrylonitrile –Ethyl acetate – Butadiene – Aniline – Titanium dioxide –Vanillin.

UNIT V BULK DRUGS PRODUCTION 9

Raw Materials – Production Techniques – Reaction Flow Sheet – Equipments – Utilities for the production of drugs below – Paracetamol – Aspirin – Ibuprofen – Diazepam – Vitamin C – Salbutamol – Ranitidine – Sulphamethoxazole – Cephalosporins – Erythromycin-Prednisolone.

TOTAL: 45 PERIODS

OUTCOMES:

The student will be able to

- Apply the knowledge of the production techniques of fine chemicals and bulk drugs.
- Acquire the knowledge on plant design, process development and chemical hazards in fine chemical and bulk drug industry.
- Understand kinetics, thermodynamics and plant construction materials for the production of bulk drugs and fine chemicals.

.**TEXT BOOKS:**

1. Gopal Rao, M. and Sittig, M., "Dryden's Outlines of Chemical Technology", 3rd Edition, Affiliated East West Press Pvt. Ltd., 2001.

2. Austin, G.T., "Shreve's Chemical Process Industries", 5th Edition, McGraw Hill BookCompany, 2012.
3. Pandey, G.N., "A Text Book of Chemical Technology", Vol. II, Vikas Publishing House (P) Ltd., 2000.

REFERENCES:

1. Coulson and Richardson, "Chemical Engineering" Vol 6, 4th edition, Butterworth Heinemann, 2005.
2. Shah, K.M., "Hand Book of Industrial Chemistry", Vol. I and II, Multi-Tech Publishing Co, 1999.
3. Neal G. Anderson, "Practical Process Research and Development" 1st Edition, academic Press, 2000

PY8010 ADVANCED MEDICINAL CHEMISTRY L T P C
3 0 0 3

OBJECTIVES:

The content of this syllabus is designed

- To understand the role of enzyme induction and inhibition for drug biotransformation
- To cater essential features of pharmacophores to enable a ligand molecule to interact with a specific target receptor.
- To understand the mode of action and structure activity relationship of Chemotherapeutic agents, Amino acids, peptide, nucleotides and related drugs and Steroids and related drugs

UNIT I BIOTRANSFORMATION OF DRUGS 9

Protein Binding, Prodrug approach, Soft Drug approach, enzymes responsible for biotransformation, microsomal and non-microsomal mechanisms. Factors influencing enzyme induction and inhibition.

UNIT II PHARMACOPHORE CONCEPT 9

Methods of conformational search used in pharmacophore mapping. Comparison between the popular pharmacophore methods like Catalyst/HipHop, DiscoTech, GASP with practical examples. De Novo drug design techniques: Receptor/enzyme cavity size prediction. Predicting the functional components of cavities, designing drugs fitting into cavity.

UNIT III CHEMOTHERAPEUTIC AGENTS 9

Synthetic procedures of selected drugs, mode of action, uses, structure activity relationship including Physico-Chemical properties of Antitubercular, Antimalarial, Antifungal, and Antiamoebic drugs.

UNIT IV PEPTIDES, NUELEOTIDES AND RELATED DRUGS 9

Synthetic procedures of selected drugs, mode of action, uses, structure activity relationship including Physico-Chemical properties of the following classes of drugs Thyroid and Anti thyroid drugs, Insulin and oral hypoglycaemic agents.

UNIT V STEROIDS AND RELATED DRUGS 9

Synthetic procedures of selected drugs, mode of action, uses, structure activity relationship including Physico-Chemical properties of the following classes of drugs Steroidal nomenclature

and stereochemistry, androgens and anabolic agents, estrogens, and progestational agents, adrenocorticoids.

TOTAL: 45 PERIODS

OUTCOMES:

- The student would be equipped with the advanced knowledge of identification of different targets in different diseases.
- The student will be able to involve in drug discovery programmes including lead identification, design of pro drug and their metabolic pathways.
- The student will be able to interpret structure-activity relationships and fundamental principles governing the molecular interactions of a drug with its target.

TEXT BOOKS:

1. Donald J. Abraham, David P. Rotella (Eds.,), Burger's Medicinal Chemistry and Drug Discovery, Vol. I-VIII, 7th Edition, John Wiley and Sons, Inc., New Jersy, 2010.
2. Wilson and Gisvold, Textbook of Organic Medicinal and Pharmaceutical Chemistry, 12th Edition, Lippincott Williams & Wilkins –Philadelphia, 2010.
3. William O Foye, Thomas L Lemke, David A Williams Foye's Principles of Medicinal Chemistry, 7th Edition, Wolters Kluwer Health Adis (ESP) Publisher, 2012.
4. Daniel Lednicer, Lester A. Mitscher (Eds.), The Organic Chemistry of Drug Synthesis, Vol. I-VII, Wiley Publisher, 2007.

REFERENCES:

1. Ariens, Drug Design: Medicinal Chemistry, Volume I-X, Academic Press, 2009.
2. Corwin, Hansen, Comprehensive Medicinal Chemistry III, 3rd Edition, Elsevier, 2017.
3. Richard B. Silvermann, Mark W. Holladay, The Organic Chemistry of Drug Design and Drug Action 3rd Edition, Academic Press, 2014.
4. H. John Smith, Hywel Williams, Introduction to principles of Drug Design, CRC Press, 2005.
5. Camille Wermuth, David Aldous, Pierre Raboisson, Didier Rognan, The Practice of Medicinal Chemistry, 4th Edition, Elsevier Publications, 2001

PY8011 NUTRACEUTICALS L T P C
3 0 0 3

OBJECTIVES:

- To understand the basic concepts of Nutraceuticals and functional food, their chemical nature and methods of extraction.
- To understand the role of Nutraceuticals and functional food in health and disease.

UNIT I INTRODUCTION AND SIGNIFICANCE 6

Introduction to Nutraceuticals and functional foods; importance, history, definition, classification, list of functional foods and their benefits, Phytochemicals, zoochemicals and microbes in food, plants, animals and microbes.

UNIT II PHYTOCHEMICALS AS NUTRACEUTICALS 11

Phytoestrogens in plants; isoflavones; flavonols, polyphenols, tannins, saponins, lignans, lycopene, chitin, caratenoids. Manufacturing practice of selected nutraceuticals such as lycopene, isoflavonoids, glucosamine, phytosterols. Formulation of functional foods containing nutraceuticals – stability, analytical and labelling issues.

UNIT III ASSESSMENT OF ANTIOXIDANT ACTIVITY 11

In vitro and *in vivo* methods for the assessment of antioxidant activity, Comparison of different *in vitro* methods to evaluate the antioxidant, antioxidant mechanism, Prediction of the antioxidant activity of natural phenolics from electrotopological state indices, Optimising phytochemical release by process technology; Variation of Antioxidant Activity during technological treatments, new food grade peptidases from plant sources

UNIT IV ROLE IN HEALTH AND DISEASE 11

The health benefit of - Soy protein, Spirulina, Tea, Olive oil, plant sterols, Broccoli, omega3 fatty acid and eicosanoids. Nutraceuticals and Functional foods in Gastrointestinal disorder, Cancer, CVD, Diabetic Mellitus, HIV and Dental disease; Importance and function of probiotic, prebiotic and synbiotic and their applications, Functional foods and immune competence; role and use in obesity and nervous system disorders.

UNIT V SAFETY ISSUES 6

Health Claims, Adverse effects and toxicity of nutraceuticals, regulations and safety issues-International and national.

TOTAL: 45 PERIODS

OUTCOMES:

- Students will develop a good insight in the concepts of functional foods and their nutraceutical importance.
- The mechanism of action of some important phytochemicals and zoochemicals as nutraceuticals and their role in health and diseases.
- Describe pharmacological, toxicological properties and regulatoryequirements of nutraceuticals.

TEXT BOOKS:

1. Bisset, Normal Grainger and Max WichH “Herbal Drugs and Phytopharmaceuticals”, 2nd Edition, CRC, 2001.
2. Handbook of Nutraceuticals and Functional Foods: Robert Wildman, CRC, Publications. 2006
3. WEBB, PP, Dietary Supplements and Functional Foods Blackwell Publishing Ltd (United Kingdom), 2006
4. Ikan, Raphael “Natural Products: A Laboratory Guide”, 2nd Edition, Academic Press / Elsevier, 2005.

REFERENCES:

1. Asian Functional Foods (Nutraceutical Science and Technology) by John Shi (Editor), Fereidoon Shahidi (Editor), Chi-Tang Ho (Editor), CRC Publications, Taylor & Francis, 2007
2. Functional Foods and Nutraceuticals in Cancer Prevention by Ronald Ross Watson (Author), Blackwell Publishing, 2007
3. Marketing Nutrition: Soy, Functional Foods, Biotechnology, and Obesity by Brian Wansink.
4. Functional foods: Concept to Product: Edited by G R Gibson and C M Williams, Wood head Publ., 2000
5. Hanson, James R. “Natural Products: The Secondary Metabolites”, Royal Society of Chemistry, 2003.

PY8012 **PHARMACOGENOMICS** **L T P C**
3 0 0 3

OBJECTIVES:

- The course intends to provide knowledge about pharmacogenomics and drug design using genomic applications for drug action and toxicity.
- To understand how individualization of drug therapy can be achieved based on a person's genetic makeup while reducing unwanted drug effects.

UNIT I PHARMACOGENOMICS AND PERSONALIZED MEDICINE 9

Pharmacogenetics- Roots of pharmacogenomics and it is not just pharmacogenomics, Genetic drug response profiles, the effect of drugs on Gene expression, pharmacogenomics in drug discovery and drug development. Concept of individualized drug therapy, Drivers and the promise of personalized medicine, Strategies for application of pharmacogenomics to customize therapy, Barriers.

UNIT II HUMAN GENOME 9

Expressed sequence Tags (EST) and computational biology, Microbial genomics, computational analysis of whole genomes, computational genome analysis, Genomic differences that affect the outcome of host pathogen interactions, Protein coding genes, repeat elements, genome duplication, analysis of proteome, DNA variation, Biological complexity. Single nucleotide polymorphisms (SNP's) in Pharmacogenomics - approaches, number and types of SNPs, Study design for analysis, Analytical issues, Development of markers.

UNIT III ASSOCIATION STUDIES IN PHARMACOGENOMICS 9

Viability and Adverse drug reaction in drug response, Multiple inherited genetic factors influence the outcome of drug treatments, Association studies in pharmacogenomics, Strategies for pharmacogenomics Association studies, Benefits of Pharmacogenomics in Drug R & D.

UNIT IV GENOMICS APPLICATIONS FOR DRUG ACTION, TOXICITY AND DESIGN 9

Platform technologies and Pharmaceutical process, its applications to the pharmaceutical industry, Understanding biology and diseases, Target identification and validation, Drug candidate identification and optimization, safety and toxicology studies. The need of protein structure information, protein structure and variation in drug targets-the scale of problem, Mutation of drug targets leading to change in the ligand binding pocket.

UNIT V PHARMACOGENOMICS – CASE STUDIES 9

Study of pharmacogenomics of human P-Glycoprotein, drug transporters, lipid lowering drugs, chemotherapeutic agents for cancer treatment.

TOTAL: 45 PERIODS

OUTCOMES:

At the completion of course, the student will be able to

- Distinguish the effect of genetic differences between individuals in the outcome of drug therapy and in drug efficacy and toxicity.
- Describe the role of single nucleotide polymorphism as a biomarker for the prediction of risk, therapeutic response and prognosis of malignancies.
- Utilize and manage the new genomics based tools as they become available as well as make best treatment choices.

TEXT BOOKS:

1. Martin M. Zdanowicz, M.M. “Concepts in Pharmacogenomics” Second Edition, American Society of Health-System Pharmacists, 2017.
2. Licinio, J and Wong, Ma-Li. “Pharmacogenomics: The Search for the Individualized Therapies”, Wiley-Blackwell, 2009.
3. Yan Q, “Pharmacogenomics in Drug Discovery and Development” Humana Press, 2nd Edition, 2014.

REFERENCES:

1. Brazeau, D.A. and Brazeau, G.A. “Principles of the Human Genome and Pharmacogenomics” American Pharmacist Association, 2011
2. Werner, K., Meyer, U.A., Tyndale, R.F. “Pharmacogenomics”, Second Edition, Taylor and Francis, 2005.
3. Langman, L.J. and Dasgupta, A. "Pharmacogenomics in Clinical Therapeutics", Wiley – Blackwell, 2012

PY8013 TECHNOLOGY OF STERILE PRODUCTS L T P C
3 0 0 3

OBJECTIVE:

- To impart the knowledge of the various types and stages of process of sterile pharmaceutical products.

UNIT I PARENTERALS 9

Introduction, historical perspective - parenteral routes of administration - formulation additives. Small volume parenterals - large volume parenterals.

UNIT II STERILIZATION 9

Sterilization methods – Steam - Dry heat – Filtration – Gas - Ionizing radiation with their advantages and disadvantages. Validation of sterility. Particulate contamination.

UNIT III INJECTIONS 9

Types of injections - aqueous and non- aqueous vehicles used for injection – manufacturing – packaging - labeling - storage of injections.

UNIT IV PARENTERAL SUSPENSION AND EMULSION 9

Introduction – need for parenteral suspension and emulsion - manufacturing additives – formulation of parenteral suspension and emulsion – characterization – applications.

UNIT V OPHTHALMIC PRODUCTS 9

Absorption of drugs in the eye - raw materials - ocular penetration enhancers - general safety consideration. Formulation of various ophthalmic products with their characterization.

TOTAL: 45 PERIODS

OUTCOMES:

- Able to understand the concepts of different types of sterile pharmaceutical formulations.
- Able to understand the sterilisation process for the sterile products.
- Understand the technology used for formulations of various sterile products.

TEXT BOOKS:

1. Loyd V. Allen, Howard C. Ansel, Pharmaceutical Dosage Forms and Drug Delivery Systems, 10th Edition, Wolters Kluwer Health 2013.
2. Roop K. Khar, SP. Vyas "Lachman/Liebermans: The Theory and Practice of Industrial Pharmacy", 4th Edition CBS Publishers and Distributors 2013.

REFERENCES:

1. James Swarbrick "Encyclopedia of Pharmaceutical Science and Technology",4th Edition, CRC Press 2012.
2. Sandeep Nema, Nema Sandeep, John D "Pharmaceutical Dosage Forms: Parenteral Medications", 3rd Edition, Informa Healthcare 2010.

PY8014 INTRODUCTION TO BIOMATERIALS AND TISSUE ENGINEERING L T P C
3 0 0 3

OBJECTIVE:

- The objective of this course is to enable the students to learn the fundamentals of tissue engineering and tissue repairing and to acquire knowledge on biomaterials and its applications

UNIT I INTRODUCTION 10

Introduction to tissue engineering: Basic definition-current scope - cell numbers and growth rates-measurement of cell characteristics –morphology- number viability- motility and functions. Measurement of tissue characteristics - appearance- cellular component-ECM component-physical properties.

UNIT II TISSUE ARCHITECTURE 8

Tissue types and Tissue components, Tissue repair and Engineering -wound healing and sequence of events - Cell-Matrix- Cell-Cell Interactions - telomeres and Self renewal- Control of cell migration in tissue engineering.

UNIT III BIOMATERIALS 9

Biomaterials: Properties of biomaterials-Surface, bulk, mechanical and biological- Scaffolds & tissue engineering - Types of biomaterials-biological and synthetic materials- Biopolymers-Applications – Modifications - Role of Nanotechnology.

UNIT IV BASIC BIOLOGY OF STEM CELLS 9

Stem Cells: Introduction- hematopoietic differentiation pathway -Potency and plasticity of stem cells- Stem Cell markers- Types and sources of stem cell with characteristics: embryonic- adult-haematopoietic- fetal- cord blood-placenta- bone marrow-primordial germ cells- cancer stem cells-induced pleuripotent stem cells.

UNIT V CLINICAL APPLICATIONS 9

Stem cell therapy-Molecular therapy - In vitro Organogenesis-Neuro degenerative diseases- spinal cord injury- heart disease- diabetes- burns and skin ulcers- muscular dystrophy-orthopaedic applications - Patent protection and regulation of tissue engineered products- ethical issues.

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of this course, the students would get

- Ability to understand the components of the tissue architecture

- Opportunity to get familiarized with the stem cell characteristics and their relevance in medicine
- Awareness about the properties and broad applications of biomaterials
- Overall exposure to the role of tissue engineering and stem cell therapy in organogenesis

TEXT BOOKS:

1. Bernhard O.Palsson, Sangeeta N.Bhatia, "Tissue Engineering" Pearson Publishers 2009.
2. Meyer, U.; Meyer, Th.; Handschel, J.; Wiesmann, H.P. Fundamentals of Tissue Engineering and Regenerative Medicine. 2009.
3. R. Lanza, J. Gearhart et al (Eds), Essential of Stem Cell Biology, Elsevier Academic press, 2006.

REFERENCES:

1. J. J. Mao, G. Vunjak-Novakovic et al (Eds), Translational Approaches in Tissue Engineering & Regenerative Medicine" Artech House, INC Publications, 2008
2. Bernard N. Kennedy (editor), Stem cell transplantation, tissue engineering, and cancer applications, New York: Nova Science Publishers, 2008.
3. Raphael Gorodetsky, Richard Schäfer Stem cell- based tissue repair, Cambridge: RSC publishing, 2011.

PY8015 IPR FOR PHARMA INDUSTRY L T P C
3 0 0 3

OBJECTIVES:

- To provide the basic fundamental knowledge of different forms of Intellectual Property Rights in national and international level.
- To provide the significance of the Intellectual Property Rights about the patents, copyrights, industrial design, plant and geographical indications.
- This paper is to study significance of the amended patent act on pharma industry.

UNIT I INTRODUCTION- INTELLECTUAL PROPERTY RIGHTS 9

Introduction, Types of Intellectual Property Rights -patents, plant varieties protection, geographical indicators, copyright, trademark, trade secrets.

UNIT II PATENTS 9

Patents-Objective, Introduction, Requirement for patenting- Novelty, Inventive step (Non-obviousness) and industrial application (utility), Non-patentable inventions, rights of patent owner, assignment of patent rights, patent specification (provisional and complete), parts of complete specification, claims, procedure for obtaining patents, compulsory license.

UNIT III PLANT VARIETY-TRADITIONAL KNOWLEDGE –GEOGRAPHICAL INDICATIONS 9

Plant variety- Justification, criteria for protection of plant variety and protection in India. Traditional knowledge- Concept of traditional knowledge, protection of traditional knowledge under Intellectual Property frame works in national level and Traditional knowledge digital library (TKDL). Geographical Indications – Justification for protection, National and International position.

UNIT IV ENFORCEMENT AND PRACTICAL ASPECTS OF IPR 9

Introduction – civil remedies – injunction, damage, account of profit – criminal remedies – patent, trademark. Practical aspects – Introduction, benefits of licensing, licensing of basic types of IPR,

licensing clauses of IPR. Case studies of patent infringement, compulsory licensing, simple patent license agreements.

UNIT V INTERNATIONAL BACKGROUND OF INTELLECTUAL PROPERTY 9

International Background of Intellectual Property- Paris Convention, Berne convention, World Trade Organization (WTO), World Intellectual Property Organization (WIPO), Trade Related Aspects of Intellectual Property Rights (TRIPS) and Patent Co-operation Treaty (PCT).

TOTAL:45 PERIODS

OUTCOMES:

The student will be able to

- Understand the basic fundamental of Intellectual Property Rights.
- Assess and critique some basic theoretical justifications for Patents, Copyrights and Plant varieties.
- Analyse the effects of intellectual property rights on International society.

TEXT BOOKS:

1. N. Nagpal, M. Arora, M.R.D. Usman, S. Rahar, “Intellectual Property Rights” Edu creation Publishing, New Delhi, 2017.
2. The Patents Act, 1970 (Bare Act with Short Notes) (New Delhi: Universal Law Publishing Company Pvt. Ltd. 2012.
3. B.S. Rao, P.V. Appaji, “Intellectual Property Rights in Pharmaceutical Industry: Theory and Practice”, 2015.

REFERENCES:

1. Patents for Chemicals, Pharmaceuticals, & Biotechnology-Fundamentals of Global Law, Practice and Strategy. Philip W. Grubb, Oxford University Press, 2004.
2. Basic Principles of patent law – Basics principles and acquisition of IPR. Ramakrishna T. CIPRA, NLSIU, Bangalore, 2005
3. S. Lakshmana Prabu, TNK. Suriyaprakash, “Intellectual Property Rights”, 1st ed., In Tech open access, Croatia, 2017.

PY8016 COMPUTER AIDED DRUG DESIGN L T P C

3 0 0 3

OBJECTIVES:

The objective of this course is

- to find a chemical compound that can fit to a specific cavity on a protein target both geometrically and chemically.
- to know the informatics approaches to the prediction of chemical properties of new drugs
- to present the appropriate tools for such a modelling, ranging from electronic Structure methods, Molecular modelling, Structure Activity Relationships in drug design, QSAR, Molecular docking and Molecular dynamics

UNIT I ELECTRONIC STRUCTURE METHODS 8

Quantum chemical methods semi-empirical and ab initio methods. Conformational analysis, energy minimization, predicting the mechanism of organic reactions using electronic structure methods.

UNIT II MOLECULAR MODELING 9

Bioactive vs. global minimum conformations. Automated methods of conformational search. Advantages and limitations of available software. Molecular graphics. Computer methodologies behind molecular modeling including artificial intelligence methods.

UNIT III STRUCTURE ACTIVITY RELATIONSHIPS IN DRUG DESIGN 9

Qualitative versus quantitative approaches advantages and disadvantages. Random screening, Non-random screening, rational approaches to lead discovery. Homologation, chain branching, ring-chain transformations. Insights into molecular recognition phenomenon. Structure based drug design, ligand based drug design.

UNIT IV QSAR: ELECTRONIC EFFECTS 9

Hammett equation, lipophilicity effects. Hansch equation, steric effects. Taft equation. Experimental and theoretical approaches for the determination of physicochemical parameters, parameter inter-dependence: Regression analysis, Descriptor calculation. The importance of biological data in the correct form; 2D QSAR; 3D-QSAR examples of CoMFA and CoMSIA.

UNIT V MOLECULAR DOCKING 10

Rigid docking, flexible docking, manual docking. Advantages and disadvantages of Flex-X, Flex-S, Autodock and Dock softwares, with successful examples. Dynamics of drugs, biomolecules, drug-receptor complexes, Monte Carlo simulations and Molecular dynamics in performing conformational search and docking.

TOTAL:45 PERIODS

OUTCOMES:

The student able

- To gain knowledge about fundamental concepts, challenges, and rich opportunities in developing and applying algorithms for structural bioinformatics and healthcare.
- To interpret and practice the fundamental concepts of Molecular Modeling and Computer-aided Drug Design.
- To develop practical skills in computational approaches to analyze, predict, and engineer biomolecules and biomolecular systems.

TEXT BOOKS:

1. Andrew R. Leach, Molecular Modelling Principle and Application, 2nd Edition, Prentice Hall, England,2001.
2. Richard B. Silverman, Mark W. Holladay, Organic Chemistry of Drug Design and Drug Action, 3rd Edition, Academic Press, USA, 2014.
3. Paul S. Charifson, Practical Applications of computer aided drug design, 1st Edition, Marcel Dekker, New York, 1997.
4. J. M. Goodman, Chemical Applications of Molecular Modelling, The Royal Society of Chemistry, Cambridge, 1998.

REFERENCES:

1. Donald J. Abraham, Burger's Medicinal Chemistry and Drug Discovery, Vol V, 6th Edition, John Wiley and Sons, Inc., 2003.
2. John B. Taylor and David J. Triggle, Comprehensive Medicinal Chemistry II, Vol IV, Elsevier Science, 2006.
3. Graham L. Patrick, An Introduction to Medicinal Chemistry, 5th Edition, Oxford University Press, UK, 2013.

4. David. C. Young, Computational Drug Design – A Guide for Computational and Medicinal Chemists, John Wiley and Sons Ltd, Hoboken, United States, 2009.
5. Alan Hinchliffe, Molecular Modelling for Beginners, 2nd Edition, Wiley, United University of California, 2008.

PY8071 CLINICAL TRIALS L T P C
3 0 0 3

OBJECTIVES:

- To highlight the epidemiologic methods, study design, protocol preparation
- To gain knowledge in the basic bio-statistical techniques involved in clinical research.
- To describe the principles involved in ethical, legal and regulatory issues in clinical trials.

UNIT I ROLE OF CLINICAL TRIALS IN NEW DRUG DEVELOPMENT 9

Drug Discovery, regulatory guidance and governance, pharmaceutical manufacturing, nonclinical research, clinical trials, post-marketing surveillance, ethical conduct during clinical trials.

UNIT II FUNDAMENTALS OF TRIAL DESIGN 9

Randomised clinical trials, uncontrolled trials. Protocol development, endpoints, patient selection, source and control of bias, randomization, blinding, sample size and power.

UNIT III ALTERNATE TRIAL DESIGNS 9

Crossover design, factorial design, equivalence trials, bioequivalence trials, non-inferiority trials, cluster randomized trials, multi-center trials.

UNIT IV BASICS OF STATISTICAL ANALYSIS 9

Types of data and normal distribution, significance tests and confidence intervals, comparison of means, comparison of proportions, analysis of survival data, subgroup analysis, regression analysis, missing data.

UNIT V REPORTING OF TRIALS 9

Overview of reporting, trial profile, presenting baseline data, use of tables, figures, critical appraisal of report, meta-analysis.

TOTAL: 45 PERIODS

OUTCOMES:

The student will be able to

- Explain key concepts in the design of clinical trials.
- Describe study designs used, identify key issues in data management for clinical trials.
- Describe the roles of regulatory affairs in clinical trials.

TEXT BOOKS:

1. Fundamentals of Clinical Trials, Lawrence M. Friedman, Springer Science & Business Media, 2010
2. Textbook of Clinical Trials, David Machin, Simon Day, Sylvan Green, John Wiley & Sons, 2007
3. Clinical Trials: A Practical Approach, Stuart J. Pocock, John Wiley & Sons, 17-Jul-2013

REFERENCES:

1. Clinical trials, A practical guide to design, analysis and reporting. Duolao Wang and AmeetBakhai. Remedica. 2006.
2. Introduction to statistics in pharmaceutical clinical trials. T.A. Durham and J Rick Turner. Pharmaceutical Press.
3. Clinical Trials: Study Design, Endpoints and Biomarkers, Drug Safety, and FDA and ICH Guidelines, Tom Brody, Academic Press, 2016.

PY8017 PHARMACOVIGILANCE L T P C
3 0 0 3

OBJECTIVES:

- The course intends to provide knowledge about development and global scenario of pharmacovigilance and establishment of pharmacovigilance programme in an organization
- To develops the skills of classifying drugs, diseases and adverse drug reactions.

UNIT I INTRODUCTION TO PHARMACOVIGILANCE 9

Scope and development of Pharmacovigilance - Importance of safety monitoring of Medicine - WHO international drug monitoring programme - Pharmacovigilance Program of India (PvPI) - Definitions and classification of adverse drug reactions - Detection and reporting - Methods in Causality assessment - Severity and seriousness assessment - Predictability and preventability assessment - Management of adverse drug reactions - Terminologies used in pharmacovigilance, adverse medication related events and Regulatory terminologies.

UNIT II SOURCES OF DATA 9

Anatomical, therapeutic and chemical classification of drugs - International classification of diseases -Daily defined doses - International Nonproprietary Names for drugs - Drug dictionaries and coding in pharmacovigilance - WHO adverse reaction terminologies - MedDRA and StandardisedMedDRA queries - WHO drug dictionary - Eudravigilance medicinal product dictionary Information resources in pharmacovigilance - Basic drug information resources - Specialised resources for ADRs Establishing pharmacovigilance programme - Pre-clinical studies- Human volunteer studies - Clinical trials - Post-marketing surveillance - Systematic reviews and meta-analysis -

UNIT III PHARMACOVIGILANCE METHODS 9

Pharmacovigilance methods - Passive surveillance – Spontaneous reports and case series - Stimulated reporting - Active surveillance – Sentinel sites, drug event monitoring and registries - Comparative observational studies – Cross sectional study, case control study and cohort study - Targeted clinical investigations. Communication in pharmacovigilance - Effective communication in Pharmacovigilance -Communication in Drug Safety Crisis management - Communicating with Regulatory Agencies, Business Partners, Healthcare facilities & Media.

UNIT IV STATISTICAL METHODS FOR EVALUATING MEDICATION SAFETY DATA 9

Safety data generation - Pre clinical phase - Clinical phase - Post approval phase. ICH Guidelines for Pharmacovigilance - Organization and objectives of ICH - Expedited reporting - Individual case safety reports - Periodic safety update reports - Post approval expedited reporting - Pharmacovigilance planning - Good clinical practice in pharmacovigilance studies.

UNIT V PHARMACOGENOMICS OF ADVERSE DRUG REACTIONS 9

Drug safety evaluation in special population - Pediatrics - Pregnancy and lactation – Geriatrics. CIOMS - CIOMS Working Groups - CIOMS Form. CDSCO (India) and Pharmacovigilance - D&C Act and Schedule Y - Differences in Indian and global pharmacovigilance requirements

TOTAL: 45 PERIODS

OUTCOME:

At the completion of course, the student will be able

- To report adverse drug reaction in proper format.
- To analyze and compare the data generated during pharmacovigilance study
- To manage and adhere with regulatory requirements of different country.

TEXT BOOKS:

1. SumitVerma, S and Gulati, Y. Fundamentals of Pharmacovigilance, Paras Medical Publishers, 2017
2. Gupta, S. K. Text book of Pharmacovigilance, Jaypee Brothers Medical Publishers, 2011.
3. Mohanta, G.P and Manna, P.K. A Textbook of Pharmacovigilance: Concept and Practice, PharmaMed Press, 2015.

REFERENCES:

1. Andrews, E.B and Moore, N. Mann's Pharmacovigilance, Wiley-Blackwel, 3rd Edition, 2014.
2. Waller, P and Harrison□Woolrych, M. An Introduction to Pharmacovigilance, Wiley-Blackwel, 2nd Edition, 2017
3. Orleans-Lindsay, J. Pharmacovigilance Medical Writing: A Good Practice Guide, Wiley-Blackwell, 2012.

GE8074 HUMAN RIGHTS L T P C

3 0 0 3

OBJECTIVES:

- To sensitize the Engineering students to various aspects of Human Rights.

UNIT I INTRODUCTION 9

Human Rights – Meaning, origin and Development. Notion and classification of Rights – Natural, Moral and Legal Rights. Civil and Political Rights, Economic, Social and Cultural Rights; collective / Solidarity Rights.

UNIT II THEORIES 9

Evolution of the concept of Human Rights Magana carta – Geneva convention of 1864. Universal Declaration of Human Rights, 1948. Theories of Human Rights.

UNIT III UNITED NATIONS PRESPECTIVE 9

Theories and perspectives of UN Laws – UN Agencies to monitor and compliance.

UNIT IV NATIONAL REGULATIONS 9

Human Rights in India – Constitutional Provisions / Guarantees.

UNIT V CONCERNING THE DIFFERENTIALLY ABLED SECTION OF THE SOCIETY 9

Human Rights of Disadvantaged People – Women, Children, Displaced persons and Disabled persons, including Aged and HIV Infected People. Implementation of Human Rights – National

and State Human Rights Commission – Judiciary – Role of NGO's, Media, Educational Institutions, Social Movements.

TOTAL: 45 PERIODS

OUTCOME:

- Engineering students will acquire the basic knowledge of human rights.

REFERENCES:

1. Kapoor S.K., "Human Rights under International law and Indian Laws", Central Law Agency, Allahabad, 2014
2. Chandra U., "Human Rights", Allahabad Law Agency, Allahabad, 2014.
3. Upendra Baxi, The Future of Human Rights, Oxford University Press, New Delhi.

PY8018 PHARMACEUTICAL NANOTECHNOLOGY L T P C
3 0 0 3

OBJECTIVE:

- The goal of this course is to provide an insight into the fundamentals of nanotechnology in biomedical and Pharmaceutical research. It will also guide the students to understand how nanomaterials can be used for a diversity of analytical and medicinal rationales

UNIT I NANOSTRUCTURES 9

Preparation, properties and characterization - Self-assembling nanostructure - vesicular and micellar polymerization-nanofilms - Metal Nanoparticles- lipid nanoparticles- nanoemulsion - Molecular nanomaterials: dendrimers, etc.,

UNIT II NANOTECHNOLOGY IN BIOMEDICAL INDUSTRY 9

Reconstructive Intervention and Surgery- Nanomaterials in bone substitutes and dentistry – Implants and Prosthesis -in vivo imaging- genetic defects and other disease states –– Nanorobotics in Surgery –Nanocarriers: sustained, controlled, targeted drug delivery systems

UNIT III NANOTECHNOLOGY IN CANCER THERAPY 9

Cancer Cell Targeting and Detection- Polymeric Nanoparticles for cancer treatment - mechanism of drug delivery to tumors -advantages and limitations - Multifunctional Agents - Cancer Imaging – Magnetic Resonance Imaging- Cancer Immunotherapy.

UNIT IV NANOTECHNOLOGY IN COSMETICS 9

Polymers in cosmetics: Film Formers – Thickeners – Hair Colouring – Conditioning Polymers: conditioning, Cleansing – Silicons – Emulsions – Stimuli Responsive Polymeric Systems - Formulation of Nano Gels, Shampoos, Hair-conditioners -Micellar self-assembly Sun-screen dispersions for UV protection – Color cosmetics

UNIT V NANOTOXICITY 9

NanoToxicology- introduction, dose relationship- Hazard Classification-Risk assessment and management - factors affecting nano toxicity- Dermal Effects of Nanomaterials, Pulmonary, Neuro and Cardiovascular effects of Nanoparticles - Gene–Cellular and molecular Interactions of Nanomaterials

TOTAL:45 PERIODS

OUTCOMES:

The students will be able to

- Comprehend the structural and functional principles of Pharmaceutical nanotechnology
- Recognize nanomaterials for analysis and sensing techniques

- Apprehend the biomedical applications of nanotechnology

TEXT BOOKS:

1. Springer Handbook of Nanotechnology- Ed. by B. Bhushan, Springer-Verlag 2004
2. Nanobiotechnology: Concepts, Applications and Perspectives,. CM.Niemeyer C A. Mirkin, (Eds) , Wiley, 2004
3. Nanotechnology: Health and Environmental Risks, Jo Anne Shatkin, Second Edition, CRC Press, 2013
4. Sarah E. Morgan, Kathleen O. Havelka, Robert Y. Lochhead "Cosmetic Nanotechnology: Polymers and Colloids in Cosmetics", American Chemical Society, 2006.

REFERENCES:

1. Nanotechnology in Biology and Medicine: Methods, Devices and Applications, Tuan VoDinh, CRC Press, 2007
2. The Chemistry of Nanomaterials: Synthesis, Properties and Applications, C.N.R. Rao, A. Muller, A. K. Cheetham (Eds), Wiley-VCH Verlag 2004
3. Nanotechnology: Environmental Health and safety, Risks, Regulation and Management, Matthew Hull and Diana Bowman, Elsevier, 2010

PY8019 PROTEIN STRUCTURE, FUNCTION AND PROTEOMICS L T P C
3 0 0 3

OBJECTIVES:

To enable the students

- To identify the importance of protein biomoleculesto access, use and evaluate the information available in protein databases to find about a protein of interest.
- To realize and explain key concepts in protein function such as affinity and specificity, allosteric regulation.

UNIT I BONDS, ENERGIES, BUILDING BLOCKS OF PROTEINS 9

Covalent, Ionic, Hydrogen, Coordinate, hydrophobic and Vander walls interactions in protein structure. Interaction of electromagnetic radiation (radio, micro, infrared, visible, ultraviolet, X-ray) and elucidation of protein structure. Amino acids (the students should be thorough with three and single letter codes) and their molecular properties (size, solubility, charge, pKa), Chemical reactivity in relation to post-translational modification (involving amino, carboxyl, hydroxyl, thiol, imidazole groups).

UNIT II PROTEIN ARCHITECTURE 9

Primary structure: peptide mapping, peptide sequences - automated Edman method & High-throughput protein sequencing setup. Secondary structure: Alpha, beta and loop structures and methods to determine. Super-secondary structure: Alpha-turn alpha, beta-turn- beta (hairpin), beta-sheets, alpha-beta-alpha, topology diagrams, up and down & TIM barrel structures nucleotide binding folds.

UNIT III TERTIARY STRUCTURE 9

Prediction of substrate binding sites, Tertiary structure: Domains, folding, denaturation and renaturation, overview of methods to determine 3D structures. Quaternary structure: Modular nature, formation of complexes, protein-protein interactions and methods to study it.

UNIT IV STRUCTURE-FUNCTION RELATIONSHIP 9

DNA-binding proteins: prokaryotic transcription factors, Helix-turn-Helix motif in DNA binding, Trp repressor, Eukaryotic transcription factors, Zn fingers, helix-turn helix motifs in homeodomain, Leucine zippers, Membrane proteins: General characteristics, Trans-membrane segments, prediction, bacteriorhodopsin and Photosynthetic reaction center, Immunoglobulins: IgG Light chain and heavy chain architecture and Enzymes: Serine proteases.

UNIT V PROTEOMICS 9

Introduction to the concept of proteome, components of proteomics, proteomic analysis, importance of proteomics in biological functions, protein arrays, cross linking methods, affinity methods, yeast hybrid systems and protein arrays. It needs Virtual labs and E-learning proteomics tools for the above said syllabus.

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of this course, students will be able:

- To analyze various interactions in protein makeup and be familiar with different levels of protein structure.
- To know the role of functional proteins in various field of study and to practice the latest application of protein science in their research.
- To introduce the concept of proteome, components of proteomics and proteomic analysis.

TEXT BOOKS:

1. Branden C. and Tooze J., "Introduction to Protein Structured" 2nd Edition, Garlan Publishing, 1999'
2. Creighton T.E. "Proteins" 2nd Edition. W.H. Freeman, 1993.
3. Pennington, S.R and M.J. Dunn, "Proteomics: Protein Sequence to Function". VivaBooks, 2002

REFERENCES:

1. Liebler, "Introduction to Proteomics" Humana Press, 2002.
2. David Whitford, "Proteins: Structure and Function" John wiley& Sons ltd, 2005.

PY8020 PHARMACEUTICAL PACKAGING TECHNOLOGY L T P C
3 0 0 3

OBJECTIVE:

- To provide the importance of packaging technology and its requirements in pharmaceutical products.

UNITI PHARMACEUTICAL PACKAGING 9

Introduction of packaging - classification of packaging - packaging essential requirements-functions of packaging - importance / significance of pharma packaging - main packaging materials - ideal package material properties.

UNIT II PRIMARY PACKAGING MATERIAL 9

Glass containers- introduction - selection of glass as packaging materials for the pharmaceutical products - properties of glass - production of glass - types of glass - test for glass containers-advantages and disadvantages of glass containers. Metalscontainers- aluminium - aluminium foil - collapsible tubes and stainless steel. Polymers -and plastics- introduction toplastics - raw materials

of plastics - types of plastics - resin identification code - plastics and packaging and testing of plastic containers.

UNIT III SOLID DOSAGE FORM PACKAGING 9

Blister package- introduction to blister package - types of blisters - advantages and disadvantages of blister packaging - types of problems/ defects. Strip package- strip Packaging Process - packaging materials - child-resistant and multi-dose strip packaging.

UNIT IV LIQUID FORMULATION AND STERILE PRODUCT PACKAGING 9

Liquid Formulation - Factors influencing selection of liquid filling machinery - balanced and unbalanced constant level filling – volumetric – gravimetric - level sensing - time fill - peristaltic and overflow liquid filling machinery. Sterile product packaging- various types of containers used for sterile products like ampoules – vials - bottles for I.V. fluid, etc. Types of closures used for the sterile products. Sterile product filling and sealing machinery i.e. ampoule filling and sealing machine.

UNITV QUALITYCONTROL AND REGULATIONS OFPACKAGING MATERIALS 9

Specifications–quality control tests–methods and evaluation of packaging of materials– stability of packaging materials–law and regulations governing packaging.

TOTAL:45 PERIODS

OUTCOMES:

- Understand the various categories of packaging materials used in pharmaceutical industry.
- Chooseproperpackagingmaterialsfordifferentpharmaceuticaldosageforms.
- Understand the regulations of the packaging materials.

TEXT BOOKS:

1. D.A. Deak, E.R. Evans, I.H. Hall, “Pharmaceutical Packaging Technology”, TaylorandFrancis,2000.
2. Edward J. Bauer, Pharmaceutical Packaging Handbook. CRC Press, 2009.
3. S. Natarajan, M. Govindarajan, B. Kumar, “Fundamental of Packing Technology”, PHI Learning Pvt ltd., New Delhi, 2009.

REFERENCES:

1. Anonymous,“Quality Assurance of Pharmaceuticals:A Compendium of Guidelines and Related Materials”,2nd Edition, World Health Organization,2004.
2. U.K. Jain, D.C. Goupale, S. Nayak, “Pharmaceutical Packaging Technology”, 2nd ed., Pharma Med Press, Hyderabad, 2008.
3. Remington: The Science and Practice of Pharmacy. 21st ed., 2005.
4. James Swarbrick, “Encyclopedia of Pharmaceutical Science and Technology”, 4th ed., CRC Press, 2013.

PY8021 EXPERIMENTAL DESIGN AND ANALYSIS L T P C

3 0 0 3

OBJECTIVES:

- To define, learn, and understand the principles of experimental design;
- To plan and select statistical tools; To execute effectively and analyze results of experimental data

UNIT I FUNDAMENTALS OF STATISTICS 9

Define Statistics, intuitive biostatistics, relevance to research, preparation of data, analysis of data,frequency tables, graphical techniques, measuring variability, identify measures of centraltendency and variability, probability, tools in statistics, selection of various statistics tools

UNIT II PRINCIPLES OF EXPERIMENTAL DESIGN 9

Designing an experiment, controlled experiments, natural and quasi-experiments, population definitions, sampling unit, types of variables, treatment structure, design structure, collecting andanalyzing data, types of effects, randomization, replication, blocking, orthogonality, factorialdesign, completely randomized design, randomized complete block design,

UNIT III CORRELATION AND REGRESSION 9

Correlation and regression: Graphical presentation of two continuous variables; Pearson's productmoment correlation coefficient; its statistical significance; Multiple and partial correlations; Linearregression; Regression line; Coefficient of determination; Interval estimation and hypothesistesting for population slope; Introduction to multiple linear regression models; Probit and logittransformations.

UNIT IV PARAMETRIC TESTS 9

Estimation and Hypothesis testing: Point and interval estimation including fiducial limits; Conceptsof hypothesis testing and types of errors; Student-t and Chi square tests; Sample size and power;Experimental design and analysis of variance: Completely randomized,randomized blocks; Latinsquare and factorial designs; Post- hoc procedures.

UNIT V NON-PARAMETRIC TESTS 9

Non-parametric tests: Sign; Mann-Whitney U; Wilcoxon matched pair; Kruskalwallis and Friedman two-wayanova tests. Spearman rank correlation; Statistical techniques in pharmaceutics: Experimental design in clinical trials; Parallel and crossover designs; Statisticaltest for bioequivalence; Dose response studies; Statistical quality control.

TOTAL: 45 PERIODS

OUTCOMES:

After completing this course, students should demonstrate competency in the following topics:

- Basic probability axioms and rules and the moments of discrete and continuous random variables.
- They will be able to utilize Joint distributions, correlation, regression and various parametric and non parametric tests in their research analyses.

TEXT BOOKS:

1. Gupta S.P, Statistical Methods, Sultan Chand & Sons, New Delhi, 2005.
2. P.S.S. Sundar Rao, P.H.Richard, J.Richard, An introduction to Biostatistics, Prentice Hall of India(P) Ltd., New Delhi, 2003.

REFERENCES:

1. Jerrold H. Zar, Bio Statistical Analysis, Tan Prints(I) Pvt. Ltd., New Delhi, 2003.
2. Goulden, Methods of Statistical Analysis, Asia Publishing Co., New Delhi, 1962.
3. Intuitive Biostatistics by Harvey Motulsky. Copyright © 1995 by Oxford University PressInc.

PY8022 **SAFETY AND HEALTH EVALUATION** **L T P C**
3 0 0 3

OBJECTIVE:

- To instill basics of various hazards and their effects. To create awareness among the students about the importance of safety and health evaluation.

UNIT I INDUSTRIAL HYGIENE 9

Definition of Industrial Hygiene, Industrial Hygiene: Control Methods, Substitution, Changing the process, Local Exhaust Ventilation, Isolation, Wet method, Personal hygiene, housekeeping and maintenance, waste disposal, special control measures

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UNIT II CHEMICAL HAZARDS 9

Introduction to chemical hazards, dangerous properties of chemical, dust, gases, fumes, mist, Vapours, Smoke and aerosols. Route of entry to human system, recognition, evaluation and control of basic hazards, concepts of dose response relationship, bio-chemical action of toxic substances. Concept of threshold, limit values.

UNIT III PERSONAL PROTECTIVE EQUIPMENTS 9

Need, selection, supply, use, care and maintenance, Personal protective devices for head, ear, face, eye, foot, knee and body protection, Respiratory personal protective devices.

UNIT IV HAZARDOUS WASTE MANAGEMENT 9

Hazardous waste management in India - waste identification, characterization and classification-collection, treatment and disposal of hazardous waste. Collection and disposal of solid wastes - health hazards - toxic and radioactive wastes incineration and vitrification

UNIT V MONITORING FOR SAFETY, HEALTH 9

Introduction to Occupational safety, Health & Environment management system – Concepts of Bureau of Indian standards on safety & Health: 14489-1998 & 15001-2000, ILO and EPA standards.

TOTAL: 45 PERIODS

OUTCOMES:

- Identify major types of hazards to health and safety.
- Able to apply and practice the protective equipments and monitor safety and health.
- Able to apply the knowledge of waste management.

TEXT BOOKS:

1. R. K. Jain and Sunil S. Rao, Industrial Safety, Health and Environment Management Systems, 3rd Edition, Khanna publishers, New Delhi 2006
2. Danuta Koradecka, Handbook of Occupational Safety and Health, CRC Press 2010
3. Charles D. Reese, James Vernon Eidson, Handbook of OSHA Construction Safety and Health, Second Edition, CRC Press, 2012

REFERENCES:

1. David L. Goetsch,Occupational Safety and Health for Technologists, Engineers, and Managers 8th edition, Pearson 2014.
2. "Encyclopedia of occupational safety and health", 4th edition, International Labor Office 2012.