Syllabus for Bachelor of Technology
In
Pharmaceutical Chemistry and Technology

(Under the National Education Policy, NEP 2020)
(2023-2024)

Department of Pharmaceutical Sciences and Technology
INSTITUTE OF CHEMICAL TECHNOLOGY
(University Under Section-3 of UGC Act, 1956)
Elite Status and Center for Excellence
Government of Maharashtra

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A. Preamble

The undergraduate programmes at the Institute of Chemical Technology are reputed worldwide. Alumni from these programmes have found a place of pride in the Indian chemical industry including some top names and many as entrepreneurs, in Universities/ Institutes and Research Organization's throughout India and the world. The B.Tech. Programmes in the then Department of Chemical Technology, University of Mumbai started in 1934 as post B.Sc., second graduation as B.Sc. (Tech.). Keeping national, societal needs in focus, post-independence, the programme grew into multiple branches keeping connection with chemical engineering content. Once the Institute became a university in 2009, these became independent B. Tech. Programmes retaining their dual core nature. The Institute of Chemical Technology is committed to keeping its syllabi updated and globally relevant for the industry. We have revamped the syllabi of all the B. Tech. programmes now in 2023 as per NEP 2020. The 176-credit programme each has the following Credit Distribution.

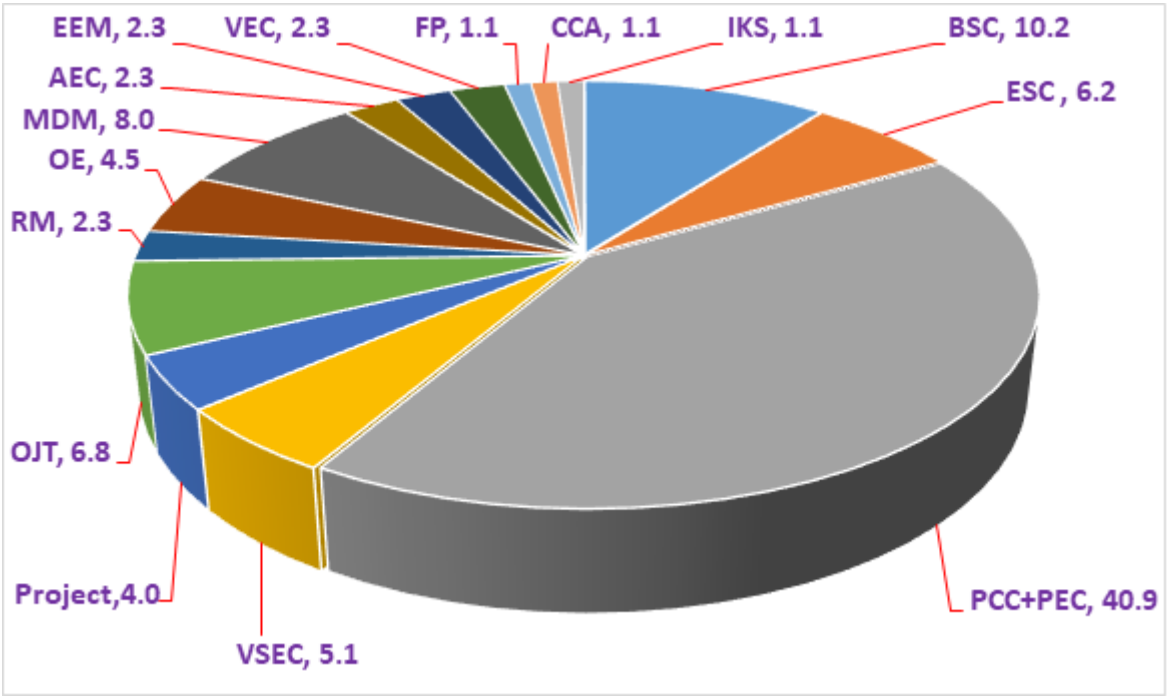

Figure 1 Distribution of various course types (in percentage) for the programme as per the NEP2020 guidelines. This distribution does not include Honours courses having 18 credits in total.

All the courses are credit based and the evaluations are grade based. The credit system is a systematic way of describing an educational programme by attaching credits to its components. The definition of credits is based on student workload, learning outcomes and contact hours. This system is described in detail in Regulation No.9 of the Institute. Each theory course consists of Lectures and tutorials. During tutorial session, it is expected that the problem solving / case studies / relevant real-life applications/ student presentations / home assignments/individual or group projects are discussed in the presence of the teacher. Teachers can have the freedom to interchange lectures / tutorials depending upon the topic. The institute gives emphasis on continuous evaluation with considerable freedom to the teacher in deciding the mode of evaluation.

A. Programme Educational Objectives for B. Tech Pharmaceutical Chemistry and Technology

PEO1	**Successful Career**	Graduates from the programme will have successful careers in Pharmaceutical and allied industries at various levels of management.
PEO2	**Higher Study**	Graduates from the programme will pursue higher study related to Pharmaceutical Chemistry and Technology and allied disciplines in premier institutions across the world and make a career in academics or research.
PEO3	**Multi-disciplinary Skills**	Graduates from the programme will work in a multi-disciplinary environment in the domain of Pharmaceutical technology.

B. Program Outcomes as defined by the National Board of Accreditation (NBA): 12 Graduate Attributes

PO1	**Engineering knowledge**	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis**	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
PO3	**Design/development of solutions**	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations
PO4	**Conduct investigations of complex problems**	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage**	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations
PO6	**The engineer and society**	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability**	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development
PO8	**Ethics**	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice
PO9	**Individual and teamwork**	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication**	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance**	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments
PO12	**Life-long learning**	Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

C. Programme Specific Outcomes (PSOs) for B. Tech Pharmaceutical Chemistry and Technology

The graduates will be able to:

PSO1	Understand terminology, basic concepts of science, mathematics, and fundamentals of engineering, pharmacy and technology particularly in Pharmaceutical Chemistry and Technology.
PSO2	Know about the concept of Pharmaceutical Chemistry and analysis, formulation, phyto-constituents, biotechnology processes to meet the specified needs considering feasibility, safety, health hazards, societal, economic, and environmental or sustainability factors as well as critically analyse relationships between these factors in the field of Pharmaceutical Chemistry and Technology.
PSO3	Probe and investigate to conduct experiments, research, or model as per standards, collect and analyse information based on field visits, analysis, and interpretation of data to prepare the valid technical project reports.
PSO4	Apply basic science, basic engineering and pharmaceutical chemistry and technology knowledge in various sectors of industry, environment, life, and society, as well as develop solutions to complex molecules and its formulation applying principles and knowledge gained throughout the program or to develop new knowledge or methodologies through research.
PSO5	Furnish to the needs of Pharmaceutical and fine chemical industry, research organizations and academic institutes. Set-up their own ventures and generate employment, promote awareness in society about Pharmaceutical technology profession.

EXIT Policy

Based on the National Education Policy guidelines(NEP-2020), the following rules and regulations shall be applicable for the exit from the Degree program where the candidate is currently registered, after the First year, Second Year, and Third Year of the students can exit at each level of their four-year B.Tech Pharmaceutical Chemistry and Technology program.

a) A candidate who has earned a total of 44 credits after the First year of the Degree Course AND completed eight weeks of practical training can exit the degree course with a Certificate in a relevant degree program.
b) A candidate who has earned a total of 88 credits after the Second year of the Degree Course AND has completed eight weeks of practical training/Internship can exit the degree course with Diploma in a relevant degree program.
c) A candidate who has earned a total of 132 credits after the Third year of the Degree course AND has completed eight weeks of practical training/ Internship can exit the degree with B.Sc (Tech) in a relevant degree program.
d) The candidate shall apply for the exit from the program by this exit policy in a standard format. The letter will be addressed to The Dean, Academic Program. The exit will be permitted only on completion of the training program as prescribed by the Regulations.

Sr. No.	Exit Year	Mandatory Activity	Credits	Duration (No of Weeks)
1	1st Year (After Semester II)	8 credit course workshop/chemistry lab (after semester 2)	8	8 weeks
2	2nd Year (After Semester IV)	Certificate Course in Practice of Chemical Technology of ICT (CCPCT)	8	8 weeks
3	3rd Year (After Semester VI)	In-plant training for 3 months	8	8 weeks

Syllabus Structure for
Bachelor of Technology in Pharmaceutical Chemistry and Technology

SEMESTER – I										
Subject Code	Subject	Course Type	Credits	Hrs/Week			Marks for various Exams			
				L	T	P	CA	MS	ES	Total
CHT1405	Physical Chemistry	BSC	3	2	1	0	20	30	50	100
CHT1406	Analytical Chemistry	BSC	3	2	1	0	20	30	50	100
MAT1301	Engineering Mathematics	ESC	3	2	1	0	20	30	50	100
PYT1205	Applied Physics	BSC	2	1	1	0	20	30	50	100
GEP1129	Engineering Graphics and Computer Aided Drafting	VSEC	3	1	0	4	20	30	50	100
PHT1415	**SPL-1:** Introduction to Technology of Pharmaceuticals and Fine Chemicals	ESC	2	1	1	0	20	30	50	100
HUP1110B	Communication Skills	AEC	2	0	0	4	50	0	50	100
HUPXXXX	OPEN Activity - Sports/ Fine arts/Yoga/ Music/NSS**	CCA	2	0	0	4	50	0	50	100
PYP1101	Physics Laboratory	BSC	2	0	0	4	50	0	50	100
	Total		**22**	**9**	**5**	**16**	-	-	-	900

SEMESTER – II										
Subject Code	Subject	Course Type	Credits	Hrs/Week			Marks for various Exams			
				L	T	P	CA	MS	ES	Total
CHT1407	Organic Chemistry	BSC	3	2	1	0	20	30	50	100
CHT1408	Industrial Chemistry	BSC	3	2	1	0	20	30	50	100
PHT1416	**SPL-2**: Pharmaceutical Analysis	PCC	2	1	1	0	20	30	50	100
GET1306	Basic Mechanical Engineering	ESC	2	1	1	0	20	30	50	100
GET1125	Electrical Engineering and Electronics	ESC	2	1	1	0	20	30	50	100
CEP1720	Process Calculations	ESC	2	0	0	4	50	0	50	100
HUPXXXX	OPEN Activity- Sports/ Fine Arts/Yoga/ Music/NSS**	CCA	2	0	0	4	50	0	50	100
HUT1117	**MOOCs**/Indian Knowledge System	IKS	2	2	0	0	20	30	50	100
CHP1343	Physical and Analytical Chemistry Laboratory	BSC	2	0	0	4	50	0	50	100
CHP1132	Organic Chemistry Laboratory	VSEC	2	0	0	4	50	0	50	100
	Total		**22**	**9**	**5**	**16**	-	-	-	1000

Note:

- Universal Human Values (UHV) an audit course to be taken in inter-semester break after Semester – II to be taken as MOOC course.
- ** Students will undertake these co-curricular activities such as sports / Fine Arts / Yoga / Music / Literature etc. administered through various clubs under Technological Association approved by Dean, Students Affairs.

SEMESTER-III										
Subject Code	Subject	Course Type	Credits	Hrs/Week			Marks for various Exams			
				L	T	P	CA	MS	ES	Total
PHT1417	**SPL-3:** Pharmaceutical Formulation Technology-I	PCC	4	3	1	0	20	30	50	100
PHT1418	**SPL-4:** Pharmaceutical Green Chemistry	PCC	2	1	1	0	20	30	50	100
HUTXXXX	From Basic Sciences (Chemistry/ Physics/Biology / Maths / Humanities)	OE	4	3	1	0	20	30	50	100
HUPXXXX	Modern Indian Language (Marathi / Hindi or Any other language will be chosen)	AEC	2	0	0	4	50	0	50	100
HUT1205	Basic Economics and Finance	EEM	2	1	1	0	20	30	50	100
XXXXXXX	Value Enhancement in Emerging Areas(NPTEL)	VEC	2	1	1	0	20	30	50	100
XXXXXXX	**MDM-I**	MDM	2	1	1	0	20	30	50	100
PHP1419	**Pr-1**: Lab-1: Pharmaceutical Formulation Technology Laboratory-I	PCC	2	0	0	4	50	0	50	100
PHP1420	**Pr 2**: Lab 2: Pharmaceutical and Biochemistry Analysis	PCC	2	0	0	4	50	0	50	100
	Total		**22**	**10**	**6**	**12**	-	-	-	900

SEMESTER-IV										
Subject Code	Subject	Course Type	Credits	Hrs/Week			Marks for various Exams			
				L	T	P	CA	MS	ES	Total
CET1105	Transport Phenomena	PCC	4	3	1	0	20	30	50	100
PHT1421	**SPL-5:** Medicinal Chemistry	PCC	3	2	1	0	20	30	50	100
PHT1422	**SPL-6**: Physiology and Pharmacology	PCC	3	2	1	0	20	30	50	100
XXXXXXX	From Basic Sciences (Chemistry/ Physics/ Biology / Maths) or Humanities Discipline	OE	2	1	1	0	20	30	50	100

CET1805	Chemical Process Economics	EEM	2	1	1	0	20	30	50	100
HUT1206	Environmental Sciences and Technology	VEC	2	1	1	0	20	30	50	100
XXXXXXX	**MDM II**	MDM	2	1	1	0	20	30	50	100
HUPXXXX	Community Engagement Projects#	CEP/ FP	2	0	0	4	50	0	50	100
PHP1423	**Pr-3**: Lab-3: Pharmaceutical Chemistry Laboratory-I	VSEC	2	0	0	4	50	0	50	100
	Total		**22**	**11**	**7**	**8**	-	-	-	900

Note: # During summer vacation, students will undertake community projects as individual or group related to study of societal technological activities through various organization such as Lions club, Teach India, Marathi Vidnyan Parishad, CSR projects outsourced by various industries, ISR activities administered through Technological Association approved by the Dean, Student Affairs.

SEMESTER -V										
Subject Code	Subject	Course Type	Credits	Hrs/Week			Marks for various Exams			
				L	T	P	CA	MS	ES	Total
CET1806	Chemical Reaction Engineering	PCC	2	1	1	0	20	30	50	100
CET1807	Chemical Engineering Operations	PCC	2	1	1	0	20	30	50	100
PHT1424	**SPL-7**: Pharmaceutical Formulation Technology-II	PCC	4	3	1	0	20	30	50	100
XXXXXXX	**DPST Elective - I** Offered by Department **(SPL-8)**	PEC-1	4	3	1	0	20	30	50	100
XXXXXXX	From Basic Sciences (Chemistry/ Physics/ Biology / Maths) or Humanities Discipline	OE	2	1	1	0	20	30	50	100
XXXXXXX	**MDM-III**	MDM	4	2	0	4	50	0	50	100
PHP1427	**Pr-4**: Lab 4: Pharmaceutical Chemistry Laboratory-II	PCC	2	0	0	4	50	0	50	100
PHP1428	**Pr-5**: Lab 5: Pharmaceutical Formulation Technology laboratory-II	PCC	2	0	0	4	50	0	50	100
PHT1426	**Honors Course-I: Reagents in API Process Industry**	PCC	4	3	1	0	20	30	50	100
	Total		**26**	**14**	**6**	**12**	-	-	-	900

SEMESTER –VI										
Subject Code	Subject	Course Type	Credits	Hrs/Week			Marks for various Exams			
				L	T	P	CA	MS	ES	Total
PHT1429	**SPL-9**: Pharmaceutical Biotechnology	PCC	3	2	1	0	20	30	50	100
PHT1430	**SPL-10** : Validation and regulatory Requirements	PCC	3	2	1	0	20	30	50	100
XXXXXXX	**DPST Elective- II** Offered by Department**(SPL-11)**	PEC-2	4	3	1	0	20	30	50	100
PHT1432	**SPL-12**: Pharmaceutical Chemistry-I	PCC	4	3	1	0	20	30	50	100
XXXXXXX	**MDM IV**	MDM	2	1	1	0	20	30	50	100
CEP1714	Chemical Engineering Laboratory	VSEC	2	0	0	4	50	0	50	100
PHP1434	**Pr-6**: Lab-6 Biotechnology Laboratory	PCC	2	0	0	4	50	0	50	100
PHP1435	**Pr-7**: Lab -7 : Medicinal Natural Products Laboratory	PEC	2	0	0	4	50	0	50	100
PHT1433	**Honors Course-II: Chemistry and Technology of Fine Chemicals**	PCC	4	3	1	0	20	30	50	100
	Total		**26**	**14**	**6**	**12**	-	-	-	900

SEMESTER-VII										
Subject Code	Subject	Course Type	Credits	Hrs/Week			Marks for various Exams			
				L	T	P	CA	MS	ES	Total
PHT1436	**SPL-13**: Pharmaceutical Formulation Technology-III	PCC	3	2	1	0	20	30	50	100
PHT1437	**SPL-14**-Pharmaceutical Chemistry-II	PCC	2	1	1	0	20	30	50	100
XXXXXX	**DPST Elective - III** Offered by Department	PEC-3	3	2	1	0	20	30	50	100
XXXXXX	**DPST Elective - IV** Offered by Department	PEC-4	2	2	0	0	20	30	50	100
PHTXXXX	**MDM V**	MDM	2	1	1	0	20	30	50	100
PHP1442	Literature Review (Research Methodology - I)	RM-1	2	1	0	2	50	0	50	100
PHT1443	Design and Analysis of Experiments (Research Methodology - II)	RM-2	2	1	0	2	20	30	50	100
PHP1444	Project –I (Literature search+ Expt)	Project	4	0	0	8	50	0	50	100
PHP1445	**Pr-8**: Lab-8: Pharmaceutical	PCC	2	0	0	4	50	0	50	100

	Formulation Technology Laboratory-III									
PHT1441	**Honors Course-III: Chemistry of Natural Products**	PCC	4	3	1	0	20	30	50	100
	Total		**26**	**13**	**5**	**16**	-	-	-	1000

SEMESTER -VIII (10 Weeks)										
Subject Code	Subject	Course Type	Credits	Hrs/Week			Marks for various Exams			
				L	T	P	CA	MS	ES	Total
PHT1446	**SPL-15**: Pharmaceutical Chemistry-III	PCC	3	5	1	0	20	30	50	100
XXXXXXX	**MDM-VI**	MDM	2	2	1	0	20	30	50	100
PHP1449	Project-II(Experiments)	PCC	3	0	0	16	50	0	50	100
PHP1450	**Pr-9**: Lab-9: Process Technology Laboratory	PEC	2	0	0	4	50	0	50	100
PHT1447	**Honors Course-IV: Process Technology of Drugs and Intermediates**	PCC	3	5	1	0	20	30	50	100
PHT1448	**Honors Course-V : Novel Drug Delivery System**	PCC	3	5	1	0	20	30	50	100
SEMESTER – VIII (12-16 Weeks)										
PHP1451	Internship with Industry (12 – 16 Weeks)	Internship/ On Job Training Project	12	0	0	0	50	0	50	100
	Total		**28**	**17**	**4**	**20**	-	-	-	700

BSC: Basic Science Course,
ESC: Engineering Science Course
PCC: Program Core Course, PEC: Program Elective Course
MDM: Multi-disciplinary Minor: Different discipline of engineering or different faculty altogether
OE: Open Elective: To be chosen compulsorily from faculty other than major discipline
VSEC: Vocational and Skill Enhancement Course: Hands on training corresponding to major/minor
AEC: Ability Enhancement Course: English 2 credit, Modern Indian Language 2 credit
IKS: Indian Knowledge System: Indian Architecture/Maths/Medicine
VEC: Value Enhancement Course: e.g. Understanding India, Environmental Science / Education / Digital and Tech solutions
RM: Research Methodology
CCA: Co-curricular activities: Health and wellness / Yoga / Sports / Cultural activities / NSS/NCC/Applied visual performing arts.
EEM: Entrepreneurship / Economics / Management

D. Detailed Syllabus

FIRST YEAR: SEMESTER-I

BSC	Course Code: CHT1405	Course Title: Physical Chemistry	Credits = 3		
			L	T	P
	Semester: I	Total contact hours: 45	2	1	0

List of Prerequisite Courses
Standard XII Chemistry
List of Courses where this course will be prerequisite
Physical and Analytical Chemistry laboratory(CHP1343), Transport Phenomena(CET1105)
Description of relevance of this course in the B. Tech. Program
The course will enable the students to understand and apply the principles of thermodynamics to real-world systems. The students would be able to apply the insights to understand the stability of solutions, spontaneity of physical/chemical processes, effect of thermodynamics parameters on phase and chemical equilibria,

Course Contents (Topics and subtopics)		Required Hours
Sr. No	**Course Contents (Topics and Subtopics)**	
1	**Laws of thermodynamics** – a) Enthalpy and heat capacities, application of first law to gases, thermochemistry- Hess law b) Statements and applications of second law of thermodynamics, Clausius inequality, entropy as a state function, entropy changes for reversible and irreversible processes, entropy and probability c) Third law of thermodynamics, absolute entropies, verification of third law	6
2	**Spontaneous process and equilibrium** –Helmholtz and Gibbs free energy, spontaneity and free energy, Maxwell's relations, effect of T and P on free energy,	3
3	**Multicomponent system –** free energy and entropy of mixing, partial molar quantities and chemical potential, Gibbs Duhem equation	6
4	**Equilibrium in solutions –** ideal and non-ideal solutions, Henry's law and Raoult's law, colligative properties, activity and activity coefficients, thermodynamic properties of electrolytes in solution	7
5	**Solubility equilibria** – solubility constant, common ion effect, effect of added salts on solubility pH, weak and strong acids and bases, buffer solutions, ionic solutions **Chemical Equilibria –** le Chaterlier's principle, Effect of temperature, pressure and composition on equilibrium	5
6	**Introduction** – concept of reaction rates and order, experimental methods in kinetic studies, differential and integral methods to formulate rate equations of zero, first and second order reactions Experimental methods of kinetic studies	3
7	**Kinetics and reaction mechanism** – rate determining step, steady state approximation **Complex reactions**- parallel, consecutive and reversible reactions Mechanism of thermal, photochemical chain reactions, polymerization reactions **Fast reactions –** experimental techniques	6
8	**Homogenous catalysis** – homogeneous acid / base catalysis (specific and general acid catalysis), enzyme catalysis (Michelis Menten kinetics)	6
9	**Reactions at interface –** Adsorption isotherms, kinetics of surface reactions- Hishelwood and Rideal models of surface reactions	3
	Total	**45**

List of Textbooks/ Reference Books

1	Atkins, Peter W.; Paula, Julio de; Keeler, James. Atkin's Physical Chemistry; 11th ed.; Oxford University Press (2018).	
2	Elements of Physical Chemistry (7th edition) by P. W. Atkins and J. de Paula, Oxford University Press, 2016.	
3	Chemical Kinetics (3rd edition) by Keith J. Laidler, New York : Harper & -Row, 1987.	
Course Outcomes (students will be able to….)		
CO1	Understand the concepts of thermodynamics and relate them to measurable quantities	K2
CO2	Elucidate the effect of thermodynamic quantities on physical and chemical equilibria	K4
CO3	Correlate the thermodynamic properties of chemical systems with the observed outcomes and predict the optimum conditions	K3
CO4	Comprehend fundamental knowledge in chemical kinetics with basics of order, molecularity and temperature effect	K2
CO5	Examine kinetics for complex, fast and interfacial reactions	K3
CO6	Comprehend different theories in kinetics to explain the molecular origin of kinetic phenomena	K4
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	3	2	1	2	0	0	1	0	2
CO2	2	3	2	3	2	2	2	1	1	1	1	1
CO3	2	3	2	3	2	2	2	1	1	1	1	1
CO4	2	3	1	2	2	1	2	0	0	1	0	2
CO5	3	3	2	3	2	2	2	1	0	1	0	1
CO6	2	2	3	3	2	1	1	1	0	1	1	1

3-Strong Contribution; 2-Moderate Contribution; 1-Low Contribution, 0 – No contribution

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	2	1	1
CO2	2	1	1	1	0
CO3	2	2	2	1	1
CO4	2	2	2	1	1
CO5	2	1	2	0	0
CO6	2	1	1	1	1

BSC	**Course Code: CHT1406**	**Course Title: Analytical Chemistry**	**Credits = 3**		
			L	**T**	**P**
	Semester: I	**Total contact hours: 45**	**2**	**1**	**0**
List of Prerequisite Courses					
Standard XII Chemistry					
List of Courses where this course will be prerequisite					

Physical and Analytical Chemistry Laboratory (CHP1343), Pharmaceutical Analysis (PHT1416), Structure Analysis by Spectroscopy (PHT1438)		
Description of relevance of this course in the B. Tech. Program		
The course introduces the students to key concepts of chemical analysis – sampling, selection of analytical method and data analysis. It presents basic techniques like spectroscopy and chromatography. The students should be able to select an appropriate analytical technique and apply it in accordance with its strengths and limitations.		
Course Contents (Topics and subtopics)		**Required Hours**
1	Introduction to chemical analysis, terminology (technique / method / procedure / protocol), broad classification of analytical techniques, good laboratory practices	5
2	Criteria for selecting analytical methods – accuracy, precision, sensitivity, selectivity, and detection limit Calibration and validation	8
3	**Data analysis**: errors – systematic and random errors, statistical treatment of experimental results (F, Q and t tests, rejection of data, and confidence intervals), least square method, correlation coefficients	6
4	**Spectroscopic methods**: General principle, instrumentation and applications of • UV-visible spectroscopy • Infrared spectroscopy • fluorescence spectroscopy	8
5	**Electrochemical methods:** General principle, instrumentation and applications of • Conductometry • Potentiometry	8
6	**Chromatographic methods:** General principle, instrumentation and applications of • Gas chromatography (GC) • HPLC	10
	Total	**45**
List of Textbooks/ Reference Books		
1	David Harvey. Modern Analytical Chemistry; McGraw-Hill (1999)	
2	R. A. Day and A. L. Underwood. Quantitative Analysis, Prentice Hall of India (2001)	
3	H. H. Willard, L. L. Merritt, J. A. Dean and F. A. Settle. Instrumental Methods of Analysis, 7th ed.; Wadsworth Publishing, USA (2004)	
4	D. A. Skoog, D. M. West, F. James Holler and S. R. Crouch. Fundamentals of Analytical Chemistry; 9th ed.; Cengage Learning (2013)	
5	D. A. Skoog, F. James Holler and S. R. Crouch. Principles of Instrumental Analysis; 6th ed.; Cengage Learning (2016)	
Course Outcomes (students will be able to….)		
CO1	Explain the principles of UV-visible and fluorescence spectroscopic methods	K3
CO2	Explain the principles of electrochemical methods	K3
CO3	Understand the principles of chromatographic separations	K3
CO4	Evaluate the results of chemical analysis in terms of accuracy and precision	K4
CO5	Apply the principles of sampling to design an optimum analytical protocol	K4
CO6	Identify conditions to minimize the error and increase the sensitivity of analysis	K5
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	2	2	1	1	0	1
CO2	2	3	2	3	3	2	2	1	1	1	0	1
CO3	2	3	2	3	3	2	2	0	1	1	0	1

CO4	2	3	2	3	3	2	2	1	1	1	0	1
CO5	2	2	2	1	2	1	1	1	0	1	1	0
CO6	2	2	1	1	2	1	2	1	0	0	0	0

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	2	1	1	1
CO2	1	2	1	2	1
CO3	2	2	2	1	1
CO4	1	2	1	2	1
CO5	1	2	1	1	1
CO6	1	2	1	1	1

3-Strong Contribution; 2-Moderate Contribution; 1-Low Contribution, 0 – No contribution

ESC	**Course Code: MAT1301**	**Course Title: Engineering Mathematics**	**Credits = 3**		
			L	**T**	**P**
	Semester: I	**Total contact hours: 45**	**2**	**1**	**0**

List of Prerequisite Courses

XII Standard Mathematics

List of Courses where this course will be prerequisite

Chemical Engineering Laboratory (CEP1714), Process Calculations(CEP1720), Design and Analysis of Experiments (Research Methodology-II (PHT1443)

Description of relevance of this course in the B. Tech. Program

This is a basic Mathematics course which will give the students the required foundations of mathematics to understand engineering/technology concepts in the later part of the technology programs. This course will also introduce probability distributions and basic statistics will be helpful to understand various data science studies in different technology disciplines.

	Course Contents (Topics and subtopics)	**Required Hours**
1	**Linear Algebra:** Vectors in $\mathbb{R}^n$, notion of linear independence and dependence. $\mathbb{R}^n$ as a vector space, vector subspaces of $\mathbb{R}^n$, basis of a vector subspace, row space, null space, and column space, rank of a matrix. Determinants and rank of matrices. Linear transformations in $\mathbb{R}^n$, Matrix of a linear transformation, change of basis and similarity, rank-nullity theorem, and its applications. Inner product spaces, orthonormal bases, Gram-Schmidt orthogonalization process, Eigenvalues and eigenvectors, characteristic polynomials, eigenvalues of special Orthogonal projection and its application to least square methods, Diagonalization of matrices and its applications to stochastic matrices	15
2	**Differential Calculus:** Higher order differentiation and Leibnitz Rule for the derivative, Taylor's and Maclaurin's theorems, Maxima/Minima, convexity of functions and applications. Functions of two or more variables, Limit and continuity, Partial differentiation, Total derivatives, Taylor's theorem for multivariable functions and its application to error calculations, Maxima/Minima, Method of Lagrange Multipliers, Introduction to double and triple integrals.	15
3	**Probability & Statistics:** Random variables and cumulative distribution function; probability mass function and probability density function; Some common univariate distributions: Binomial, Poisson, Uniform, exponential, Normal; Expectation and	15

	Moments; Moment generating function, Multiple random variables, and Joint distribution; marginal distributions, Covariance and Correlation. Concept of parameter estimation: maximum likelihood estimation; method of least squares and simple linear regression; nonlinear regression	
	Total	**45**
List of Textbooks/ Reference Books		
1	G. Strang, Linear Algebra and its Applications (4th Edition), Thomson (2006).	
2	Howard Anton, Elementary Linear Algebra, John Wiley & Sons (2016)	
3	Stewart, James, Single Variable Calculus, 6th Edition, Cenage learning (2016)	
4	Hughes-Hallett et al., Calculus - Single and Multivariable (3rd Edition), John-Wiley and Sons (2003).	
5	E. Kreyszig, Advanced Engineering Mathematics (8th Edition), John Wiley (1999). (Officially prescribed)	
6	S. R. K. Iyengar, R. K. Jain, Advanced Engineering Mathematics Narosa, (2020)	
7	A First Course in Probability, Sheldon Ross, Pearson Prentice Hall, 9th Edition (2018)	
8	W.W. Hines, D. C. Montgomery, D.M. Goldsman, John-Wiely, Probability and Statistics in Engineering, John Wiley & Sons (2008)	
9	Alexander M. Mood, Duane C. Boes, and Franklin A. Graybill, Introduction to the Theory of Statistics, Mc GrawHill, (1973)	
Course Outcomes (students will be able to….)		
CO1	Understand the notion of differentiability and be able to find maxima and minima of functions of one and several variables.	K3
CO2	Understand the notion of integrability and be able to compute multiple integrals and apply them in engineering applications.	K3
CO3	Understand the computational and geometrical concepts related to linear transformations, eigenvalues and eigenvectors and apply them to solve computational problems	K3
CO4	Demonstrate understanding of different concepts in linear algebra in solving computational problems related to vectors and matrices and apply them to solve problems arising the technology especially in AI and ML.	K4
CO5	Understand the concepts of various probability distributions and apply them to analyze various technology problems and make inference about the system	K3
CO6	Understand the method of linear and nonlinear least squares method and apply it to choose appropriate mathematical functions for modelling real data sets, arising from technology disciplines	K3
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	1	0	0	0	0	0	0	3
CO2	2	2	1	1	1	0	0	0	0	0	0	3
CO3	2	2	1	1	1	0	0	0	0	0	0	3
CO4	2	2	1	1	2	0	0	0	0	1	0	3
CO5	2	2	1	1	1	0	0	0	0	0	0	3
CO6	2	3	3	1	2	1	0	0	3	1	0	3

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	1	1	1	1
CO2	2	1	1	2	0
CO3	1	1	2	1	1
CO4	2	1	1	2	1

CO5	1	0	1	1	0
CO6	2	1	1	2	0

BSC	**Course Code: PYT1205**	**Course Title: Applied Physics**	**Credits = 2**		
			L	**T**	**P**
	Semester: I	**Total contact hours: 30**	**1**	**1**	**0**

List of Prerequisite Courses		
Standard XII Science		
List of Courses where this course will be prerequisite		
Project-II (PHP1449), Transport Phenomena (CET1105)		
Description of relevance of this course in the B. Tech. Program		
Materials and their properties play a key role in chemical technology. The Applied Physics course will provide the students with the necessary fundamentals to develop a broad understanding of various aspects related to materials, thereby equipping them with the ability to apply it wherever required in their course of study.		
Course Contents (Topics and subtopics)		**Required Hours**
1	Crystal Structure of Solids: A revision of concepts of a lattice, a basis, a unit cell, different crystal systems (SC, BCC, FCC, HCP), co-ordination numbers and packing fractions. Single crystalline, Polycrystalline, and Amorphous materials.	3
2	Crystallographic planes and directions: concept of Miller indices and its determination, examples; calculation of inter-planar spacing in terms of Miller indices.	3
3	Determination of crystal structure using X-rays: Bragg's law of X-ray diffraction, types of diffractometers, Indexing diffraction peaks, and calculation of various lattice parameters and crystallite size	4
4	Energy band in solids and classification of solids, the concept of Fermi level and Fermi distribution function, Intrinsic and extrinsic semiconductors, Transport properties of semiconductors: Conductivity in semiconductors and its dependence of carrier concentration and mobility	5
	Physics of Fluids	
5	A revision of the basic concepts of hydrostatics and ideal fluid flow: Equation of continuity and Bernoulli's equation.	4
6	The concept of viscosity, Newton's law of viscosity, Reynold's number, Poiseuille's equation for streamline flows	4
7	An introduction to Rheology: Parameters of viscous flows, Newtonian and non-Newtonian behavior, Variation of viscosity with shear rate, shear time, temperature, and pressure (qualitative ideas with illustrative examples), measuring properties of viscous flows. The concept of viscoelasticity, Maxwell and Kelvin models of relaxation, relaxation spectrum, creep testing.	7
	Total	**30**
List of Textbooks/ Reference Books		
1	Fundamentals of Physics - Halliday, Resnick, Walker - 6th Edition - John Wiley	
2	Sears and Zeemansky's University Physics - Young and Freedman - 12th Edition - Pearson Education	
3	A Textbook of Engineering Physics - M N Avadhanulu, P G Kshirsagar, TVS Arun Murthy - 11th Edition - S. Chand Publishers	
4	Solid State Physics - S. O. Pillai - 10th Edition - New Age Publishers	
5	Solid State Physics - A. J. Dekker - MacMillan India	
6	Engineering Physics - V Rajendran - 6th Edition - McGraw Hill Publishers	

7	Introduction to Rheology-H. A. Barnes, J. F. Hutton and K. Walters-4th Edition-Elsevier Science.
8	Viscoelastic Properties of Polymers – J. D. Ferry – 3rd Edition – Wiley

Course Outcomes (students will be able to….)		
CO1	Assign Miller indices to various crystallographic planes and directions in a crystal lattice, thereby understanding periodicity in the crystal lattice.	K4
CO2	Analyze a given x-ray diffraction pattern to deduce the material's crystal structure and calculate the values of the basic structural parameters.	K4
CO3	Classify solids, and in turn semiconductors, based on electron occupancy and calculate basic quantities related to charge transport in them.	K3
CO4	Analyze simple ideal fluid flows by applying the continuity equation and Bernoulli's equation	K3
CO5	Describe the basic behavior of viscous flows and the relationships between various flow parameters.	K4
CO6	Understand simple models that are used to describe viscoelastic flows.	K4
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	2	1	1	1	1	1	1	2
CO2	3	3	3	2	2	1	1	1	1	1	1	3
CO3	3	3	2	2	2	2	1	1	1	1	1	3
CO4	3	2	3	3	2	1	1	1	1	1	1	2
CO5	2	2	2	3	2	1	1	2	1	1	1	3
CO6	2	2	3	2	2	1	1	1	1	1	1	3

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	1	1
CO2	2	2	2	2	0
CO3	3	3	2	1	1
CO4	2	3	3	2	0
CO5	3	2	2	1	1
CO6	3	2	2	2	1

VSEC	**Course Code:** GEP1129	**Course Title:** Engineering Drawing and Computer Aided Drafting	**Credits = 3**		
			L	**T**	**P**
	Semester: I	**Total contact hours: 75**	**1**	**0**	**4**
List of Prerequisite Courses					
Standard XII Mathematics					
List of Courses where this course will be prerequisite					

Project-I (PHP1444) and Project-II (PHP1449), Professional Career (Industrial drawing, Equipment Design, Manufacturing and designing of any component, industrial 3D product modelling etc.)		
Description of relevance of this course in the B. Tech. Program		
Drawing is a language used by technologists. A student is required to know the various equipment's used to carry out the processes. Some of the elementary areas like product sizing, manufacturing etc., are very common to all the branches of technology. These and many other processes require machines and equipment's. One should be familiar with the design, manufacturing, working, maintenance of such machines and equipment's. The subject of "drawing" is a medium through which one can learn all such matters, because the "drawings" are used to represent objects and various processes on paper. Through the drawings, a lot of accurate information is conveyed which will not be practicable through a spoken word or a written text. This course is required in many subjects as well as later in the professional career.		
Course Contents (Topics and subtopics)		**Required Hours**
1	**Orthographic projections:** Introduction, Principles of Projection, Methods of Projection, Planes of projection, Quadrants, First-angle method of projection, Third-angle method of projection, and concept of orthographic projections.	15 (3L+12P)
2	**Sectional Projections and Missing Views:** Need for the drawing sectional views, concept of sectioning and section lines, Sectional drawings of different solids and machine components, Auxiliary planes, and views. **Missing Views**: Concept of recognizing missing views and their interpretation, drawing of missing views from given orthographic drawings.	15 (3L+12P)
3	**Isometric projections:** Concept of isometric views, isometric projections and isometric scale, Iso metric projections of different solids and machine components.	10 (2L+8P)
4	**Computer Aided Drafting and Assembly drawing:** Basic introduction to CAD softwares, Design and Development of new products, Application of CAD, 2D, 3D part modelling on softwares, drawing modification and dimensioning, modelling of different machine components. Basics of Assembly drawing, preparation of 2D, 3D components and assembling on CAD software, conversions, labelling and table creation for bill of materials.	10(2L+8P)
1	**Orthographic projections:** Introduction, Principles of Projection, Methods of Projection, Planes of projection, Quadrants, First-angle method of projection, Third-angle method of projection, and concept of orthographic projections.	25(5L+20P)
	Total	**75(15L+60P)**
List of Textbooks/ Reference Books		
1	Engineering Drawing by N.D.Bhat, CHAROTAR publishing house, Anand, Gujrat, 51th Edition.	
2	Engineering Drawing by N.H.Dubey, Nandu Printers & Publishers Pvt. Ltd, 15th Edition.	
3	CAD/CAM: Theory and Practice by Ibrahim Zeid and R Sivasubramanian, McGraw Hill Education, 2nd Edition.	
Course Outcomes (students will be able to….)		
CO1	Draw Orthographic Projections of Solid objects.	K4+P2
CO2	Draw Third view of solid object when two views are given	K4+P2
CO3	Draw isometric Projections of Solid objects.	K4+P2
CO4	Draw assembly of various machine components	K4+P2
CO5	Understand basic commands of CAD software	K2+P2
CO6	Use CAD software for drafting and editing 2 dimensional drawings	K3+P2
K1-Remembering, K2-Understanding, K3-Applying, K4-Analyzing, K5-Evaluating, K6- Creating P1 – Imitate, P2 – Manipulate, P3 – Perfect, P4 – Articulate, P5 – Embody		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	0	0	0	0	0	0	0	1	0	0	0
CO2	3	0	0	0	0	0	0	0	1	0	0	0
CO3	3	0	0	0	0	0	0	0	1	0	0	0
CO4	3	0	0	0	0	0	0	0	1	0	0	0
CO5	3	0	0	0	3	0	0	0	2	0	0	0
CO6	3	0	0	0	3	0	0	0	2	0	0	0

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	1	1	1	1
CO2	1	0	1	1	1
CO3	2	0	1	2	1
CO4	1	1	1	1	1
CO5	1	0	1	1	1
CO6	2	0	1	1	1

ESC	**Course Code: PHT1415**	**Course Title: SPL1: Introduction to Technology of Pharmaceuticals and Fine chemicals**	**Credits = 2**		
			L	**T**	**P**
	Semester: I	**Total contact hours: 30**	**1**	**1**	**0**

List of Prerequisite Courses

Standard XII Science

List of Courses where this course will be prerequisite

Pharmaceutical Formulation Technology-I(PHT1417), Medicinal Chemistry (PHT1421), Physiology and Pharmacology(PHT1422), Pharmaceutical Formulation Technology-II(PHT1424)

Description of relevance of this course in the B. Tech. Program

A Chemical Technology student is required to know various aspects of the Technology of Pharmaceuticals and Fine Chemicals. This subject will fulfill the need and the advanced courses which follow as later will built the professional career of the students.

	Course Contents (Topics and subtopics)	**Required Hours**
1	**General Aspects:** Definition of drug. Various drug categories such as Prescription and OTC drugs Drug nomenclature: Chemical name, Generic name, Prototype Brief history of Pharma industry (From Dyes to Small Molecules to Biologicals) Introduction about core subjects of Pharmacy: Pharmaceutics (including Biopharmaceutics and Pharmacokinetics), Pharmacology, Pharmaceutical and analytical chemistry, Pharmacognosy. Laws governing the drugs and various compendia (official and non-official)	5
2	**Medicinal Chemistry and Process Chemistry:** Discovery of Hits and Leads Lead optimization Introduction to Process chemistry industry and its brief overview	6
3	**Pharmacology and Pharmacognosy:** Brief overview of Pharmacokinetic principles Brief overview of mechanism of action of drugs Brief overview of Adverse Drug Reactions Introduction to Pharmacognosy Extraction and isolation of Phyto-constituents.	6

4	**Dosage forms of the drugs:** Various definitions such as Formulation, Dosage form, API, Excipient, Vehicles Brief overview of following dosage forms Solid dosage forms Liquid dosage forms for internal and external use Inhalations, Aerosols, and suppositories Targeted Drug Delivery systems	6
5	**Drug administration:** Brief overview of following routes of administration with their advantage and disadvantage Enteral: Oral, Sublingual and Rectal Parenteral: Injections, Inhalation, Transdermal Topical routes: Ophthalmic, Nasal, Auditory	2
6	**Overview of drug development:** Various aspects of preclinical studies in brief Clinical trials and its phases in brief	2
7	**Introduction to biological therapeutics:** Peptides and proteins as drugs and their synthesis in brief Introduction of rDNA technology Monoclonal antibodies	3
	Total	**30**
List of Textbooks/ Reference Books		
1	An introduction to pharmaceutical sciences: Production, chemistry, techniques, and technology, Jiben Roy, Woodhead Publishing Series in Biomedicine	
2	Remington - The Science And Practice Of Pharmacy (Vol.1& 2), David B. Troy, 21st edition, 2006, Lippincott Williams &Wilkins	
3	Real World Drug Discovery: A Chemist's Guide to Biotech and Pharmaceutical Research, Robert M. Rydzewski, Elsevier Science (2008)	
4	Dewick P.M., Medicinal Natural Products- A Biosynthetic Approach, 2nd edition/2002, John Wiley & Sons Ltd	
5	Pharmaceutical Dosage Form And Drug Delivery Systems, Howard C. Ansel, Nicholas G. Popovich, Lord V. Alien, 6th edition, 1995,	
6	Principles of Pharmacology, HL Sharma, KK Sharma, Paras Medical Publisher	
7	PK Gupta, Elements of biotechnology, 2nd ed, Rastogi Publications (2015)	
Course Outcomes (students will be able to….)		
CO1	Explain overview of pharmaceutical Industry	K2
CO2	Explain Perspectives of Medicinal and Pharmaceutical Chemistry	K3
CO3	Explain role and importance of Phyto-constituents Pharmaceutical Industry	K2
CO4	Describe aspects of various dosage forms	K2
CO5	Understanding of role of Pharmacology and importance.	K2
CO6	Describe role of biotechnology in Pharmaceutical Industry	K2
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	2	1	2	1	2	2	1	1	2
CO2	2	2	1	2	0	2	1	2	2	1	1	2
CO3	2	2	1	2	1	2	1	2	2	1	1	2
CO4	2	2	1	2	0	2	1	2	2	1	1	2
CO5	2	2	1	2	0	2	1	2	2	1	1	2

CO6	2	2	1	2	1	2	1	2	2	1	1	2

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	2	2	1
CO2	3	3	2	2	1
CO3	3	3	2	3	1
CO4	2	2	2	2	1
CO5	3	3	2	3	1
CO6	3	3	2	3	1

AEC	**Course Code: HUP1110B**	**Course Title: Communication Skills**	**Credits = 2**		
			L	**T**	**P**
	Semester: I	**Total contact hours: 60**	**0**	**0**	**4**

List of Prerequisite Courses

Standard XIIth

List of Courses where this course will be prerequisite

All courses in this and subsequent semesters

Description of relevance of this course in the B. Tech. Program

This is an important course for the effective functioning of an Engineer and a Technologist. Communication skills are required in all courses and professional career.

	Course Contents (Topics and subtopics)	**Required Hours**
1	Communication as a way of life Process of communication and its elements Functions of communication and importance in future careers Essentials of good communication	6
2	The communication cycle The 5 steps communication cycle: Idea formation Message encoding Message transmission Decoding Feedback	4
3	Factors affecting effective communication Planning for effective communication Modes of communication	3
4	Non-verbal communication Gestures Facial expressions Posture and movement Paralinguistics Eye contact Image management	4
5	Presentation skills What makes good presentation Prsenting the message Presenting oneself Visual Communication	8
6	Introduction to research study Introduction to databases	5

	Introduction to citation and referencing styles How to conduct literature review Preparation of a report based on literature review	
	Total	**60**
List of Textbooks/ Reference Books		
1	Elements of Style – Strunk and White	
Course Outcomes (students will be able to….)		
CO1	Student would be able to illustrate the 5 step communication process	K2+P2
CO2	Student would be able to explain the end goal of communication	K2+P2
CO3	Student would be able to explain barriers to clear communication	K2+P2
CO4	Student would be able to articulate the role of visual communication within society, and implement the creative process to express himself/herself.	K2+P2
CO5	Student would be able to identify the most relevant textbooks, reviews, papers and journals	K2+P2
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating P1 – Imitate, P2 – Manipulate, P3 – Perfect, P4 – Articulate, P5 – Embody		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	0	0	0	0	0	0	1	1	2	2	2	2
CO2	0	0	0	0	0	0	1	1	2	2	2	2
CO3	0	0	0	0	0	0	1	1	2	2	2	2
CO4	0	0	0	0	0	0	1	1	2	2	2	2
CO5	0	0	0	0	0	0	1	1	2	2	2	2

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	0	1	1	0	0
CO2	0	1	1	0	1
CO3	0	1	1	0	1
CO4	0	1	1	0	1
CO5	0	1	1	0	1

CCA	**Course Code: XXXXXXX**	**Course Title: Yoga and Self Development**	**Credits= 2**		
			L	**T**	**P**
	Semester: I	**Total contact hours: 60**	0	0	4
Prerequisites					
It may be necessary to gather some basic information about the students, such as their age, marital status, academic schedules, and recreational activities, whether they have any sleep issues and stress because of any situation. It shall be better to know how the students deal with stress, and whether they have proper					

nutrition. We also might need information about any injuries past or current and any other medical condition that may interfere in the program.		
List of Courses where this course will be prerequisite		
Applicable throughout professional and personal lives		
Description of relevance of this course in the B. Tech. Program		
Yoga is not course but a journey. The benefits of Yoga are many. It brings in calmness of mind besides the physical fitness by doing Yoga Aasanas. Apart from flexibility developed by regular physical activities, it makes one aware of his own potential. Professional and personal lives are full of situations that can be stressful. Yoga helps the students to withstand the stress coming from the expectations and demands of their own lives.		
Sr. No	**Course Contents (Topics and subtopics)**	**Reqd. hours**
1	**Yoga** The principles and foundations of yoga. Both concentrative and insight meditation techniques may be practiced for each session. Behavioural techniques of self-monitoring should also be practiced observing the stream of consciousness from the perspective of a vigilant but detached observer. The students shall be trained to practice different models of mindfulness and meditation so as to elicit a state of deep physical and behavioural relaxation. They may work on selectively influencing or changing the symmetry in hemispheric brain activity. Positive addiction, meta-cognitive practices etc. are exercised to make the students experience the universal human capacity through spiritual experiences. The students may learn to turn-off or bypass the cognitive processing of usual daily preoccupations and concerns, allowing access to mindful, spiritual and meditative state of self-realization The students shall keep a small journal to write down their own journey/progress on physical flexibility, strength building and most importantly, how they deal with stressful conditions. This record will form the paper assessment of the student. Yoga helps to develop many mental skills like mindfulness, self-control, focus, and even self-compassion. It's mainly a physical practice. The students are taken through different movements and poses during the yoga sessions.	40
2	**Assessment: The** following assessments are recommended: Regular attendance **Paper Assessment**: A paper assessment may include assessing student's understanding of the basic philosophy of yoga Verbal Assessment on the basis of his/her ability to assimilate the philosophy of yoga and practicing in daily life. Mobility & Flexibility assessment is to assess the strength and flexibility, like twist.	20
	List of Books	
1	Yoga Sutra of Patanjali, Ramakrishna Mission, Kolkata	
2	RN Jha, Science of Consciousness Psychotherapy and Yoga Practices, Vidyanidhi Prakashan, Delhi 2016	
Course Outcomes (students will be able to…..)		
CO1	Keep physically fit and mentally agile	K2
CO2	Manage stress in studies and later in life	K2
CO3	Coordinate body and mind together	K2
CO4	Understand own emotions and maintain healthy daily routine	K2
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	0	1	2	0	1	0	1	2	2	1	0	1
CO2	0	1	1	0	1	0	1	2	1	1	0	1
CO3	0	1	2	0	1	0	1	2	2	1	0	1
CO4	0	1	2	0	1	0	1	2	2	1	0	1

CCA	**Course Code:** XXXXXXX	**Course Title: Fine Arts and Performing Arts**	**Credits = 2**		
			L	**T**	**P**
	Semester: I	**Total contact hours: 60**	**0**	**0**	**4**

List of Prerequisite Courses

NA

List of Courses where this course will be prerequisite

NA

Description of relevance of this course in the B. Tech. Program

Cultivation of arts is an integral part of the development of human beings since the arts are what make us most human, most complete as people. They offer us the experience of wholeness because they touch us at the deepest levels of mind and personality. They come into being not when we move beyond necessity but when we move to a deeper necessity, to the deeper human need to create order, beauty and meaning out of chaos. They are the expressions of deepest human urges, imperatives and aspirations

Sr. No	**Course Contents (Topics and subtopics)**	**Reqd. hours**
1	The Institute offers a range of courses in different art forms: music, dance, theatre, painting, and other art forms. Students will be given an option to choose a particular art form, and learn and practice it under an artist-instructor. At the end of the course, a student should be able to demonstrate basic proficiency in that particular art form.	60
	Total	**60**

Course Outcomes (students will be able to…..)

CO1	Enhance perceptual and cognitive skills	K3
CO2	Develop self-esteem, motivation, aesthetic awareness, cultural exposure	K2
CO3	Be creative with improved emotional expression	K4
CO4	Develop social harmony and appreciation of diversity.	K2
CO5	Develop an understanding and sharing of culture, with social skills that enhance the awareness and respect of others	K2

K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	0	0	1	0	2	1	1	2	2	2	1	2
CO2	0	0	1	0	2	1	1	2	2	2	1	2
CO3	0	0	1	0	2	1	1	2	2	2	1	2
CO4	0	0	2	0	1	1	1	2	2	1	1	2
CO5	0	0	2	0	1	1	1	2	2	1	1	2

BSC	Course Code: PYP1101	Course Title: Physics Laboratory	Credits = 2		
			L	T	P
	Semester: I	Total contact hours: 60	0	0	4

List of Prerequisite Courses	
XII Physics	

List of Courses where this course will be prerequisite
Project-II(PHP1449)

Description of relevance of this course in the B. Tech. Program

The hands-on experience gained by the students in the Applied Physics laboratory course will equip them with basic experimental skills related to measurement of various important physical quantities. These skills will act as a useful foundation for other laboratory and theory courses in their area of specializations.

	Course Contents (Topics and subtopics)	Required Hours
1	Determination of Co-efficient of Viscosity by Poiseuille's method	4
2	Thermistor characteristics: Determination of Bandgap of a semiconductor	4
3	Determination of compressibility of liquids using an Ultrasonic Interferometer	4
4	Measurement of thermal conductivity of a solid: Lee's disc method	4
5	Photoelectric effect: Determination of h/e	4
6	Hall effect-I (sample current variation) Determination of carrier type and concentration in a semiconductor	4
7	Hall effect-II (magnetic field variation) Determination of carrier type and concentration in a semiconductor	4
8	Newton's rings: Determination of wavelength of light	4
9	Laser Diffraction: Determination of particle size	4
10	Studying variation of compressibility of liquid as function of temperature	4
11	Estimating resistivity of semiconductor using four probe method	4
12	Determination of magnetic susceptibility of paramagnetic liquid using Quincke's method	4
	Total	**60**

List of Textbooks/ Reference Books	
1	Fundamentals of Physics - Halliday, Resnick, Walker - 6th Edition - John Wiley
2	Sears and Zeemansky's University Physics - Young and Freedman - Pearson Education
3	Engineering Physics - V Rajendran - 6th Edition - McGraw Hill Publishers
4	Fundamentals of Optics - F. Jenkins and H. White - 4th Edition McGraw Hill
5	ICT Physics Laboratory Manual (supplied to students)

Course Outcomes (students will be able to….)		
CO1	Independently set up, handle, and use basic setups to measure and obtain various physical quantities.	K4+P2
CO2	Use basic instruments like vernier-caliper, screw-gauge, travelling microscope, thermometer, etc. to make accurate measurements.	K4+P2
CO3	Correlate and use directly measured quantities to obtain the relevant parameters through appropriate formulae, calculations, and/or graphical plotting, thereby understand the measurement principle involved in the experimental setups.	K3+P2
CO4	Preliminarily treat the obtained datasets statistically to obtain errors in the experiments.	K4+P2

K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating

P1 – Imitate, P2 – Manipulate, P3 – Perfect, P4 – Articulate, P5 – Embody

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	1	1	2	1	1	1	3	1	1	0
CO2	2	3	1	1	2	1	1	1	3	1	1	0
CO3	2	3	1	1	2	1	1	1	1	1	1	0
CO4	2	3	1	1	2	1	1	1	1	1	1	0

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	3	2	1
CO2	3	3	3	1	1
CO3	3	1	2	2	1
CO4	2	2	3	1	1

SEMESTER-II

BSC	**Course Code: CHT1407**	**Course Title: Organic Chemistry**	**Credits = 3**		
			L	**T**	**P**
	Semester: II	**Total contact hours: 45**	**2**	**1**	**0**

List of Prerequisite Courses

Standard XII Chemistry

List of Courses where this course will be prerequisite

Pharmaceutical Chemistry, Medicinal Chemistry, Biochemistry and several Special Subjects of Chemical Technology Departments

Description of relevance of this course in the B. Tech. Program

To acquaint the students with IUPAC and other types of Nomenclature of organic compounds, fundamentals of Organic Chemistry including reaction mechanisms, organic transformations, types of reactions, selectivity of chemical transformations, etc., stereochemical implications of organic reactions, functional group identification and reactions

	Course Contents (Topics and subtopics)	**Required Hours**
1	**Chemistry of Carbonyl Compounds** Concept of acidity and tautomerism of carbonyl compounds, General methods of preparation and Nucleophilic Addition reactions Enolate chemistry, Aldol and related condensation reactions, Michael reaction, Robinson annulation, Claisen condensation, Dieckmann condensation, Mannich reaction.	**9**
2	**Aromatic Substitution Reactions** **A) Electrophilic Substitution Reactions** Nitration, Halogenation, Alkylation, Acylation and Sulfonation Activating, deactivating and orienting effects of functional groups in mono- and poly-substituted benzenes Friedel-Crafts alkylation, Acylation, Gattermann, Gattermann-Koch, Riemer-Tiemann reactions. **B) Nucleophilic Substitution Reactions:** Addition and elimination mechanism, Benzyne mechanism, Sandmeyer reaction.	**10**
3	**Heteroaromatic Compounds**	**8**

	IUPAC nomenclature, structures and common names, comparison with benzenoid compounds, reactivity and synthesis – pyrroles, furans, thiophenes and pyridines	
4	**Named Organic Reactions** Perkin reaction (Mauvine synthesis-dyes), Fischer indole synthesis, (dyes), Jacobson Corey epoxide synthesis (Pharmaceutical), Ziegler Natta polymerisation (polymer), Multicomponent reactions, Mailard reaction (foods), Strecker amino acid synthesis (Pharmaceuticals & Food), Wittig reactions, Prilezhaev reaction	**10**
5	**Stereochemistry of Organic Compounds** Containing one and two asymmetric carbon atoms, Stereo descriptors – R/S, E/Z, erythro and thero, Conformation – Ethane and butane. Enantiomers and Diastereomers, meso compounds, different representations of stereoisomers – Saw-horse, Newmann, Wedge and dash and Fischer and their interconversions	**8**
	Total	**45**

List of Textbooks/ Reference Books	
1	Clayden, J., Greeves, N., Warren, S.; Organic Chemsitry; 2nd ed.; Oxford University Press (2012)
2	Graham Solomons, T. W.; Fryhle, Craig B.; Snyder, Scott A. Organic Chemistry; 12th Ed.; John Wiley & Sons. Inc. (2016)
3	Smith, M. B.; March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure; 7th ed.; Wiley, India (2015)
4	Carey F. A., Sundberg, R. J. Advanced Organic Chemistry: Part A: Structure and Mechanisms; 5th ed.; Springer (2005)
5	Carey F. A., Sundberg, R. J.; Advanced Organic Chemistry: Part B: Reaction and Synthesis; 5th ed.; Springer (2007)
6	Wade, L. G.; Simek, J. W.; Singh, M. S. Organic Chemistry; 9th ed.; Pearson Education (2019)
7	Eliel, E. L. Stereochemistry of Carbon Compounds; Mcgraw-Hill (2001)
8	Bruice, Paula, Y. Organic Chemistry; 8th Ed.; Pearson Education (2020)

Course Outcomes (students will be able to….)		
CO1	Draw structures of organic compounds and write their IUPAC names correctly	K2
CO2	Understand principles of aromatic chemistry and interpret the outcome of general transformations	K3
CO3	Understand the importance of heterocycles, learn the properties and synthetic routes, interpret the IUPAC of compounds and decipher outcomes of various transformations involving heterocycles	K3
CO	Apply the knowledge obtained through the course to predict the outcome of reactions and devise solutions to unknown problems	K4
CO5	Appreciate the stereo-chemical implications of organic compounds and visualize and appreciate the chirality concept	K4
CO6	Understand organic chemistry reactions related to aliphatic as well as aromatic compounds as well as decipher the outcome of a given organic transformation	K4
CO7	Interpret and analyze reactions having different functionalities, deduce and solve problems related to the reactions as well as apply them	K5
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	1	1	1	0	2	1	0	2	0	2
CO2	2	2	2	2	2	1	3	1	1	1	0	2
CO3	1	2	2	1	1	1	3	2	0	1	1	2
CO4	3	3	2	3	2	1	2	1	0	2	1	1

CO5	2	3	3	1	2	1	3	1	0	1	0	1
CO6	2	3	2	1	1	2	2	0	1	1	0	1
CO7	2	3	3	3	2	2	2	2	1	1	1	1

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	2	3	2
CO2	2	1	3	2	1
CO3	2	2	2	2	1
CO4	3	3	3	3	1
CO5	3	2	2	2	1
CO6	3	3	3	3	1
CO7	3	3	3	3	1

BSC	**Course Code: CHT1408**	**Course Title: Industrial Chemistry**	**Credits = 3**		
			L	**T**	**P**
	Semester: II	**Total contact hours: 45**	**2**	**1**	**0**

List of Prerequisite Courses	
Standard XII Chemistry	

List of Courses where this course will be prerequisite
Chemistry and Technology of Fine Chemicals(PHT1433), Process Technology of Drugs and Intermediates(PHT1447)

Description of relevance of this course in the B. Tech. Program
It is important for technology graduates to be familiar with the industrial scale-up of basic organic and inorganic reactions. The course aims to acquaint the students with synthesis, properties and applications of various industrial inorganic chemicals of commercial importance. The economic and ecological factors to be considered while selection and execution of such processes will also be discussed.

Course Contents (Topics and subtopics)		**Required Hours**
1	**Introduction to Chemical Industry**: Bulk chemicals, fine chemicals, intermediates, active pharmaceutical ingredients (API), etc.	3
2	**Petrochemical Industry**: operations and processes in manufacture of ethers, hydrocarbons, aromatic compounds, etc.	6
3	**PRIMARY INORGANIC MATERIALS**: Water, Hydrogen, Hydrogen Peroxide and Inorganic Peroxide Compounds, Nitrogen and Nitrogen Compounds, Phosphorus and its Compounds, Sulfur and Sulfur Compounds, Halogens and Halogen Compounds,	8
4	**MINERAL FERTILIZERS**: Phosphorus-Containing Fertilizers, Nitrogen-Containing Fertilizers, Potassium-Containing Fertilizers	4
5	**METALS AND THEIR COMPOUNDS**: Alkali and Alkaline Earth Metals and their Compounds Aluminum and its Compounds, Chromium Compounds and Chromium, Silicon and its Inorganic Compounds, Manganese Compounds and Manganese	8
6	**ORGANIC BULK CHEMICALS**: Manufacture of methanol, acetic acid, ethanol, ethylene, propylene, butadiene, acetaldehyde, acetylene, BTX, alkyl benzenes, acetone, phenol, styrene, esters, ethylene oxide, phthalic acid, Vinyl-Halogen and Vinyl-Oxygen Compounds, azo dyes, Polyamides, Propene Conversion Products, Aromatics - Production and Oxidation Products of Xylene and Naphthalene	8

7	Important pharmaceutically active ingredients, agrochemicals, insecticides, pesticides, perfumery chemicals.	8
	Total	**45**
List of Textbooks/ Reference Books		
1	Industrial Organic Chemistry, 3rd, Completely Revised Edition, Klaus Weissermel, Hans-Jürgen Arpe ISBN: 978-3-527-61459-2 July 2008.	
2	Industrial Inorganic Chemistry, 2nd Completely Revised Edition, Karl Heinz Buchel, Hans-Heinrich Moretto, Dietmar Werner, ISBN: 978-3-527-61333-5, 667 pages, November 2008, Wiley-VCH.	
3	Inorganic Chemistry – an industrial and environmental perspective, T.W. Swaddle, ISBN 0-12- 678550-3 , 482 pages, Academic Press	
Course Outcomes (students will be able to….)		
CO1	Understand the important chemical principles applied to various industrial processes	K2
CO2	Describe the fundamental processes underlying manufacture of important organic chemicals	K2
CO3	Describe the fundamental processes underlying manufacture of important inorganic chemicals	K2
CO4	Review and assess the impact of the chemical factors on the efficiency of industries and feedstock manufacturing	K3
CO5	Modify existing applications for improving the efficiencies in terms of yields, energy requirement and environmental impact	K4
CO6	Evaluate the modifications in terms of long-term environmental implications	K5
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	2	2	1	3	1	1	3	0	2
CO2	3	2	3	2	2	2	3	1	2	2	1	2
CO3	3	3	3	2	1	2	3	2	2	2	2	2
CO4	3	3	3	2	1	3	3	2	2	2	2	2
CO5	2	1	3	1	1	2	2	1	1	1	0	0
CO6	2	2	1	1	1	1	2	1	1	1	0	0

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	2	2	1	1
CO2	2	2	2	2	2
CO3	2	2	2	2	2
CO4	1	1	1	1	1
CO5	1	2	2	1	1
CO6	2	2	2	2	2

PCC	**Course Code: PHT1416**	**Course Title: SPL2: Pharmaceutical Analysis**	**Credits = 2**		
			L	**T**	**P**
	Semester: II	**Total contact hours: 30**	**1**	**1**	**0**
List of Prerequisite Courses					
XII Science					

List of Courses where this course will be prerequisite		
Structure Analysis by Spectroscopy (PHT1440)		
Description of relevance of this course in the B. Tech. Program		
The course is designed to acquaint the students with the basics of Pharmaceutical Analysis including Pharmacopoeial monographs, analytical method validation, spectroscopic and spectrometric techniques, chromatographic separations, structural elucidation and thermal analysis.		
Course Contents (Topics and subtopics)		**Required Hours**
1	**Introduction to Pharmacopoeial Monographs**, Documentation and record-keeping	2
2	**Analytical Method Validation** (as per USP and ICH guidelines): Accuracy, Precision, Limit of Detection (LOD), Limit of Quantification (LOQ), Linearity, Range, Robustness, Ruggedness	3
3	**Introduction to Sample Preparation Methods** Solvent Extraction: Basic principles, classification, mechanism of extraction, equilibria, techniques and applications; Solid-Phase Extraction	3
4	**Polarimetry:** Theory, instrumentation and applications	2
5	**Fourier Transform Infra-Red (FT-IR) and Raman Spectroscopy:** Basics, Theory, Instrumentation Applications in - Structural elucidation of organic compounds, qualitative and quantitative analyses, atmospheric chemistry, forensic sciences, pharmaceutical and material sciences, earth sciences (geology)	4
6	**Nuclear Magnetic Resonance (NMR) Spectroscopy:** ^{1}H-NMR: Principle, Precessional frequency, Chemical shift, Spin-spin coupling, Coupling constant, Instrumentation ; Introduction to ^{13}C NMR; Applications of NMR	6
7	**Mass Spectrometry:** Principle, methods of ionization - chemical ionization, fast-atom bombardment (FAB), thermospray, electrospray; Fragmentation patterns – α-fission, βfission, McLaffarty rearrangement, Retro Diels-Alder; Introduction to quadrupole mass analyzers; applications of mass spectrometry	5
8	**Hyphenated Techniques:** GC-MS, LC-MS, LC-MS/MS, interfaces, advantages and limitations	3
9	**Examples** encompassing structural elucidation of simple organic compounds using ^{1}H-NMR, Mass and FT-IR techniques	2
	Total	**30**
List of Textbooks/ Reference Books		
1	Indian Pharmacopoeia 2018, Vol. I-IV; 8th ed.; The Indian Pharmacopoeia Commission, Gaziabad, India (2018)	
2	USP 2019 – United States Pharmacopoeia 42 – National Formulary 37 (USP 42 – NF 37), Vol. 1-5; The United States Pharmacopeial Convention, USA (2019)	
3	BP 2020 – British Pharmacopoeia 2020, Vol. 1-5; British Pharmacopoeia Convention, UK (2019)	
4	Practical Pharmaceutical Chemistry; 4th ed. - Part 2; Beckett, A. H., Stenlake, J. B., Eds.; The Athlone Press, London, UK (1988)	
5	Pharmaceutical Analysis; Lee, D. C., Webb, M., Eds.; Blackwell Publishing Ltd., Oxford, UK (2003)	
6	Analytical Chemistry; 6th ed.; Christian, G. D., Ed.; Wiley India (P.) Ltd., New Delhi, India (2008)	
7	Vogel's Textbook of Quantitative Chemical Analysis; 6th ed.; Mendham, J., Denney, R. C., Barnes, J. D., Thomas, M., Sivasankar, B., Eds.; Dorling Kindersley (India) Pvt. Ltd. (Pearson Education Ltd.), New Delhi, India (2000)	
8	Introduction to Spectroscopy; Pavia, D. L., Lampman, G. M., Kriz, G. S., Vyvyan, J. R., Eds.; Cengage Learning, Stamford, USA (2015)	
9	Fundamentals of Analytical Chemistry; 9th ed.; Skoog, D. A., West, D. M., Holler, F. J., Crouch, S. R., Eds.; Cengage Learning, Boston, USA (2014)	
10	William Kemp, Organic Spectroscopy; 3rd ed.; Macmillan Education, UK (1991)	
Course Outcomes (students will be able to….)		

CO1	Describe various analytical method validation criteria as per USP and ICH along with other relevant guidelines.	K2
CO2	Understand and follow identification and quantitative analytical aspects of Active Pharmaceutical Ingredients (APIs), related substances and impurities.	K3
CO3	Suggest suitable analytic method(s) for the analysis of sample under investigation.	K4
CO4	Follow structural elucidation of simple organic molecules in stepwise manner.	K4
CO5	Understanding of Hyphenated techniques in Pharmaceutical development	K2
CO6	Evaluation of analytical challenges in the pharmaceutical development	K5
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	0	3	3	3	3	3	3	2
CO2	3	2	2	1	3	3	3	1	2	3	2	2
CO3	3	2	1	2	1	2	2	2	3	3	3	1
CO4	3	1	2	2	2	3	1	3	2	1	3	2
CO5	2	2	1	2	1	2	1	2	2	1	2	2
CO6	1	2	2	2	2	1	1	2	1	2	1	2

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	1	2	1
CO2	3	3	2	2	1
CO3	2	3	2	3	1
CO4	2	2	2	2	1
CO5	2	1	2	1	1
CO6	2	2	2	2	2

ESC	**Course Code:** **GET1306**	**Course Title:** **Basic Mechanical Engineering**	**Credits = 2**		
			L	**T**	**P**
	Semester: II	**Total Contact Hours: 30**	**1**	**1**	**0**
List of Prerequisite Courses					
Applied Physics(PYT1205), Engineering Mathematics(MAT1301)					
List of Courses where this course will be prerequisite					
Professional Career					
Description of relevance of this course in the B. Tech. Program					
Students will be able to understand various equipment's like steam turbine, gas turbine, pumps, compressors, and power transmission system.					
Course Contents (Topics and subtopics)			**Required Hours**		
	Introduction- Concept of Stress • Condition of Equilibrium for concurrent coplanar and non-concurrent coplanar forces. • Deformation in solids- Hooke's law, stress and strain- tension, compression and shear stresses, Stress-Strain diagrams, elastic constants and their relations volumetric, linear and shear strains.		6		

	Introduction to Thermodynamics • First Law of Thermodynamics, • Steady-flow energy equation, Second Law of Thermodynamics	4
	Basics of Power Station • **Steam Generators:** Fire tube and Water tube boiler, Low pressure, and high-pressure boilers, Mountings and accessories, Boiler efficiency. • **Steam Turbines:** Working principle of steam, gas and water turbines, Concept of impulse and reaction steam turbines. • **Compressors and Pumps:** Types of Compressors and their applications, Different Types of Pumps, and their applications	8
	Transmission of Power • Introduction to various drives such as belt, rope, chain and gear drives, • Introduction to mechanical elements such as keys, couplings, and bearings in power transmission.	4
	Refrigeration and Air-conditioning • Vapour compression refrigeration cycle, Vapour absorption refrigeration systems. • Properties of air such as DBT, WBT, DPT, relative humidity, Psychometric chart.	4
	Renewable Energy • Role and importance of non-conventional and alternate energy sources such as solar, wind, ocean, bio-mass and geothermal, hydrogen energy.	4
	Total	**30**

List of Textbooks/ Reference Books	
1	Strength of Materials by S. Ramamrutham, Dhanpat Rai Pvt. Ltd
2	Thermodynamics by P.K. Nag
3	Power plant by Morse
4	Heat Engines by P.L. Balani
5	Hydraulic Machines by Jagdish Lal
6	Renewable Energy resources by Tiwari and ghosal, Narosa publication.
7	Non-conventional energy sources, Khanna publications
8	Refrigeration and air conditioning by C.P. Arora
9	Theory of Machines by Rattan. S.S
10	Gas turbine theory by HiH Saravanamutoo.

Course Outcomes (students will be able to….)		
CO1	Understand different types of stresses and their effects on bodies.	K2
CO2	Understand and apply the physics of laws of thermodynamics and mass-balancing.	K3
CO3	Analyze the working of steam boilers, boiler mountings, and accessories, gas turbines, types of pumps, types of compressors and its working process.	K4
CO4	Discuss different types of power transmission systems and their typical applications.	K5
CO5	Understand the working principle of vapor compression and vapor absorption refrigeration systems.	K2
CO6	Understand the importance of non-conventional energy sources as an alternative source of fuels.	K2
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12

CO1	3	3	2	1	2	2	0	0	0	0	0	2
CO2	2	2	2	0	2	2	2	0	0	0	0	2
CO3	3	3	2	1	1	2	2	2	0	0	0	2
CO4	3	3	1	2	1	1	2	0	0	0	0	2
CO5	2	1	2	1	1	2	1	3	0	0	0	2
CO6	2	0	0	0	0	1	3	2	0	0	0	2

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	2	1	1
CO2	1	2	2	2	1
CO3	1	1	2	1	1
CO4	1	2	1	3	1
CO5	2	2	2	1	1
CO6	1	2	2	2	1

ESC	**Course Code:** **GET1125**	**Course Title:** **Electrical Engineering and Electronics**	**Credits = 2**		
			L	**T**	**P**
	Semester: II	**Total Contact Hours: 30**	**1**	**1**	**0**

List of Prerequisite Courses

XII Science, Applied Physics((PYT1101), Engineering Mathematics (MAT1301)

List of Courses where this course will be prerequisite

Pharmaceutical Green Chemistry(PHT1418)

Description of relevance of this course in the B. Tech. Program

Students will get an insight to the importance of Electrical Energy in Chemical Plants. The students will understand the basics of electricity, selection of different types of drives for a given application process. They will get basic knowledge as regards to Power supplies, instrumentation amplifiers and thyristor application in industries.

	Course Contents (Topics and subtopics)	**Required Hours**
1	**Fundamentals of DC Circuits** Voltage and Current Sources, Basic Laws, Network Theorems, Superposition Theorem and Thevenin's Theorem,	4
2	**AC Fundamentals:** A.C. through resistance, inductance and capacitance, simple RL, RC and RLC circuits. Power, power factor	4
3	**Three Phase Systems**: Three phase system of emfs and currents, Star and Delta connections, three phase power	3
4	**Single phase transformers**: Principle of working, Efficiency, regulation.	3
5	**Electrical drives**: Basic concepts of different types of Electrical motors as drives, Their suitability for various applications.	2
6	**Regulated power supplies**, Diodes as rectifiers, Half wave and Full wave rectifier, Filters and Regulators	3
7	**Bipolar junction transistors**: Different configurations, Characteristics, Concept of basic amplifier circuits, Amplifier gain, Transistor as switch	3
8	**Introduction to Integrated circuits:** Basic concepts of ICs	2
9	**Introduction to data acquisition and signal conditioning,** Basic concept and Block diagram, Concept of conversion of physical quantity to electrical signal, signal conditioning, Introduction to A/D and D/A converters	3

10	**Introduction to instrumentation amplifiers and their applications** Operational Amplifier – Notation, Pin diagram, Differential and common mode gain, CMRR, Introduction to various applications such as Non-inverting, inverting amplifiers, adder,subtractor, integrator, differentiator.	3
	Total	**30**
List of Textbooks/ Reference Books		
1	Electrical Engineering Fundamentals by Vincent Deltoro	
2	Electronic devices and circuits by Boylstead, Nashelsky	
3	Electrical Machines by Nagrath, Kothari	
4	Electrical Technology by B.L.Theraja, A.K.Theraja vol I,II,IV	
Course Outcomes (students will be able to….)		
CO1	Understand the basic concepts of D.C. supply and circuits, Solve basic electrical circuit problems	K3
CO2	Understand the basic concepts single phase and three phase AC supply and circuits, Solve basic electrical circuit problems	K3
CO3	Understand the basic concepts of transformers, evaluate, and calculate efficiency at various load condition.	K5
CO4	Understand the concept of motors and their uses as various industrial drives.	K5
CO5	Understand the basic concepts of electronic devices and their applications in power supplies, amplification and instrumentation	K4
CO6	Understand the basic concepts of operational amplifiers and their applications, Understand the concept of Data acquisition, signal conditioning	K4
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	0	0	0	0	0	2	3	2	0	0
CO2	3	3	0	0	0	0	0	2	3	2	0	0
CO3	3	3	0	0	0	0	0	2	3	2	0	0
CO4	3	3	0	0	0	0	0	2	3	2	0	0
CO5	3	3	0	0	0	0	0	2	3	2	0	0
CO6	3	3	0	0	0	0	0	2	3	2	0	0

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	1	1	1	1
CO2	2	1	1	1	1
CO3	2	1	2	1	1
CO4	2	1	1	1	1
CO5	2	1	2	1	1
CO6	2	1	2	1	1

ESC		**Course Title: Process Calculations**	**Credits = 2**

	Course Code: CEP1720		L	T	P
	Semester: II	**Total contact hours: 60**	**0**	**0**	**4**
List of Prerequisite Courses					
Standard XIIth Mathematics, Chemistry, Applied Physics(PYT1205)					
List of Courses where this course will be prerequisite					
Pharmaceutical Green Chemistry(PHT1418), Project-II(PHP1449)					
Description of relevance of this course in the B. Tech. Program					
This is a basic course. This knowledge will be required in almost all subjects later. This subject introduces the various concepts used in Chemical Engineering to the students. The knowledge of this subject is required for in All B. Tech. courses, etc. It can be applied in various situations such as process selection, economics, sustainability, environmental impacts					
Course Contents (Topics and subtopics)					**Required Hours**
1	Introduction to Chemical process calculations, overview of single stage and multistage operations, concept of process flow sheets				2
2	Revision of Units and Dimensions, Dimensional analysis of equations, Mathematical techniques				4
3	Mole concept, composition relationship, types of flow rates				2
4	Material balance in non-reacting systems: application to single and multistage processes				8
5	Stoichiometry				2
6	Material balance in reacting systems: application to single and multistage processes				6
7	Behavior of gases and vapors				4
8	Introduction to psychrometry, humidity and air-conditioning calculations.				6
9	Calculation of X-Y diagrams based on Raoult's law.				2
10	Applications of material balances to Multiphase systems				6
11	Basic concepts of types of Energy and calculations				2
12	Application of Energy balance to non-reacting systems				6
13	Application of Energy balance to reacting systems				6
14	Fuels and combustion.				4
	Total				**60**
List of Textbooks/ Reference Books					
1	Elementary Principles of Chemical Processes, Felder, R.M. and Rousseau,				
2	Chemical Process Principles, Hougen O.A., Watson K. M.				
3	Basic Principles and Calculations in Chemical Engineering, Himmelblau,				
4	Stoichiometry, Bhatt B.I. and Vora S.M.				
Course Outcomes (students will be able to….)					
CO1	Students should be able to calculate friction factor, pressure drop, power requirements of singe phase flow in a circular pipe				K2+P2
CO2	Students will be able to select appropriate pump based on flow and head requirements				K3+P2
CO3	Students should be able to calculate heat transfer coefficients and do basic sizing of double pipe and shell and tube heat exchangers				K3+P2
CO4	Students should be able to perform preliminary sizing of phase change equipment such as reboilers and condensers				K3+P2
CO5	Students should be able to calculate mass transfer coefficients and estimate mass transfer rates in simple situations				K3+P2
CO6	Students should be able to understand empirical correlations and solve various equations analytically or numerically				K4+P2
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating P1 – Imitate, P2 – Manipulate, P3 – Perfect, P4 – Articulate, P5 – Embody					

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	2	1	1	1	1	1	1	3
CO2	3	3	2	3	2	1	2	1	1	1	1	3
CO3	3	3	3	3	3	1	2	2	2	1	1	3
CO4	3	3	3	3	3	1	1	1	2	1	1	3
CO5	3	3	2	3	2	1	1	1	1	1	1	3
CO6	3	3	2	3	3	1	1	1	1	1	1	3

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	1	2	1
CO2	3	2	1	3	1
CO3	3	3	2	3	1
CO4	3	3	2	3	2
CO5	3	2	1	3	1
CO6	2	2	1	2	1

CCA	**Course Code:**	**Course Title:** Physical Activities (Sports & games)	Credits = 2		
			L	**T**	**P**
	Semester: II	**Total contact hours: 60**	0	**0**	4

List of Prerequisite Courses

None

List of Courses where this course will be prerequisite

Not Applicable

Description of relevance of this course in the B. Tech. Program

Games and sports are necessary and useful for all. Games play an important part in life. Education is incomplete without games. Games are necessary to keep the body fit and trim. Moreover, they provide recreation. As a result, one feels smart and cheerful throughout the day. If one is cheerful and healthy, he or she is able to get the best out of life. A player really enjoys life. For him, life is a song and a beauty. Games teach us the lesson of discipline, team-work, patience and punctuality. In the playground, the players obey the captain and abide by the rules of the games. Games also teach us that we should play a game for game's sake, not for victory or defeat. A healthy man is always hopeful and cheerful.

	Course Contents (Topics and subtopics)	**Reqd. hours**
1	The students shall select participating a specific sports/game/physical activity of their choice in morning/evening or at other suitable times according to the local climate. This would involve a routine of physical activity with games and sports. Physical activity means any bodily movement produced by skeletal muscles requiring energy expenditure, for example, Walking, gardening, climbing the stairs, playing soccer. Activities can be considered vigorous, moderate, or light in intensity. Activity makes one breathe harder and one's heart beat faster.	60

	Moderate physical activities include: • Walking briskly (about 3½ miles per hour) • Bicycling (less than 10 miles per hour) • General gardening (raking, trimming shrubs) • Dancing • Golf (walking and carrying clubs) • Water aerobics • Canoeing • Tennis (doubles) **Vigorous physical activities** include: • Running/jogging (5 miles per hour) • Walking very fast (4½ miles per hour) • Bicycling (more than 10 miles per hour) • Heavy yard work, such as chopping wood • Swimming (freestyle laps) • Aerobics • Basketball (competitive) • Tennis (singles)	
	Total	**60**
Course Outcomes (students will be able to…..)		
CO1	Keep physically fit and mentally agile	K2
CO2	Manage stress in studies and later in life	K2
CO3	Coordinate body and mind together	K2
CO4	Understand own emotions and maintain healthy daily routine	K2
CO5	Develop team work and an ability to work with others for a common goal	K3
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	0	1	0	0	0	1	1	1	1	1	0	1
CO2	0	1	0	0	0	1	1	1	1	1	0	1
CO3	0	1	0	0	0	1	1	1	1	1	0	1
CO4	0	1	0	0	0	1	1	1	1	1	0	1
CO5	0	1	0	0	0	1	1	1	1	1	0	1

IKS	**Course Code: HUT1117**	**Course Title:** **Traditional Indian Chemical Technology**	**Credits = 2**		
			L	**T**	**P**
	Semester: II	**Total Contact Hours: 30**	**2**	**0**	**0**
List of Prerequisite Courses					
NIL					
List of Courses where this course will be prerequisite					
NIL					
Description of relevance of this course in the B. Tech. Program					

To acquaint the students with major chronological developments in Indian science and technology.· To review the ancient discoveries and research related to chemicals in Pharmaceuticals, flavours and fragrances, metallurgy, architecture, textile, agriculture and Ayurveda etc. To know the fundamental principles of Indian health systems such as Ayurveda, which is useful in maintaining well-being. To facilitate the students to identify and develop interest in the ancient knowledge systems to make meaningful contributions to the development of science today. To develop respect and pride about Indigenous Knowledge thereby to assist the learners' understanding about conclusions/products from ancient Indian knowledge system for verifying them on modern scientific and technological footings.		
Course Contents (Topics and subtopics)		**Required Hours**
1	**Introduction to Indian Knowledge System (IKS):** - Introduction, Definition and History - Need to study it in current times Chemists and texts of the ancient era	2
2	**Traditional Indian Pharmaceutical Sciences and Technology:** Alternative systems of Medicine/ Welfare of the society: Principles of Ayurveda - Medicinal plants and crude drugs - Reappraisal of Ayurvedic Phytochemistry - Ayurvedic Dosage forms and similarity to that of modern dosage forms - Extraction of herbs in Ayurvedic System and comparison to that of modern extraction process - Detoxification of poisonous plants (*Shodhan Prakriya*) Ancient perspective of Adulterants and Substitutes	6
3	**Traditional Indian Knowledge on Oils, Perfumery and Flavoring agents** - Essential oils and fixed oils Applications in perfumery and flavoring-fragrance industry	3
4	**Traditional Indian Knowledge on Textile and Fibers** - Types of fibers - Textile patterns across the country Methods and Techniques	2
5	**Traditional Indian Knowledge on Dyes, Pigments, mordents and specialty chemicals** - Natural dyes and pigments Sources, Methods of dying	2
6	**Traditional Indian Knowledge on Polymers and surface coatings** Waxes, Gums, Carbohydrates	2
7	**Traditional Indian Food Technology**	2
8	Traditional Indian Knowledge about Metallurgy and Materials Science	3
9	**Traditional Indian Preservation Technology** - Methods of preservation: Food, monuments and artifacts Materials used in Preservation	3
10	Science associated with traditional Indian practices during festivals	2
11	Connecting The traditional Indian Knowledge with Modern Science	3
	Total	**30**
List of Textbooks/ Reference Books		
1	Acharya Prafulla Chandra Ray, A History of Hindu Chemistry, 1902, republ., Shaibya Prakashan Bibhag, centenary edition, Kolkata, 2002	
2	B. Mahadevan and Vinayak Rajat Bhat, INTRODUCTION TO INDIAN KNOWLEDGE SYSTEM: CONCEPTS AND APPLICATIONS, **PHI Learning publication, 2022**	
3	The Positive Sciences of the Ancient Hindus; Brijendra Nath Seal; 4th Edition; 2016	
4	Fine Arts & Technical Sciences in Ancient India with special reference to Someśvara's Mānasollāsa; Dr. Shiv Shekhar Mishra, Krishnadas Academy, Varanasi 1982	
5	A Concise History of Science in India, ed. D M Bose, S N Sen and B V Subbarayappa; INSA; 2009	
6	Science and Technology in Medieval India - A Bibliography of Source Materials in Sanskrit, Arabic and Persian by A Rahman, M A Alvi, S A Khan Ghori and K V Samba Murthy; 1982.	
7	Vaidya Navnitlal B. Pandya, Fundamental principles of ayurveda part – 1. October 1982 Ancient Science of Life.	

8	Vasant Lad, Textbook of Ayurveda: Fundamental Principle, reprint 2010
9	Lakshmi chandra Mishra (Editor), Scientific Basis for Ayurvedic Therapies, CRC Press LLC 2003
10	H.Panda, **Handbook on Speciality Gums, Adhesives , Oils, Rosin & Derivatives, Resins, Oleoresins, Katha, Chemicals with other Natural Products,** Asia Pacific Business Press Inc., 2022
11	Achyut Godbole, Anna, Madhushree Publication, 2022, Marathi edition
12	BHOJANAKUTUHALAM, RAGHUNATHA SURI (Author), FRLHT (Contributor), DR.M.A.ALWAR (Editor), DR.PADMA VENKAT, THE MEDPLAN CONSERVATORY SOCIETY 2019
13	R.M. Pujari, Pradeep Kolhe, N. R. Kumar, 'Pride of India: A Glimpse into India's Scientific Heritage', Samskrita Bharati Publication.
14	'Indian Contribution to science', compiled by Vijnana Bharati.
15	'Knowledge traditions and practices of India',Kapil Kapoor, Michel Danino, CBSE, India

Course Outcomes (students will be able to….)		
CO1	List the key achievements of Ancient India in different areas of Chemical Technology	K3
CO2	Describe the various features of traditional Indian knowledge in different areas of Chemical Technology	K2
CO3	Describe Key Principles of Traditional Indian Health Systems	K2
CO4	Describe the various products and key technology aspects based on traditional Indian Knowledge in context of Modern science	K2
CO5	Understanding the applications of IKS in current practices.	K3
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	1	1	3	0	1	3	3	1	0
CO2	3	2	2	1	1	3	0	1	3	3	1	0
CO3	3	2	2	1	1	3	0	1	3	3	1	0
CO4	3	2	2	1	1	3	0	1	3	3	1	0
CO5	2	1	1	3	1	1	0	1	1	3	1	1

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	1	1	3	2
CO2	2	2	1	1	1
CO3	2	1	1	3	2
CO4	2	1	1	1	2
CO5	2	2	1	1	2

BSC	**Course Code: CHP1343**	**Course Title: Physical and Analytical Chemistry Laboratory**	**Credits = 2**		
			L	**T**	**P**
	Semester: II	**Total Contact Hours: 60**	**0**	**0**	**4**
List of Prerequisite Courses					
Standard XII Chemistry, Physical Chemistry (CHT1405) and Analytical Chemistry(CHT1406)					
List of Courses where this course will be prerequisite					

Pharmaceutical Green Chemistry(PHT1418)		
Description of relevance of this course in the B. Tech. Program		
The laboratory course is mainly focused on imparting critical experimental skills in Physical and Analytical Chemistry to the undergraduate students. It is expected that they will not only become familiar with laboratory experimental skills but also planning of experiments and interpretation of experimental tasks. The course will help them to understand the relevance of chemical principles in real-life applications.		
Course Contents (Topics and subtopics)		**Required Hours**
1	The experiments will focus on the following key concepts / skills: **Physical Chemistry:** • determination of dissociation constants of a polybasic acid • determination of critical micelle concentration (CMC) of the given surfactant • study of kinetics of reaction – order of reaction, activation energy • study of weak and strong electrolytes • characterization of polymers using MW / viscosity determination **Analytical Chemistry:** • determination of water quality (hardness / BOD / COD) • determination of composition in a mixture of acids • verification of Beer-Lambert's law • quality analysis (determination of Vitamin C, for example)	4h / Practical
	Total	**60**
List of Textbooks/ Reference Books		
1	Practical Physical Chemistry – B.Viswanthan and P.S. Raghavan, 2005	
2	Practical Physical Chemistry – Alexander Findlay, 1954	
Course Outcomes (students will be able to….)		
CO1	Perform quantitative analysis of samples to determine purity / composition	K3+P2
CO2	Use common laboratory instruments with appropriate calibration and safety protocols	K3+P2
CO3	Apply concepts of equilibria and kinetics to determine properties of molecules / processes	K4+P2
CO4	Design experiments for acquiring physicochemical data and to interpret results for addressing specific queries / requirements	K4+P2
CO5	Evaluate the results in terms of accuracy and estimated precision	K4+P2
CO6	Identify the sources of errors and design steps to minimize the same	K5+P2
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating P1 – Imitate, P2 – Manipulate, P3 – Perfect, P4 – Articulate, P5 – Embody		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	2	2	1	3	1	1	3	0	2
CO2	3	2	3	2	2	2	3	1	2	2	1	2
CO3	3	3	3	2	1	2	3	2	2	2	2	2
CO4	3	3	3	2	1	2	2	2	2	2	2	2
CO5	3	2	3	2	2	2	3	1	2	2	1	2
CO6	3	3	3	2	1	2	3	2	2	2	2	2

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5

CO1	1	2	3	2	2
CO2	1	2	2	2	2
CO3	2	2	3	1	2
CO4	1	2	3	2	2
CO5	1	2	3	2	2
CO6	1	2	2	2	2

VSEC	**Course Code:** **CHP1132**	**Course Title:** **Organic Chemistry Laboratory**	**Credits = 2**		
			L	**T**	**P**
	Semester: II	**Total Contact Hours: 60**	**0**	**0**	**4**

List of Prerequisite Courses	
Standard XII Chemistry, Organic Chemistry (CHT1407)	
List of Courses where this course will be prerequisite	
Pharmaceutical Chemistry Laboratory-I(PHP1423), Pharmaceutical Chemistry Laboratory-II(PHP1427)	
Description of relevance of this course in the B. Tech. Program	
Students are introduced to basics of organic separations and identification of organic compounds based on their physicochemical properties. The course is relevant for training the students for working with binary mixtures. The laboratory training is crucial for the students to carry out work-up of organic reactions leading to separation of crude products followed by purification using recrystallization and/or distillation or related methods.	

	Course Contents (Topics and subtopics)	**Required Hours**
1	a) Principles of qualitative separation of organic mixtures using physical properties, chemical properties and their combination b) Principles of quantitative separation of organic mixtures using physical properties, chemical properties and their combination	4h/Practical
2	a) Separation of solid-solid water insoluble binary organic mixtures b) Separation of solid-solid partly water soluble binary organic mixtures c) Separation of solid-solid mixtures by fractional crystallization d) Separation of liquid-liquid mixtures by distillation e) Separation of liquid-liquid mixtures by solvent extraction	
	Total	**60**

List of Textbooks/ Reference Books	
1	Arthur, Vogel. Textbook of Practical Organic Chemistry, 5th edition, publishers Longman group Ltd, 1989
2	F.G. Mann and B.C. Saunders, Practical Organic Chemistry, 4th edition published by Orient Longman, 1974
3	Keese, R, Martin P. B, and Trevor P. Toube. Practical Organic Synthesis: A Student's Guide. John Wiley & Sons, 2006.

Course Outcomes (students will be able to….)		
CO1	Understand basic principles for separation of binary organic mixtures qualitatively and quantitatively	K3+P2
CO2	Estimate the components of binary mixtures quantitatively	K3+P2
CO3	Separate binary organic mixtures by multiple techniques and test the purity	K3+P2
CO4	Determine the purity of the individual components through quantitative analysis	K4+P2

CO5	Design experimental protocols to improve the purity of isolated components	K5+P2
CO6	Follow GLP protocols and work safely in the organic chemistry laboratory	K4+P2
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating P1 – Imitate, P2 – Manipulate, P3 – Perfect, P4 – Articulate, P5 – Embody		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	2	2	1	1	2	1	1	2	2	1
CO2	2	2	2	3	1	1	2	1	1	2	2	2
CO3	1	2	3	3	1	2	2	2	1	1	1	2
CO4	2	2	3	2	1	2	2	3	3	3	2	2
CO5	3	3	3	2	1	2	3	2	2	2	2	2
CO6	3	3	3	2	1	2	2	2	2	2	2	2

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	2	1	2
CO2	2	2	3	3	2
CO3	2	3	2	2	2
CO4	2	2	2	2	2
CO5	2	2	2	1	2
CO6	2	2	3	3	2

UHV	**Course Code: XXXXXXX**	**Course Title: Universal Human Values-I**	**Credits = 2**		
			L	**T**	**P**
	Semester: II	**Total contact hours: 60**	**0**	**0**	**4**

List of Prerequisite Courses

NA

List of Courses where this course will be prerequisite

NA

Description of relevance of this course in the B.Tech. Program

This **audit course with no extra credit** gets the student to explore oneself and allows one to experience the joy of learning, stand up to peer pressure, take decisions with courage, be aware of relationships with colleagues & supporting staff in hostel & department, be sensitive to others, etc.
A module in Universal Human Values provides the base of character building. The objective of the course is four fold:
1. Sensitization of student towards self, family (relationship), society and nature.
2. Understanding (or developing clarity) of nature, society and larger systems, on the basis of human relationships and resolved individuals.
3. Strengthening of self-reflection.
4. Development of commitment and courage to act.
5. The second year mark list, this course with result a s Pass/Fail with mandate hrs in place.

Course Contents (Topics and subtopics)		**Required Hours**
1	Purpose and motivation for the course	**60**
2	Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration 3. Continuous Happiness and Prosperity- A look at basic Human Aspirations	

3	Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority	
4	Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario	
5	Method to fulfil the above human aspirations: understanding and living in harmony at various levels.	
6	**Methodology of this Course:** Methodology of teaching this content must not be through do's and dont's, but get the students to explore and think by engaging them in a dialogue. It is best taught through group discussions and real life activities rather than lecturing. The role of group discussions, however, with clarity of thought of the teachers cannot be over emphasized. It is essential for giving exposure, guiding thoughts, and realizing values. The teachers must come from all the departments rather than only one department or from outside of the Institute. Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking	
	Total	**60**
List of Text Books		
1	Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010	
2	Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999	
3	The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi	
4	Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.	
Course Outcomes (students will be able to….)		
CO1	Become more aware of their surroundings, society, social problems and their sustainable solutions, while keeping human relationships and human nature in mind.	K2
CO2	Develop better critical ability.	K2
CO3	Become sensitive to their commitment towards what they believe in (humane values. humane relationships and humane society).	K3
CO4	Apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction	K3
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	0	1	0	0	0	1	1	1	1	1	0	1
CO2	0	1	0	0	0	1	1	1	1	1	0	1
CO3	0	1	0	0	0	1	1	1	1	1	0	1
CO4	0	1	0	0	0	1	1	1	1	1	0	1

SRCOND YEAR: SEMESTER – III

PCC	**Course Code: PHT1417**	**Course Title:** **SPL3: Pharmaceutical Formulation Technology-I**	**Credits =4**		
			L	**T**	**P**
	Semester: III	**Total Contact Hours: 60**	**3**	**1**	**0**
List of Prerequisite Courses					

XII Science, Introduction to Technology of Pharmaceuticals and Fine Chemicals(PHT1415)		
List of Courses where this course will be prerequisite		
Pharmaceutical Formulation Technology-II(PHT1424), Pharmaceutical Formulation Technology Laboratory-II(PHT1428), Pharmaceutical Formulation Technology-III(PHT1436)		
Description of relevance of this course in the B. Tech. Program		
To train the students with respect to basics of monophasics, biphasics, topical formulation, aerosols, stability testing and stabilization.		
Course Contents (Topics and subtopics)		**Required Hours**
1	**Overview of Pharmaceutical Industry** with introduction and classification of pharmaceutical dosage forms and routes of drug administration	5
2	**Origin and Development of the Pharmacopoeia** – IP/BP/USP, Introduction to monographs, Parts of monograph, Introduction to Biopharmaceutics	4
3	Solubilization techniques	3
4	**Monophasics** (Oral and Topicals) (solution, syrups, elixirs, linctus, glycerites, nasal drops, ear drops, etc.) • Preformulation • Formulation • Quality Control	5
5	**Large-scale Manufacturing of Monophasics** • Large scale manufacture and packaging with focus on equipment • Layout design and unit operations	3
6	**Biphasics – Suspensions** • Preformulation • Principles and Stabilization techniques • Formulation Development • Evaluation • Large scale manufacture and packaging with focus on equipment • Layout design and unit operations	5
7	**Biphasics – Emulsions** • Preformulation • Theories of emulsions • Formulation • Evaluation including stress testing • Large scale manufacture and packaging with focus on equipment • Layout design and unit operations	5
8	**Ointments** • Preformulation • Formulation • Evaluation • Large scale manufacture and packaging with focus on equipment • Layout design and Unit operations	5
9	**Creams** • Preformulation • Formulation • Evaluation • Large scale manufacture and packaging with focus on equipment • Layout design and Unit operations	5
10	**Gels** • Preformulation • Formulation • Evaluation • Large scale manufacture and packaging with focus on equipment • Layout design and Unit operations	5
11	**Suppositories** • Preformulation • Formulation	5

	• Evaluation • Large scale manufacturing with focus on equipment • Layout design and Unit operations	
12	**Aerosols** • Containers and Propellants • Formulation of aerosols • Evaluation of aerosols	5
13	**Stability Studies** • Introduction to International Conference on Harmonization • Climatic zones as per ICH • ICH guidelines for Stability Testing of New Drug Substances and Products [Q1A (R2)] • ICH guidelines for Stability Testing: Photo-stability Testing of New Drug Substances and Products [Q1B] • ICH guidelines for Stability Testing for New Dosage Forms[Q1C] • Stabilization of dosage forms	5
	Total	**60**

List of Textbooks/ Reference Books	
1	Pharmaceutical Dosage Form And Drug Delivery Systems, Howard C. Ansel, Nicholas G. Popovich, Lord V. Alien, 6th edition, 1995,
2	Remington - The Science And Practice Of Pharmacy (Vol.1& 2), David B. Troy, 21st edition, 2006, Lippincott Williams &Wilkins
3	Tutorial Pharmacy J.W. Cooper, Colin Gunn, 4th edition, 1950, Sir Isaac Pitman & Sons Ltd., London
4	Pharmaceutics: The Science of Dosage Form Design, Michael E. Aulton, 1998, Churchill-Livingstone Dermatological Formulations, B. W. Barry, 198, New York, Marcel Dekker
5	Pharmaceutical Production Facilities: Design & Applications, Graham C. Cole,1st Edition , 1990, Ellis Horwood
6	Theory & Practice Of Industrial Pharmacy, Leon Lachman ,Herbert A. Lieberman& Joseph Kanig, 3rd edition, 1987, Lea &Febiger, Philadelphia
7	ICH Guidelines
8	Introduction of Pharmaceutical Dosage Forms, Howard Ansel, 3rd edition, 1981, Lea & Febiger
9	Pharmacopoeias: Indian Pharmacopoeia, British Pharmacopoeia, United States Pharmacopoeia, all editions

Course Outcomes (students will be able to….)		
CO1	Explain principles of preformulations and basic formulation considerations for monophasic liquid orals and emulsions.	K2
CO2	Conceptualize and develop monophasic liquid oral and topical formulations.	K4
CO3	Conceptualize and develop biphasic oral products and semisolid formulations.	K4
CO4	Describe unit operations, large scale manufacturing and layout for monophasic, biphasics, semisolids, suppositories and aerosols.	K3
CO5	Explain stability evaluation and stabilization of products.	K2
CO6	Applying the regulatory guidelines	K3
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12

CO1	3	1	3	2	3	2	2	2	3	2	1	2
CO2	2	3	2	3	2	1	2	1	1	2	1	1
CO3	2	3	2	2	3	2	1	3	1	1	1	1
CO4	2	3	1	3	3	3	1	1	2	1	1	1
CO5	2	2	2	3	2	1	2	1	1	2	1	1
CO6	2	3	1	3	3	3	1	1	2	1	1	1

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	1	3	2
CO2	2	3	2	3	2
CO3	3	3	1	2	2
CO4	3	2	2	3	1
CO5	3	2	3	2	2
CO6	3	2	2	3	2

PCC	**Course Code: PHT1418**	**Course Title: SPL4: Pharmaceutical Green Chemistry**	**Credits =2**		
			L	**T**	**P**
	Semester: III	**Total Contact Hours: 30**	**1**	**1**	**0**

List of Prerequisite Courses

XII Science, Organic chemistry(CHT1407)

List of Courses where this course will be prerequisite

Pharmaceutical Chemistry and Catalytic Processes(PHT1425), Drug Synthesis Approaches(PHP1439), Process Technology of Drugs and Intermediates(PHT1447)

Description of relevance of this course in the B. Tech. Program

The course is designed to acquaint the students with the basics of the Green Chemistry Principles with relevant Case Studies in order to imbibe the relevance of Green Chemistry in a technocrat's professional life.

	Course Contents (Topics and subtopics)	**Required Hours**
1	**Introduction to Green Chemistry:** Green Chemistry 12 Principles, minimization of waste generation and waste prevention.	12
2	**Introduction to Alternative Methods of Chemical Synthesis:** Photochemistry, Microwave-Assisted Organic Synthesis (MAOS), Solvent-free synthesis, Electrochemistry and Sonochemistry	10
3	**Green Chemistry and Technology Case Studies from Research article:** 4-5 Examples	8
	Total	**30**

List of Textbooks/ Reference Books

1	Handbook of Green Chemistry, Vol. 11: Green Metrics; Anastas, P. T., Constable, D. J. C., Jimenez-Gonzalez, C., Eds.; Wiley-VCH, (2018)
2	ACS Green Chemistry Institute. https://www.acs.org/content/acs/en/greenchemistry/about.html
3	Green Chemistry in Industry: Green Chemical Processing.; Benvenuto, M. A., Plaumann, H., Eds.; de Gruyter, Berlin, GmbH (2018)
4	Brahmachari, G. Catalyst-free Organic Synthesis. Green Chemistry Series 51; RSC, Cryodon, UK (2018)
5	Albini, A., Protti, S. Paradigms in Green Chemistry and Technology. Springer Briefs in Molecular Science: Green Chemistry for Sustainability; Sharma, S. K., Ed.; Springer, London, UK (2016)

6	Green Chemistry Strategies in Drug Discovery. RSC Drug Discovery Series 46; Peterson, E. A., Manley, J. B. Eds.; RSC, Cambridge, UK (2015)
7	Worldwide Trends in Green Chemistry Education; Zuin, V. G., Mammino, L., Eds.; RSC, Cambridge, UK (2015)

Course Outcomes (students will be able to….)		
CO1	Understanding of basic principle of green chemistry	K3
CO2	Apply the principles for Green Chemistry in order to make a life cycle assessment for a chemical product including waste treatment (degradation/recycling).	K3
CO3	Understand the hazards, effluents and statistical methods of optimization in green technology	K5
CO4	Calculate the atomic efficiency and E-factors of chemical reactions and processes.	K4
CO4	Be able to describe classes of the most important chemicals (both organic and inorganic) that are hazardous/dangerous for human and animal health, and the environment.	K5
CO5	Analysing of the literature process based on green chemistry	K4
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	1	3	3	3	3	3	3	2
CO2	3	2	2	1	3	3	3	1	2	3	2	1
CO3	2	1	2	2	2	2	2	1	2	3	1	2
CO4	2	2	2	0	3	3	3	1	2	3	2	1
CO5	2	1	2	2	2	2	2	1	2	1	2	2

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	1	3
CO2	2	3	2	1	2
CO3	2	2	2	2	1
CO4	3	2	2	2	1
CO5	3	2	1	3	2

EEM	**Course Code: HUT1205**	**Course Title: Basic Economics and Finance**	**Credits = 2**		
			L	**T**	**P**
	Semester: III	**Total Contact Hours: 30**	**1**	**1**	**0**
List of Prerequisite Courses					
NIL					
List of Courses where this course will be prerequisite					
Chemical Process Economics(CET1805), Project-II(PHP1449)					
Description of relevance of this course in the B. Tech. Program					
A Chemical Technology student will be experience the importance of Basic Economics and Finance in various industrial processes.					
Course Contents (Topics and subtopics)			**Required Hours**		

1	**INTRODUCTION** Explaining the Economy The Supply and Demand Model Using the Supply and Demand Model	3
2	**THE COMPETITIVE EQUILIBRIUM MODEL** Deriving Demand Deriving Supply Market Equilibrium and Efficiency	5
3	**DEVIATIONS FROM COMPETITION** Monopoly and Market Power Between Monopoly and Competition Antitrust Policy and Regulation	5
4	MACRO FACTS AND MEASURES Getting Started with Macroeconomic Ideas Measuring Production, Income and Spending of Nations	5
5	**ACCOUNTING TRANSACTIONS** Journal entries Debit credit rules Compound journal entry Journal and ledger Rules of posting entries Trial balance	5
6	**CAPITAL AND REVENUE** Income and expenditure Expired costs and income Final accounts Manufacturing accounts Trading accounts Profit and Loss account Suspense account Balance sheet	5
7	CONCEPT OF DEPRECIATION	2
	Total	**30**

List of Textbooks/ Reference Books	
1	William G. Droms and Jay O. Wright Finance and Accounting for Nonfinancial Managers: All the Basics You Need to Know
2	E. Case Karl, C. Fair Ray, et al, PRINCIPLES OF ECONOMICS(12e)
3	A Temu, D W Ndyetabula, et al Microeconomics: Basic Principles and Applications
4	Basic Finance for Nonfinancial Managers: A Guide to Finance and Accounting Principles for Nonfinancial Managers- Kendrick Fernandez
5	Microeconomic Theory: Basic Principles and Extensions- Walter Nicholson and Christopher Snyder
6	Macroeconomics(10e) Part of: Pearson Series in Economics (23 books) - by Froyen
7	William G. Droms and Jay O. Wright Finance and Accounting for Nonfinancial Managers: All the Basics You Need to Know

Course Outcomes (students will be able to….)		
CO1	Students will be able to know and apply accounting and finance theory.	K3
CO2	Students will be able to understand the mechanics of preparation of financial statements, their analysis and interpretation	K2
CO3	Students will be able to explain basic economic terms, concepts, and theories	K2
CO4	Students will be able to identify key macroeconomic indicators	K3
CO5	Applying during the project cost calculation	K3
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	2	1	1	2	2	2	1	1
CO2	2	2	2	2	2	1	2	1	2	2	1	0
CO3	2	1	2	2	1	1	2	1	1	1	1	2
CO4	2	2	2	2	2	3	1	2	2	2	1	1
CO5	2	2	2	2	2	2	2	2	2	2	1	1

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	1	2	2
CO2	2	1	1	2	1
CO3	2	2	2	2	2
CO4	2	2	2	2	2
CO5	2	2	1	2	2

PCC	**Course Code: PHP1419**	**Course Title: Pr-1: Pharmaceutical Formulation Technology Laboratory-I**	**Credits =2**		
			L	**T**	**P**
	Semester: III	**Total Contact Hours: 60**	**0**	**0**	**4**

List of Prerequisite Courses

XII Science

List of Courses where this course will be prerequisite

Pharmaceutical Formulation Technology Laboratory II(PHP1428), Pharmaceutical Formulation Technology Laboratory III(PHP1445)

Description of relevance of this course in the B. Tech. Program

To train the students with respect to practical aspects of monophasic, biphasic and topical Semisolid pharmaceutical formulation development and quality control thereof.

	Course Contents (Topics and subtopics)	**Required Hours**
1	Representative examples of monophasic liquids (Preparation, packaging and evaluation)	16
2	Representative examples of emulsions (Preparation, packaging and evaluation)	8
3	Representative examples of suspensions (Preparation, packaging and evaluation)	8
4	Large-scale manufacture of one monophasic and one biphasic liquids (Preparation, packaging and evaluation)	8
5	Representative examples of semisolid dosage forms e.g. ointments, creams, gels etc. (Preparation, packaging and evaluation)	12
6	Representative examples of suppositories and aerosols (Preparation, packaging and evaluation)	8
	Total	**60**

List of Textbooks/ Reference Books

1	Latest Indian Pharmacopoeia, British Pharmacopoeia, United States Pharmacopoeia
2	Pharmaceutical Production Facilities: Design and Applications G. C. Cole, New York Ellis Horwood (1990)
3	Husa's Pharmaceutical Dispensing Martin E. W. Easton Mack Pub. Co. (1971)
4	Transdermal Delivery of Drug A. Kydonieus Florida, CRC Press (1987)

5	Transdermal Controlled System Medications Y. W. Chien, New York, Marcel Dekker (1987)
6	The Theory and Practice of Industrial Pharmacy, Lachman Bombay, K. M. Warghese Co. (1976)
7	Pharmaceutical Dosage Forms Vol. I & II, Liebermann, New York, Marcel Dekker (1996)
8	Drug Delivery Devices: Fundamentals and Applications, Tyle New York, Marcel Dekker (1988)

Course Outcomes (students will be able to….)		
CO1	Basic understanding of formulation technology	K2+P2
CO2	Prepare, evaluate and label Pharmacopoeial and non-Pharmacopoeial monophasic liquid oral formulations.	K4+P2
CO3	Prepare, evaluate and label Pharmacopoeial and non-Pharmacopoeial biphasic formulations.	K4+P2
CO4	Prepare, evaluate and label Pharmacopoeial and non-Pharmacopoeial semisolid formulations	K4+P2
CO5	Prepare, evaluate and label Pharmacopoeial and non-Pharmacopoeial suppository formulations	K4+P2
CO6	Propose unit operations in large scale manufacturing and type of container specific to product application.	K5+P2

K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating
P1 – Imitate, P2 – Manipulate, P3 – Perfect, P4 – Articulate, P5 – Embody

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	2	3	3	2	2	3	3
CO2	3	3	3	3	3	2	3	3	3	2	3	3
CO3	3	3	3	3	2	2	3	2	3	2	3	3
CO4	3	3	3	3	3	2	3	2	3	2	3	3
CO5	3	3	3	2	2	2	3	3	2	2	3	3
CO6	2	2	3	2	2	3	2	2	3	2	2	3

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	2	3	3	2
CO3	3	3	3	3	2
CO4	3	3	3	3	3
CO5	3	3	3	3	3
CO6	2	2	3	2	2

PCC	**Course Code: PHP1420**	**Course Title: Pr-2: Pharmaceutical Biochemistry Analysis**	**Credits = 2**		
			L	**T**	**P**
	Semester: III	**Total Contact Hours: 60**	**0**	**0**	**4**

List of Prerequisite Courses
Physical and Analytical Chemistry(CHP1343), Organic Chemistry(CHT1407)Pharmaceutical analysis (PHT1416), Organic Chemistry
List of Courses where this course will be prerequisite

Medicinal Natural Products Laboratory(PHP1435), Biotechnology Laboratory(PHP1434), Analysis by Spectroscopy(PHT1438)		
Description of relevance of this course in the B. Tech. Program		
Course Contents (Topics and subtopics)		**Required Hours**
1	Qualitative and Quantitative tests for Carbohydrates Methods: DNS, Folin- Wu Method (Blood Sugar)	8
2	Qualitative and Quantitative tests for Amino acids, Proteins and Precipitation of proteins Methods: Folin Lowry Method, Biuret Method	8
3	Estimation of Cholesterol	4
4	Atomic Absorption Spectroscopy (Alkali earth metal determinations), DSC,TGA Demonstration	4
5	NMR, Mass Spectroscopy, GC-MS Demonstration	4
6	NMR, Mass Spectroscopy problem-solving from recorded spectra	4
7	Absorption Spectroscopy (UV/Visible)	4
8	Fluorescence spectroscopy (Quinine salt), Quenching phenomenon	4
9	Chromatography (Paper, Column and Thin-layer) application to reaction monitoring, purity assessment of drugs, separation of the mixtures	4
10	Medicaments in formulations**: Liquid oral, tablet, injectable, aerosol, capsule, ointment, eye drops, suppositories, lozenges, etc. (one each)	4
11	Multicomponent analysis of drugs in combination**. e.g., Using Simultaneous equation method, Isoabsorption point method, Solvent extraction method, Colorimetric and UV methods	8
	Total	**60**
List of Textbooks/ Reference Books		
1	Latest edition of Indian Pharmacopoeia	
2	Latest edition of British Pharmacopoeia	
3	Latest edition of United States Pharmacopoeia	
Course Outcomes (students will be able to….)		
CO1	Prepare samples for analysis from bulk sample	K3+P2
CO2	Apply chromatographical concepts for separation of complex mixture	K4+P2
CO3	Evaluate the components of a complex mixtures using spectroscopic and spectrometric techniques	K5+P2
CO4	Apply various analytical techniques for qualitative and quantitative analyses.	K4+P2
CO5	Applying the Spectroscopic methods	K3+P2
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating P1 – Imitate, P2 – Manipulate, P3 – Perfect, P4 – Articulate, P5 – Embody		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	3	3	3	3	3	3	2
CO2	3	3	1	2	1	3	1	3	3	3	1	2
CO3	3	1	2	2	2	2	3	2	3	3	3	2
CO4	3	3	2	0	2	3	3	3	3	2	3	0
CO5	3	3	2	2	2	3	3	3	3	3	3	2

Mapping of Course Outcomes (Cos) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	1	3
CO2	1	2	1	3	3
CO3	3	2	2	1	3
CO4	1	2	1	3	3
CO5	2	2	3	3	3

SECOND YEAR: SEMESTER – IV

PCC	Course Code: CET1105	Course Title: Transport Phenomena	Credits = 4		
			L	T	P
	Semester: IV	Total Contact Hours: 60	3	1	0

List of Prerequisite Courses
Applied Physics(PYT1205), Engineering Mathematics(MAT1301), Process Calculations (CEP1720)
List of Courses where this course will be prerequisite
This is a basic course required in special subjects that deal with flow of fluids, heat and mass transfer, etc.
Description of relevance of this course in the B. Tech. Program
This basic course introduces concepts of momentum, heat and mass transfer to students. Various other concepts such as pressure, momentum, energy are introduced as well. Laws related to conservation of momentum, energy, mass are taught. Applications of these laws to various engineering and technological situations and process equipment's are explained with the help of several problems

	Course Contents (Topics and subtopics)	Required Hours
1	Fluid Statics and applications to engineering importance.	4
2	Applications of Bernoulli's Equation, Pressure drop in pipes and Fittings,meters, and fluid moving machinery such as pumps.	10
3	Particle Dynamics, Flow through Fixed and Fluidized Beds	4
4	Equations of Continuity and Motion in laminar flows and its applicationsfor simple Couette flow and Poiseuille flow applications	6
5	Heat conduction. Convective heat transfer and concept of heat transfercoefficient.	4
6	Design and constructional aspects of exchangers: Types of flows: Concurrent, counter-current and cross flows, log mean temperature difference, double pipe and Shell and tube heat exchangers. Introduction to other heat exchangers like, PHE, finned tube heat exchangers, graphite block, etc.	10
7	Heat transfer aspects in agitated tanks, condensers, reboilers and evaporators.	6
8	Fundamentals of mass transfer: Molecular diffusion in fluids, concept ofmass transfer coefficients, and interface mass transfer.	4
9	Theories of Mass transfer, Analogies for heat and mass transfer, Empirical correlations	4
10	Mass transfer applications in simple 1-D situations.	8
	Total	**60**

List of Textbooks/ Reference Books	
1	Transport Phenomena, Bird R.B., Stewart W.E., Lightfoot E.N.
2	Fluid Mechanics, Kundu Pijush K.
3	Fluid Mechanics, F. W. White
4	Unit Operations of Chemical Engineering, McCabe, Smith

Course Outcomes (students will be able to….)		
CO1	Students should be able to calculate friction factor, pressure drop, power requirements of singe phase flow in a circular pipe	K2
CO2	Students will be able to select appropriate pump based on flow and head requirements	K3
CO3	Students should be able to calculate heat transfer coefficients and do basic sizing of double pipe and shell and tube heat exchangers	K3
CO4	Students should be able to perform preliminary sizing of phase change equipment such as reboilers and condensers	K3
CO5	Students should be able to calculate mass transfer coefficients and estimate mass transfer rates in simple situations	K3
CO6	Students should be able to understand empirical correlations and solve various equations analytically or numerically	K4
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	2	1	1	1	1	1	1	3
CO2	3	3	2	3	2	1	2	1	1	1	1	3
CO3	3	3	3	3	3	1	2	2	2	1	1	3
CO4	3	3	3	3	3	1	1	1	2	1	1	3
CO5	3	3	2	3	2	1	1	1	1	1	1	3
CO6	3	3	2	3	3	1	1	1	1	1	1	3

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	3
CO2	3	3	3	1	3
CO3	2	3	3	3	3
CO4	3	3	2	3	2
CO5	3	2	1	2	1
CO6	3	3	1	2	2

PCC	Course Code: PHT 1421	Course Title: SPL5: Medicinal Chemistry	Credits = 3		
			L	T	P
	Semester: IV	Total Contact Hours: 45	2	1	0
List of Prerequisite Courses					
Organic Chemistry(CHT1407)					
List of Courses where this course will be prerequisite					
Pharmaceutical Chemistry-I(PHT1432), Pharmaceutical Chemistry-II(PHT1437) and Pharmaceutical Chemistry-II(PHT1446)					
Description of relevance of this course in the B. Tech. Program					

The course is designed to acquaint the students with general principles of Medicinal Chemistry and drug discovery of small molecules.		
Course Contents (Topics and subtopics)		**Required Hours**
1	**A General Introduction to Medicinal Chemistry:**	1
	Historical perspective, significance of medicinal chemistry - Last 150 years serendipity, natural products in drug discovery	2
	Classification of Drugs: Classification of drugs based on: Therapeutic classes, Drug targets, Mechanism of action, Chemistry, etc. Nomenclature of Drugs	4
2	**Physicochemical Properties and Drug Metabolism:**	
	Passage of molecule through biological barriers: membrane transport (paracellular, transcellular) ,drug ionization, pKa, acids and bases used for salt formation, physicochemical properties, log P and log D	5
	Drug absorption: drug dosage form, gastric emptying, gastric permeability to drug, first pass effect	2
	Drug distribution: drug-plasma binding, blood brain barrier, drug accumulation in tissues	3
	Drug Elimination: a) drug excretion b) drug biotransformation c) Biotransformation reactions: functionalization, conjugation reactions, reactions leading to toxic metabolite	7
	Prodrugs: concept of prodrugs, examples and applications, carrier prodrugs, bioprecursor prodrugs	2
	Drug Toxicity	3
	Strategies for enhancing oral bioavailability and brain penetration: Physicochemical properties, metabolic stability, structural rigidity	2
3	**Molecular targets (examples from current targets to be used)**	
	General Aspects: drug targets, concepts of drug binding, affinity, selectivity a) Types of bonds in ligand receptor interactions, role of functional groups b) Types drug-target interaction: competitive, uncompetitive, allosteric interactions c) Concept of drug targets	4
	Enzymes as Drug Targets: a) definitions and concepts-enzyme, apoenzyme,holoenzyme, coenzyme b) targeting human enzymes in physiological conditions c) targeting enzymes selective to pathogens	5
	Receptors as Drug Targets: d) Types and properties of receptors: GPCRs, Ligand gated ion channels, nuclear receptors, voltage gated ion channels, receptors with intrinsic, enzyme activity, receptors coupled to cytosolic proteins e) Cellular responses to ligand-receptor interactions	5
	Total	**45**
List of Textbooks/ Reference Books		
1	Lemke, T. L., Zito, S. W., Roche, V. F., Williams, D. A. Essentials of Foye's Principles of Medicinal Chemistry; Wolters Kluwer (2017)	
2	Silverman, R. B., Holladay, M. W. The Organic Chemistry of Drug Design and Drug Action; 3rd ed.; Elsevier (2014)	
3	Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry; Beale, J. M., Jr., Block, J. H., Eds.; 12th ed.; Wolters Kluwer (2011)	
4	Burger's Medicinal Chemistry & Drug Discovery, Vol. 1- 6; Abraham, D. J., Ed.; 6th ed.; John Wiley & Sons - New Jersey (2003)	
Course Outcomes (students will be able to….)		
CO1	Understand the broad area of Medicinal Chemistry	K2
CO2	Correlate physicochemical properties to absorption and distribution of drugs	K4
CO3	Predict metabolism of drugs and understand causes of toxicity	K5

CO4	Visualize interaction of drugs with targets at a molecular level	K4
CO5	Classify different drug targets	K5
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	1	2	2	2	2	2	0	2
CO2	2	3	3	2	3	2	2	2	2	2	0	1
CO3	2	2	3	3	3	1	2	1	2	2	0	1
CO4	2	2	2	3	3	1	1	1	2	2	0	1
CO5	3	3	2	1	1	1	1	1	2	2	0	1

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	1	3	3	2
CO2	2	2	3	2	1
CO3	2	1	3	3	2
CO4	2	1	3	2	1
CO5	2	2	3	3	1

PCC	**Course Code:** **PHT1422**	**Course Title:** **SPL6: Physiology and Pharmacology**	**Credits = 3**		
			L	**T**	**P**
	Semester: IV	**Total Contact Hours: 45**	**2**	**1**	**0**

List of Prerequisite Courses

Standard XII Science

List of Courses where this course will be prerequisite

Medicinal Chemistry (PHT1421), Pharmaceutical Chemistry-I (PHT1432), Pharmaceutical Chemistry-II (PHT1437), Pharmaceutical Formulation Technology-II (PHT1424) and Pharmaceutical Formulation Technology-II (PHT1436)

Description of relevance of this course in the B. Tech. Program

Students will understand human Anatomy and Physiology, the common disorders and their pathophysiology, the drug categories, principles of Pharmacology and their applications to Medicinal Chemistry and Pharmaceutical Technology

Course Contents (Topics and subtopics)		**Required Hours**
1	**Introduction to Human Body**, Organization of human body, Different systems of human body	2
2	**Composition and Functions** of blood, lymph, immunity	3
3	**General Pharmacology** (**A**bsorption **D**istribution, **M**etabolism **E**xcretion (ADME), routes of administration, Mechanism of Action)	3
4	**Drugs acting on Blood:** Hematinics, Thrombolytics, Coagulants/ Anticoagulants	2
5	**Structure and Function of Kidney**, Drugs acting on Kidneys: Diuretics	3
6	**Respiratory System:** Anatomy and Physiology	1
7	**Central Nervous System (CNS):** Anatomy and Physiology, Neurotransmission	4
8	**Drugs acting on CNS:** Sedatives, Hypnotics, Psychopharmacological agents,	6

	Antiepileptics, Anaesthetics, Nootropics, CNS stimulants	
9	**Autonomic Nervous System** (ANS: Anatomy and Physiology, Adrenergic (Sympathetic) and Cholinergic (Parasympathetic) Systems	2
10	**Drugs acting on ANS:** Cholinergic agents, Anticholinergic agents, Adrenergics, Adrenergic blockers, Neuromuscular blockers	5
11	**Drugs acting on Metabolic Disorders:** Antidiabetics, Antihypertensives	2
12	**Analgesics** (Narcotics/Non-narcotics)	2
13	**Miscellaneous:** Local anesthetics, Antihistaminic drugs	3
14	**Chemotherapeutic Agents:** Synthetic, Semisynthetic and Natural Antimicrobial agents, Antiparasitic Agents	4
15	**Anticancer Agents**	3
	Total	**45**
List of Textbooks/ Reference Books		
1	Elements of Pharmacology R. K. Goyal, Ahmedabad, India.	
2	Pharmacology H. P. Rang, M. M. Dale, J. M. Ritter	
3	Ross and Wilson's Anatomy and Physiology in Health and Illness Anne Waugh and Allison Grant 10th edition, 2006 Churchill Livingstone, London	
4	Elements of Pharmacology R. K. Goyal, Ahmedabad, India.	
5	Pharmacology H. P. Rang, M. M. Dale, J. M. Ritter	
Course Outcomes (students will be able to….)		
CO1	Understand the organization, placement, structures and functioning of human body as whole.	K2
CO2	Understand the anatomy and physiology of systems namely respiratory, urinary, with the disorders affecting the systems	K3
CO3	Understand different drug categories with respect to their mechanism of action on body systems/organs.	K3
CO4	Understand and apply general principles of Pharmacology including pharmacokinetics and Pharmacodynamics to drug action	K4
CO5	Study various synthetic, semisynthetic and natural antimicrobial and anticancer agents.	K4
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	3	3	3	3	3	3	2
CO2	3	2	2	3	2	3	3	3	2	3	2	2
CO3	3	2	1	2	1	2	2	2	3	3	3	1
CO4	3	3	2	2	2	3	3	3	2	2	2	2
CO5	3	2	2	3	2	3	3	3	2	3	3	2

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	1
CO2	3	3	2	2	1
CO3	3	3	2	3	1
CO4	3	3	2	3	1
CO5	3	2	2	3	2

EEM	Course Code: CET1805	Course Title: Chemical Process Economics	Credits = 2		
			L	T	P
	Semester: IV	Total contact hours: 30	1	1	0
List of Prerequisite Courses					
Process Calculations(CEP1720), Basics of Economics and Finance(HUT1205)					
List of Courses where this course will be prerequisite					
Project-I PHP1444, Process Technology of Drugs and Intermediates (PHP1447) and Project-II(PHP1449)					
Description of relevance of this course in the B. Tech. Program					
This course is required for the future professional career.					

	Course Contents (Topics and subtopics)	Required Hours
1	Estimation of Plant and Machinery cost, Capacity Index, Cost Indices	8
2	Relationship between price of a product and project cost and cost of production, EV Analysis. Elements of cost of production, monitoring of the same in a plant, Meaning of Administrative expenses, sales expenses etc. Introduction to various components of project cost and their estimation. Project financing, debt: equity ratio, promoters, contributors, shareholders R	8
3	Project financing, debt: equity ratio, promoters, contributors, shareholders contribution, source of finance, time value of money. Concept of interest, time value of money, selection of various alternative equipment or system based on this concept. Indian norms, EMI calculations. Depreciation concept, Indian norms and their utility in estimate of working results of project. Working capital concept and its relevance to project.	8
4	Estimate of working results of proposed project. Capacity utilization, Gross profit, operating profit, profit before tax, Corporate tax, dividend, Net cash accruals. Project evaluation: Cumulative cash flow analysis Break-Even analysis, incremental analysis, various ratios analysis, Discounted cash flow analysis	6
5	Estimation of Plant and Machinery cost, Capacity Index, Cost Indices	8
	Total	**30**

List of Textbooks/ Reference Books	
1	Chemical Project Economics, MahajaniV.V.and Mokashi SM.
2	Plant Design and Economics for Chemical Engineers, Peters M.S.,TimmerhausK.D.
3	Process Plant and Equipment Cost Estimation, Kharbanda O.P.

Course Outcomes (students will be able to….)		
CO1	Calculate working capital requirement for a given project	K3
CO2	Calculate cost of equipment used in a plant total project cost	K3
CO3	Calculate cash-flow from a given project	K3
CO4	Select a site for the project from given alternatives	K4
CO5	List out various milestones related to project concept to commissioning	K2
CO6	Calculate overall profitability and rate of return for a given project	K5
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	2	2	1	2	2	3	1	3	3
CO2	3	3	1	2	2	1	2	1	3	1	3	3
CO3	3	3	2	3	2	1	2	2	1	1	3	3
CO4	3	3	3	2	2	2	3	1	1	1	3	3
CO5	3	3	2	2	1	1	1	2	3	1	3	3
CO6	3	3	2	3	3	2	2	1	3	1	3	3

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	1	2	2	3
CO2	2	1	2	1	3
CO3	2	1	2	2	1
CO4	2	2	3	1	1
CO5	1	1	1	2	3
CO6	2	1	2	2	3

VEC	**Course Code:** **HUT1206**	**Course Title:** **Environmental Science and Technology**	**Credits =2**		
			L	**T**	**P**
	Semester: IV	**Total Contact Hours: 30**	**1**	**1**	**0**

List of Prerequisite Courses

Pharmaceutical Green Chemistry(PHT1418)

List of Courses where this course will be prerequisite

Project-II(PHP1449)

Description of relevance of this course in the B. Tech. Program

The course is very useful for the future Chemical Engineers and Technologists for assessing and appreciating impact of chemical processes and technologies on the Environment. The students will be exposed to the nitty-gritties of the impact of design principles on the Environment. Thorough understanding of these technology aspects is going to help in innovative solutions with positive impact on the environment.

	Course Contents (Topics and subtopics)	**Required Hours**
1	Introduction to all prevailing international standards of Health, Safety, and Environment (HSE); Environmental laws and regulations; Standards (air quality, noise, water), ISO14000+	2
2	Environmental impact assessment, Life cycle assessment (LCA)	2
3	Pollution prevention in chemical manufacturing, effluent valorization	2
4	Air pollution; Air pollutants: sources (specific pollutants), effects, and dispersion modelling, air pollution, air quality, pollutants minimisation and control, fugitive emissions (source and control), Noise pollution	3
5	Wastewater treatment; Groundwater and surface water pollution, removal of specific water contaminants; Solid waste; Hazardous waste	3
6	Inherent safety; Major disasters (e.g. Flixborough, UK; Bhopal, India; Seveso, Italy; Pasadena, Texas; Texas City, Texas; Jacksonville, Florida; Port Wentworth, Georgia)	2

7	Toxicology; Industrial hygiene	2
8	Source models; Toxic release and dispersion models	3
9	Fires and explosions; Concepts to prevent fires and explosions	3
10	Chemical reactivity	2
11	Reliefs and reliefs sizing; Hazard identification; Risk assessment	2
12	Safety procedures and designs	2
13	Some case histories	2
	Total	**30**
List of Textbooks/ Reference Books		
1	Environmental Studies by R. Rajagopalan, Oxford University Press.	
2	Essentials of Environmental Studies by Kurian Joseph & Nagendran, Pearson	
3	Education Renewable Energy by Godfrey Boyle, Oxford Publications	
4	Perspective of Environmental Studies, by Kaushik and Kaushik, New Age	
5	International Environmental Studies by. Anandita Basak, Pearson Education	
6	Textbook of Environmental Studies by Dave and Katewa, Cengage Learning	
7	Environmental Studies by Benny Joseph, Tata McGraw Hill	
8	Textbook of Environmental studies by Erach Books Bharucha, University Press.	
Course Outcomes (students will be able to….)		
CO1	Calculate BOD / COD for a given composition of effluent stream, estimation of biokinetics.	K3
CO2	Calculate adiabatic lapse rate and determine conditions for suitability of atmospheric dispersion, effective stack height, chimney design.	K3
CO3	Calculate concentrative of pollutant at any point in the neighborhoods of emission given atmospheric conditions like wind, dispersion, environmental factors, etc.	K3
CO4	Calculate size/time/power required for primary clarifier, secondary treatment, tertiary treatment, sizing of different types of Biological treatments etc.	K3
CO5	Identify hazards in a given process and assess the same and provide solutions for operating safely.	K4
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	2	2	2	3	2	2	3	2	2
CO2	1	3	2	2	1	1	3	3	2	3	2	1
CO3	2	3	1	2	2	2	1	3	2	1	2	2
CO4	2	1	2	2	2	2	3	3	1	3	1	2
CO5	1	3	2	3	2	1	3	3	2	3	3	2

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	2	1	2
CO2	2	2	1	3	2
CO3	3	2	2	3	1
CO4	2	2	2	1	3
CO5	2	2	3	3	2

CEP/FP	Course Code: XXXXXXX	Course Title: Community Engagement Projects	Credits = 2		
			L	T	P
	Semester: IV	Total Contact Hours: 60	0	0	4

List of Prerequisite Courses
NIL

List of Courses where this course will be prerequisite
NIL

Description of relevance of this course in the B. Tech. Program
Students will explore the various community projects as individual or group related to study of societal technological activities through various organizations.

	Course Contents (Topics and subtopics)	Required Hours
1	Chemical Technology have the main objective of making the knowledge useful for the benefit of society. In the first step, students, individually or in a group not more than 5, shall identify the problems faced by the society in their neighborhood or city, or the state. They shall collect necessary data, collate relevant information and identify a problem that can be solved using the knowledge of own field or general sciences and propose an affordable solution. The team shall then execute the project with support from Institute, Local Society groups, NGOs, Industry. OR Community service: Helping students in studies, Making colorful charts, short notes, providing coloring books and colors , Activity games ,Teaching street children ,Helping in school assignments, Visiting old age homes and child care Centre etc.	60
	Total	**60**

List of Textbooks/ Reference Books	
1	General Books, Newspaper etc

Course Outcomes (students will be able to….)		
CO1	This course will help students to contribute of social networking as a bridge between the various government schemes and the people of India. The course also outlines the benefits of community engagement through research and innovation.	K2
CO2	Sensitivity towards the environment and education, safety and energy, enthusiasm towards physical, mental and spiritual health along with simple living and high thinking have been explained for better understanding of the students.	K2
CO3	Students will be able to understand the various problems of any community and the possible ways to address the same.	K3
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	2	1	1	2	1	1	2	1	2	2
CO2	1	1	2	1	1	2	1	1	2	1	2	2
CO3	1	1	2	1	1	2	1	1	2	1	2	2

SEC	Course Code: PHP1423	Course Title: Pr-3: Pharmaceutical Chemistry Laboratory-I	Credits = 2		
			L	T	P
	Semester: IV	Total Contact Hours: 60	0	0	4

List of Prerequisite Courses
Organic Chemistry and analytical Chemistry Laboratory (CHP1343)
List of Courses where this course will be prerequisite
Pharmaceutical Chemistry-II(PHT1427)
Description of relevance of this course in the B. Tech. Program
To train the students in standard laboratory practices with respect to safety, understand qualitative analysis of organic molecules.

	Course Contents (Topics and subtopics)	Required Hours
1	Preparation of commonly used simple organic compounds in pharmaceutical industry involving simple transformations(5 Examples)	20
2	Few examples of synthesis using green approaches	16
3	Application of synthetic methods reported in recent literature	12
4	Demonstration of Pharmaceutically importance equipment's	12
	Total	**60**

	List of Textbooks/ Reference Books
1	Arthur, Vogel. Textbook of practical organic chemistry, 5thedition, publishers Longman group Ltd. (1989)
2	Keese, R, Martin P. B, and Trevor P. Toube. Practical organic synthesis: a student's guide. John Wiley &Sons (2006)
3	J. Leonard, trvor P. Toube, B. Lygo, G Advanced Practical Organic Chemistry. Proctor, 2nd edition, Stanley Thornes (1990)

	Course Outcomes (students will be able to….)	
CO1	Understanding of basic chemistry in organic synthesis	K3+P2
CO2	Basic work safely in the organic chemistry laboratory.	K3+P2
CO3	Design and carry out experiments for simple organic transformations.	K4+P2
CO4	Understand and apply reaction mechanisms and their practical implications.	K4+P2
CO5	Understanding Principle of laboratory instruments	K2+P2
CO6	Implement techniques for synthetic reactions.	K5+P2

K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating
P1 – Imitate, P2 – Manipulate, P3 – Perfect, P4 – Articulate, P5 – Embody

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	2	3	3	3	3	3	3	2
CO2	3	3	2	3	2	3	3	1	3	3	3	3
CO3	2	3	3	1	3	3	3	3	3	2	2	1
CO4	3	3	3	3	3	1	3	3	3	1	3	3
CO5	2	3	3	1	2	3	3	1	2	3	3	1
CO6	2	2	2	2	2	2	2	2	2	2	2	2

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5

CO1	2	3	3	3	3
CO2	2	3	3	1	2
CO3	3	3	3	3	3
CO4	3	1	3	3	2
CO5	2	2	2	2	2
CO6	2	2	2	2	1

THIRD YEAR: SEMESTER-V

PCC	Course Code: CET1806	Course Title: Chemical Reaction Engineering	Credits = 2		
			L	T	P
	Semester: V	Total contact hours: 30	1	1	0

List of Prerequisite Courses
Physical Chemistry(CHT1405) , Process Calculations(CEP1720), Transport Phenomena(CET1105)
List of Courses where this course will be prerequisite
Chemical engineering laboratory(CEP1714), Project-I (PHP1444), Process Technology of Drugs and Intermediates (PHP1447) and Project-II(PHP1449)
Description of relevance of this course in the B. Tech. Program
Chemical Reaction Engineering is concerned with the utilization of chemical reactions on a commercial scale. This course is very relevant but not limited to the following industries: Inorganic chemicals, organic chemicals, petroleum & petrochemicals, Pulp & paper, Pigments & paints, rubber, plastics, synthetic fibers, Foods, Dyes and intermediates, Oils, oleochemicals, and surfactants, Minerals, clean sing agents, Polymers and textiles, Biochemical and biotechnology, pharmaceuticals and drugs, Microelectronics, energy from conventional and non-conventional resources, Metals.

	Course Contents (Topics and subtopics)	Required Hours
1	Kinetics of homogeneous reactions, Interpretation of batch reactor data, Single ideal reactors including design aspects	8
2	Multiple reactions, Temperature, and pressure effects	3
3	Introduction to Non ideal flow, RTD measurements, Models to predict conversions	2
4	Homogeneous and Heterogeneous Catalysis, Kinetics of Solid Catalyzed Reactions. Design of gas – solid catalytic reactors	8
5	Introduction to Multiphase reactors	4
6	Mass transfer with chemical Reactions: Regimes of operation and Model contactors	5
	Total	**30**

	List of Textbooks/ Reference Books
1	Elements of Chemical Reaction Engineering – H.Scott Fogler
2	Heterogeneous Reactions, Vol.I and II –L.K. Doraiswamy, M.M.Sharma

	Course Outcomes (students will be able to….)	
CO1	Estimate kinetics of chemical reaction based on laboratory data	K3
CO2	Derive design expressions for ideal reactor systems such as batch, plug flow and continuous stirred tank reactor	K3
CO3	Estimate conversion, yield and selectivity for different chemical reactions	K3
CO4	Compare various reactors and select an appropriate reactor for a given situation	K4

CO5	Select appropriate multiphase reactor based on reaction chemistry, heat and mass transfer aspects	K4
CO6	Identify rate controlling mechanism of a given reaction system involving mass transfer	K4
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	1	1	1	2	1	1	3
CO2	3	3	3	3	3	1	1	1	2	1	1	3
CO3	3	3	3	2	2	1	1	1	1	1	1	3
CO4	3	3	3	3	2	1	3	1	1	1	1	3
CO5	3	3	3	3	1	2	1	1	2	1	1	3
CO6	3	3	3	3	2	1	1	1	2	1	1	3

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	1	1	3
CO2	3	3	2	2	3
CO3	2	2	1	1	2
CO4	3	2	1	3	3
CO5	3	1	2	1	3
CO6	3	2	1	1	3

PCC	**Course Code: CET1807**	**Course Title: Chemical Engineering Operations**	**Credits =2**		
			L	**T**	**P**
	Semester: V	**Total contact hours: 30**	**1**	**1**	**0**
List of Prerequisite Courses					
Process Calculations(CEP1720), Transport Phenomena(CET1105)					
List of Courses where this course will be prerequisite					
Project-I (PHP1444), Process Technology of Drugs and Intermediates (PHP1447) and Project-II(PHP1449)					
Description of relevance of this course in the B. Tech. Program					
This is an applied Chem Engg. subject. The principles learnt in this course are required in this pharmaceutical technology courses and throughout the professional career of student					

Course Contents (Topics and subtopics)		**Required Hours**
1	**Distillation**: Fundamentals of flash, batch and continuous distillation, distillation columns internals, steam and azeotropic distillation	10
2	**Liquid-Liquid Extraction**: Solvent selection, construction of ternary diagrams, staged calculations, types of extraction equipment.	5
3	**Crystallization**: Phase diagram (temp/solubility relationship), evaporative and cooling crystallization, introduction to different types of crystallizers	5
4	**Filtration**: Mechanism of filtration, basic equation, constant volume, constant pressure filtration, rate expressions with cake and filter cloth resistances, compressible and incompressible cakes, introduction to various types of filters	5

5	**Drying**: Drying mechanism, drying rate curves, estimation of drying time and types of dryers	5
	Total	**30**
List of Textbooks/ Reference Books		
1	Richardson, J.F., Coulson, J.M., Harker, J.H., Backhurst, J.R., 2002. Chemical engineering: Particle technology and separation processes. Butterworth-Heinemann, Woburn, MA.	
2	Seader, J.D., Henley, E.J., 2005. Separation Process Principles, 2 ed. Wiley, Hoboken, N.J.	
3	Svarovsky, L., 2000. Solid-Liquid Separation. Butterworth-Heinemann, Woburn, MA.	
4	McCabe, W., Smith, J., Harriott, P., 2004. Unit Operations of Chemical Engineering, 7 ed. McGraw-Hill Science/Engineering/Math, Boston.	
5	Green, D., Perry, R., 2007. Perry's Chemical Engineers' Handbook, Eighth Edition, 8 ed. McGraw-Hill Professional, Edinburgh.	
6	Dutta, B.K., 2007. Principles of Mass Transfer and Separation Process. Prentice-Hall of India Pvt. Ltd, New Delhi.	
Course Outcomes (students will be able to….)		
CO1	Understand and compare various unit operations used in the chemical and allied industries	K3
CO2	Perform preliminary sizing of continuous and batch distillation columns	K3
CO3	Analyze filtration data and select systems based on requirements, estimate filtration area for given requirements, understand filter aids and their usage	K4
CO4	Construct ternary equilibrium diagram based on laboratory scale experimental data	K3
CO5	Understand the working principle of various industrial extraction, crystallization, filtration and drying equipment	K2
CO6	Select and carry out preliminary sizing of various industrial extraction, crystallization, filtration and drying equipment	K3
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	2	1	1	1	1	2	1	1	3
CO2	3	2	3	3	2	2	1	2	2	1	1	3
CO3	3	3	3	2	2	1	1	2	2	1	1	3
CO4	3	3	2	2	3	1	1	2	2	1	1	3
CO5	3	2	2	2	1	1	1	1	2	1	1	3
CO6	3	3	2	2	3	2	2	2	2	1	1	3

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	3
CO2	3	2	2	1	3
CO3	2	2	3	2	2
CO4	2	2	1	1	2
CO5	2	2	3	2	2
CO6	3	3	2	2	3

PCC	**Course Code:** **PHT1424**	**Course Title:** **SPL7: Pharmaceutical Formulation Technology -II**	**Credits=4**		
			L	**T**	**P**

	Semester: V	Total contact hours: 60	3	1	0
List of Prerequisite Courses					
Pharmaceutical Formulation Technology-I (PHT1417), Pharmaceutical Formulation Technology Laboratory-I (PHP1419)					
List of Courses where this course will be prerequisite					
Pharmaceutical Formulation Technology-III (PHT1436)Validation and Regulatory Requirements(PHT1430), Pharmaceutical Formulation Technology Laboratory -III(PHP1445)					
Description of relevance of this course in the B. Tech. Program					
The course is designed to train the students with respect to basics and application of Technology of Solid Dosage Forms and introduce novel drug delivery systems					

	Course Contents (Topics and subtopics)	Required Hours
1	**Tablets Introduction** • Introduction to tablet dosage form, rationale, advantages and limitations • Preformulation considerations for tablet dosage form • Granulation techniques, Direct compression	5
2	**Excipients in Tablets**	3
3	**Tablets Formulation** • Unit operations, tablet punching: physics of tablet punching, single punch and rotary tablet press, tablet tooling • Quality control of tablets	5
4	**Types of Tablets**	5
5	**Problems in Tableting**	2
6	**Large-scale Manufacturing**, packaging and layout design for tablets	5
7	**Tablet Coating:** • Introduction to tablet coating: rationale, advantages etc. • Pre-formulation considerations for tablet coating • Types of coating • Quality control of coated tablets • Large scale manufacture and packaging with focus on equipment • Layout design and Unit operations	5
8	**Capsules:** • Introduction to capsule dosage form: rationale, advantages etc. • Pre-formulation considerations for capsule dosage form • Hard gelatin capsules: formulation considerations, capsule manufacture equipment's, quality control tests, packaging, Large-scale manufacture, layout design • Soft gelatin capsules: formulation considerations, capsule filling equipment's, quality control tests, packaging, Large scale manufacture, layout design • Large scale manufacture and packaging with focus on equipment • Layout design and Unit operations	5
9	**Microencapsulation:** • Fabrication techniques • Evaluation • Large scale manufacture and packaging with focus on equipment	5
10	**Oral Sustained-release and Controlled-release Formulations** • Principles and dose calculations • Pre-formulation • Formulation of matrix and reservoir type systems • Liquid oral sustained release formulations	5
11	**Quality Control**, large scale manufacture and layout design of oral sustained release formulations	5
12	**Novel Drug Delivery Systems** • Introduction to Transdermal and Transmucosal (buccal, sublingual, nasal, vaginal, rectal) drug delivery systems	5

13	**Overview of Cosmetic Products** • Definition of cosmetics; historical background, classification of cosmetics and primary functions • Brief overview of types of cosmetics [Skin care, haircare, nail care, eye care, dental products] • Formulation • Large scale manufacture and packaging with focus on equipment • Layout design and Unit operation	5
	Total	**60**
List of Textbooks/ Reference Books		
1	Therapeutic Systems: Pattern-Specific Drug Delivery, Heilmann, Struttgart, G. Thiense Pub. (1978)	
2	Encyclopedia of Pharmaceutical Technology, J. Swarbrick, New York, Marcel Dekker (1993)	
3	Remington's Pharmaceutical Sciences, A. R. Gennaro Mac Pub. Co. Easton, Pennsylvania (1990)	
4	Indian Pharmacopoeia, British Pharmacopoeia, United States Pharmacopoeia.	
5	Theory & Practice of Industrial Pharmacy. L. Lachman, Herbert A. Lieberman& J. Kanig, Lea & Febiger, Philadelphia (1987)	
6	Pharmaceutical Dosage Form: Dispersed Systems (Vol.1 & 2) Herber A. Lieberman, Martin A. Rieger, G. S. Ban, Marcel Dekker Inc. (1993)	
7	Modern Pharmaceutics. Gilbert S.Banker, C.T. Rhodes, Marcel Dekker Inc. (1990)	
8	Pharmaceutical Dosage forms: Parenteral Medications in Three volumes, Kenneth E. Avis, Herbert A. Lieberman, Leon Lachman, Marcel Dekker Inc. (1993)	
Course Outcomes (students will be able to….)		
CO1	Describe pre-formulation, formulation, unit operation, large-scale manufacturing, and layout design of tablets.	K3
CO2	Explain the coating polymers, technology and equipment's used for coating of tablets and describe microencapsulation techniques.	K4
CO3	Apply principles of dosage form design and evaluation for various solid oral dosage forms.	K5
CO4	Design and evaluate the novel drug delivery systems.	K4
CO5	Applying and Analyzing of concept of cosmetic product formulation	K4
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	3	2	3	2	2	2	3	2	1	2
CO2	3	3	2	1	2	3	1	3	1	2	1	2
CO3	3	2	2	1	3	2	1	3	1	1	1	2
CO4	3	2	1	3	3	1	3	1	2	1	1	1
CO5	3	1	3	1	2	1	3	1	3	1	2	1

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	1	3	1
CO2	2	3	2	3	2
CO3	3	3	1	2	2
CO4	3	2	2	3	1
CO5	3	1	3	1	2

PCC	**Course Code:**	**Course Title:**	**Credits = 2**

	PHP1427	Pr-4: Pharmaceutical Chemistry Laboratory-II	L	T	P
	Semester: V	Total Contact Hours: 60	0	0	4

List of Prerequisite Courses

Organic Chemistry Laboratory(CHP1132), Pharmaceutical Chemistry Laboratory-I(PHP1423)

List of Courses where this course will be prerequisite

Project-II(PHP1449), Process Technology Laboratory(PHP1450)

Description of relevance of this course in the B. Tech. Program

To train the students in standard laboratory practices with respect to safety, understand qualitative analysis of organic molecules.

	Course Contents (Topics and subtopics)	Required Hours
1	Techniques in organic synthesis	8
2	Esterification	4
3	Hydrolysis	4
4	Amide formation (acetylation, benzoylation)	4
5	Diazotization and coupling	4
6	Bromination	4
7	Nitration and Sulfonation in aromatic rings	8
8	Simple oxidation and reduction reactions	8
9	Synthesis of Heterocycles (e.g., Hydantoin, Benzimidazole)	8
10	Aliphatic substitution reactions	4
11	Clasien/Aldol condensation	4
	Total	**60**

List of Textbooks/ Reference Books

1	Arthur, Vogel. Textbook of practical organic chemistry, 5thedition, publishers Longman group Ltd. (1989)
2	J. Leonard, trvor P. Toube, B. Lygo, G Advanced Practical Organic Chemistry. Proctor, 2nd edition, Stanley Thornes (1990)
3	Keese, R, Martin P. B, and Trevor P. Toube. Practical organic synthesis: a student's guide. John Wiley &Sons (2006)

Course Outcomes (students will be able to….)

CO1	Work safely in the organic chemistry laboratory.	K4+P2
CO2	Implement techniques for synthetic reactions.	K5+P3
CO3	Design and carry out experiments for simple organic transformations	K5+P2
CO4	Understand and apply reaction mechanisms and their practical implications.	K3+P2
CO5	Analyzing of the synthetic process with respect to yield and quality.	K4+P3

K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating
P1 – Imitate, P2 – Manipulate, P3 – Perfect, P4 – Articulate, P5 – Embody

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	1	3	3	1	1	1	1	2
CO2	2	1	2	3	1	1	3	2	2	2	2	2
CO3	2	2	2	2	1	3	3	1	1	1	1	2
CO4	2	1	2	3	1	2	3	2	2	2	2	1
CO5	2	2	2	2	1	3	3	1	1	1	1	2

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)

	PSO1	PSO2	PSO3	PSO4	PSO5

CO1	2	2	2	2	2
CO2	2	1	1	1	2
CO3	2	1	2	1	2
CO4	2	1	1	2	2
CO5	2	1	2	1	2

PCC	Course Code: PHP1428	Course Title: Pr-5: Pharmaceutical Technology Laboratory-II	Credits = 2		
			L	T	P
	Semester: V	Total contact hours: 60	0	0	4

List of Prerequisite Courses

Pharmaceutical Formulation Technology-I (PHT1417) Pharmaceutical Technology Laboratory-I(PHP1419)

List of Courses where this course will be prerequisite

Pharmaceutical Technology Laboratory-III(PHP1436), Pharmaceutical Technology Laboratory-III(PHP1445)

Description of relevance of this course in the B. Tech. Program

The course is designed to impart necessary skills to budding technocrats in the major sections of Pharmaceutical Sciences and Technology, i.e., Chemistry and Formulation. In the Chemistry area, the students will practice Green Chemistry approaches while preparing the commonly used organic compounds in the Pharmaceutical Industry. In the Formulation area, the students will be trained on the formulation aspects of solid oral dosage forms, including sustained-release drug products.

	Course Contents (Topics and subtopics)	Required Hours
1	Preparation of organic compounds in common use in pharmaceutical industry involving simple transformations (5 X 4 Hrs)	20
2	Few examples of synthesis using green approaches	5
3	Application of synthetic methods reported in recent literature	5
	Formulation	
5	Representative examples of granules ready for compression (Preparation, packaging and evaluation)	4
6	Representative examples of tablets (Preparation, packaging and evaluation)	10
7	Representative examples and demonstration of tablet coating (Preparation, packaging and evaluation)	4
8	Representative examples of capsules (Preparation, packaging and evaluation)	4
9	Dissolution testing: Conventional marketed formulations (including Sustained-release formulations) representing- soluble drug, poorly soluble drug (selection of medium)	4
10	Representative examples of microencapsulation (Preparation, packaging and evaluation)	4
	Total	**60**

List of Textbooks/ Reference Books

1	Arthur, Vogel. Textbook of Practical Organic Chemistry, 5th edition, Longman Group Ltd. (1989)
2	Green Methods of Preparation published by Department of Science and Technology
3	Latest editions of Indian, British and United States Pharmacopoeia
4	Pharmaceutical Dosage Forms Vol. I & II, Liebermann, New York, Marcel Dekker (1996)
5	Drug Delivery Devices: Fundamentals and Applications, Tyle New York, Marcel Dekker (1988)
6	The Theory and Practice of Industrial Pharmacy, Lachman Bombay, K. M. Warghese Co. (1976)
7	Husa's Pharmaceutical Dispensing Martin E. W. Easton Mack Pub. Co. (1971)

Course Outcomes (students will be able to….)

CO1	Plan and develop organic synthetic routes for small organic compounds.	K4+P3
CO2	Develop a set of separation and purification and structural characterization skills.	K5+P3

CO3	Prepare, evaluate and label pharmacopoeial and non pharmacopoeial solid Oral dosage forms.	K5+P3
CO4	Perform dissolution testing for conventional and non-conventional solid oral dosage forms.	K4+P3
CO5	Understanding and evaluation of microencapsulation	K5+P3
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating P1 – Imitate, P2 – Manipulate, P3 – Perfect, P4 – Articulate, P5 – Embody		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	3	3	1	2	1	2	3	2	3	2
CO2	1	2	3	2	2	3	2	1	3	1	3	1
CO3	2	3	2	2	1	1	1	2	3	2	3	2
CO4	2	1	2	3	2	2	2	2	3	2	3	1
CO5	2	2	1	2	2	1	2	2	1	2	2	2

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	3	2	2
CO2	3	2	3	1	1
CO3	2	3	3	2	2
CO4	3	1	3	1	3
CO5	2	2	1	2	2

THIRD YEAR: SEMISTER-VI

PCC	Course Code: PHT1429	Course Title: SPL9: Pharmaceutical Biotechnology	Credits = 3		
			L	T	P
	Semester: VI	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

XII Science, Industrial Chemistry (CHT1408) Introduction to Technology of Pharmaceuticals and Fine Chemicals(PHT1415), Physiology and Pharmacology(PHT1422)

List of Courses where this course will be prerequisite

Molecular Biology(PHT1458)

Description of relevance of this course in the B. Tech. Program

To familiarize students with areas of biotechnology and their application in healthcare, with techniques in biotechnology involving natural, enriched and engineered microorganisms, or their components or plant/mammalian cells for production of pharmaceutically relevant compounds of industrial importance and about the structural features and functions of immune system components and their involvement in development of immune response, the use of immunological techniques as analytical tools and he principles governing vaccination

	Course Contents (Topics and subtopics)	Required Hours
1	**Introduction to Pharmaceutical Biotechnology** and its role in healthcare and diagnostics	6
2	**Fermentation Technology:**	12

	Introduction to fermentation Types of fermentation, microorganisms in fermentation, strain improvement, Fermenters and types; Stages of fermentation; typical fermentation types – batch, continuous, fed-batch; factors affecting fermentation, Typical fermenter designs and explanation of design characteristics. Examples of industrial products	
3	**Enzyme Fermentation and Immobilization**	3
4	**Basics of Immunology** Immune system, humoral and cell mediated immunity Antibodies, antigen-antibody reactions Active and Passive immunity	16
5	**Plant and Animal Tissue Culture** Techniques and applications	6
6	**Pharmacogenomics**	2
	Total	**45**
List of Textbooks/ Reference Books		
1	PK Gupta, Elements of biotechnology, 2nd ed, Rastogi Publications (2015)	
2	Owen JA, Punt J, Stranford SA. Kuby immunology. New York: WH Freeman (2013)	
3	Gamborg, Oluf L., and Gregory C. Phillips. "Laboratory facilities, operation, and management." In Plant Cell, Tissue and Organ Culture, pp. 3-20. Springer Berlin Heidelberg, (1995)	
4	Walsh, Gary. Pharmaceutical biotechnology: concepts and applications. John Wiley & Sons, (2007)	
5	Stanbury, Peter F., Allan Whitaker, and Stephen J. Hall. Principles of fermentation technology. Elsevier (2013)	
Course Outcomes (students will be able to….)		
CO1	Explain and utilize various concepts of biotechnology in academia and research in diagnostic, therapeutic and allied industrially relevant fields of molecular biology and biotechnology.	K3
CO2	Explicate and employ various concepts of fermentation and different fermentative strategies, based on natural, enriched and engineered microorganisms, or their components as well as design a simple containment system (Bioreactor/fermenter) for producing compounds of industrial importance.	K3
CO3	Explicate and exploit various components of immune system and mechanisms involved in immune system development and responsiveness as well as various immunological techniques to develop vaccines and vaccine formulations.	K3
CO4	Elucidate and apply common cell culture techniques, e.g. callus culture, micropropagation, embryogenesis in plants and in mammalian cells to produce compounds of industrial, specifically therapeutic importance.	K5
CO5	Explain how individual genetic variations affect responses to drug and formulations to be able to develop ‘personalized’ medicines	K4
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	3	2	2	3	3	2	2	2
CO2	3	3	3	3	3	3	3	3	3	2	3	3
CO3	2	2	3	3	3	3	3	3	2	2	2	3
CO4	3	3	3	3	3	2	3	3	3	2	3	3
CO5	2	2	3	3	3	2	3	3	2	2	2	3

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	2
CO2	3	3	3	1	1
CO3	3	3	3	2	1
CO4	3	3	3	3	2
CO5	3	2	1	1	2

PCC	Course Code: PHT1430	Course Title: SPL10: Validation and Regulatory Requirements	Credits = 3		
			L	T	P
	Semester: VI	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

Pharmaceutical Formulation Technology I(PHP1417), Pharmaceutical Formulation Technology II(PHP1424)

List of Courses where this course will be prerequisite

NIL

Description of relevance of this course in the B. Tech. Program

The course is designed to train the students in understanding the principles behind Good Manufacturing Practices (GMP), scientific and risk-based product development approaches, and validation and regulatory requirements for Pharmaceuticals.

	Course Contents (Topics and subtopics)	Required Hours
1	**Good Manufacturing Practices (GMP) and Facility Design** • GMP: Personnel, Facility, Environmental and manufacturing factors • Quality assurance • Quality audits	3
2	**Regulations governing Pharmaceutical Product Development:** New Drugs and Clinical Trial Rules, 2019	2
3	**Pilot Plant Scale-up:** • Introduction • Pilot Plant Scale-up Techniques – Group responsibilities, Facilities, General considerations • Case studies (solid, liquid, semisolid dosage forms)	5
4	**Quality by Design (QbD):** • QbD elements • Design of experiments • Examples of scaling up of Liquid, Solid oral formulations, Semisolids, Parenteral preparations using QbD approach	5
5	**Validation:** • Introduction to validation, process validation and scope • Priority order for pharmaceutical validation • Types of validation (prospective, retrospective. concurrent and revalidation) • Steps in validation • Case studies (solid, liquid, semisolid dosage forms)	5
6	Case Studies on validation of Processes, Equipment's and Products	5
7	**Documentation for Pharmaceuticals**	5
8	**Introduction to Regulatory Aspects of Pharmaceuticals** • Introduction to regulatory aspects of pharmaceuticals, need, advantages and limitations • Introduction to major regulatory bodies worldwide • Rationale for regulatory harmonization and introduction of ICH • Introduction to Common Technical Document (CTD) Modules	5

	• Comparison of Indian and European guidelines w.r.t. USFDA guidelines	
9	**Regulatory Procedures for Pharmaceutical Product Market Approval as per USFDA Guidelines:** Investigational New Drug (IND), New Drug Application (NDA) [505(b)(1) and (b)(2)], Abbreviated New Drug Application (ANDA) 505 (j) filing, Review and Approval process	5
10	**Legal Acts** • Drugs and Cosmetics Act, 1940 and Drugs and Cosmetics Rules, 1945 • Drug Price Control Order (DPCO)	5
	Total	**45**

List of Textbooks/ Reference Books	
1	Beotra's Law of Drugs Medicins and Cosmetics K. K. Singh, L. R. Bugga for the Law Book Co. Pvt. Ltd., Allahabad
2	Modern Pharmaceutics, G. S. Banker, New York, Marcel Dekker (1990)
3	Fundamentals of Pharmacy, Blome H. E., Philadelphia, Fea and Febiger (1985)
4	Pharmaceutical Production Facilities: Design and Applications, G. C. Cole, New York, Ellis, Horwood (1990)
5	Drug Delivery Devices: Fundamentals and Applications. Tyle, New York, Marcel Dekker (1988)
6	Microbial Quality Assurance in Pharmaceuticals Cosmetics and Toiletries, S. F. Bloomfield, Chichester, Ellis, Horwood (1998)
7	Encyclopedia of Pharmaceutical Technology, J. Swarbrick, New York, Marcel Dekker (1993)
8	Remington's Pharmaceutical Sciences, A. R. Gennaro Mac Pub. Co. Easton, Pennsylvania (1990)
9	Pharmaceutical Product Development: Insights into Pharmaceutical Processes, Management and Regulatory Affairs, Patravale V, Rustomjee M, Dsouza J., CRC Press (2016)
10	Latest Editions of Indian Pharmacopoeia (IP), British Pharmacopoeia (BP), United States Pharmacopoeia (USP), Japanese Pharmacopoeia (JP), European Pharmacopoeia (Ph. Eur.)
11	Oral Mucosal Drug Delivery, Rathbone, New York, Marcel Dekker (1996)
12	Good Laboratory Practice Regulations, A. F. Hirsch, New York, Marcel Dekker (1989)
13	Good Laboratory Practice Regulations, Weinberg, New York, Marcel Dekker (1995)

Course Outcomes (students will be able to….)		
CO1	Explain regulatory concepts such as QbD, GMP and many others.	K3
CO2	Comprehend product and process validation and documentation required for the same	K4
CO3	Analyze the regulatory pathways for new drug application and generic product development for various products.	K5
CO4	Comprehend relevant regulations and laws governing the pharmaceutical manufacturing.	K4
CO5	Exploring of the approval process and regulatory requirements for drug products	K5
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	3	3	3	3	3	2	2	2	2	2	3
CO2	3	3	3	3	3	1	1	1	2	2	3	3
CO3	2	3	3	3	3	2	2	2	2	2	3	3
CO4	2	3	3	3	3	2	2	3	2	2	3	3
CO5	3	1	2	3	1	1	3	1	2	3	2	1

Mapping of Course Outcomes (Cos) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5

CO1	3	3	3	3	3
CO2	3	2	3	3	3
CO3	3	2	3	3	3
CO4	3	3	3	3	3
CO5	2	3	1	3	2

PCC	**Course Code: PHT1432**	**Course Title: SPL12: Pharmaceutical Chemistry-I**	**Credits = 4**		
			L	**T**	**P**
	Semester: VI	**Total Contact Hours: 60**	**3**	**1**	**0**

List of Prerequisite Courses

Organic Chemistry (CHT1407), Medicinal Chemistry(PHP1421), Physiology and Pharmacology(PHT1422)

List of Courses where this course will be prerequisite

Pharmaceutical Chemistry-II(PHP1437), Drug synthesis approaches(PHT1439), Pharmaceutical chemistry-III(PHT1446)

Description of relevance of this course in the B. Tech. Program

To acquaint the students with Nomenclature, Classification, Molecular Mechanism of Action, Synthesis and Structure-Activity Relationship (SAR), New Drug Approvals, Drug Withdrawals, Marketed Formulations of the following therapeutic categories of drugs:

	Course Contents (Topics and subtopics)	**Required Hours**
	Part-I	
1	**Antibacterial Agents:** *Antibiotics:* Beta-lactam antibiotics including Penicillin's, Cephalosporins, Carbapenems, Monobactams Tetracyclincs and Glycylcyclins Marcolides and Ketolides Aminoglycosides Miscellaneous including Chloramphenicol, Vancomycin, Bacitracin and Newer Agents *Synthetic Antibacterial:* Sulfonamides and DHFR inhibitors, Quinolones, Oxazolidinediones and other miscellaneous agents	20
2	*Antiparasitic Agents:* Antiamoebics, Antimalarials, Anthelmintics Miscellaneous agents including drugs against Trypanosomiasis, Leishmaniasis, Scabies, Filariasis, Overview of DND*i*	8
3	*Antifungal Agents:* Azoles, Polyene antibiotics Miscellaneous agents including Allylamines, Tolnaftate, Griseofulvin, etc.	6
4	*Antimycobacterial Agents:* Antitubercular agents, Antileprotic agents, Drugs against *Mycobacterium avium complex* (MAC), Newer Antitubercular targets	6
5	*Anticancer Agents:* Alkylating agents, Nitrosoureas: Procarbazines, Triazines and miscellaneous. Organoplatinum agents Antibiotics, Antimetabolites including DNA polymerase inhibitors, Pyrimidine and purine antagonists and miscellaneous agents Mitosis inhibitors and Emerging Anticancer and Cancer Stem Cell (CSC) Inhibitors	10
6	*Antiviral Agents:*	10

	General aspects, Nucleic acid synthesis inhibitors Amantidine and its analogs, Interferons (IFNs) and its inducers Neuraminidase inhibitors Antiretroviral drugs including NRTI, NNRTI and protease inhibitors Drugs against Emerging Viral Infections, e.g., Coronaviruses	
	Total	**60**
List of Textbooks/ Reference Books		
1	Lemke, T. L., Zito, S. W., Roche, V. F., Williams, D. A. Essentials of Foye's Principles of Medicinal Chemistry; Wolters Kluwer (2017)	
2	Lemke, T. L., Williams, D. A., Roche, V. F., Zito, S. W. Foye's Principles of Medicinal Chemistry; 7th ed.; Wolters Kluwer (2013)	
3	Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry; Beale, J. M., Jr., Block, J. H., Eds.; 12th ed.; Wolters Kluwer (2011)	
4	Burger's Medicinal Chemistry & Drug Discovery, Vol. 1- 6; Abraham, D. J., Ed.; 6th ed.; John Wiley & Sons - New Jersey (2003)	
5	Kleeman, A., Engel, J., Kutscher, B., Reichert, D. Pharmaceutical Substances: Syntheses, Patents and Applications of the Most Relevant APIs; 5th ed.; Thieme Medical Publishers Inc. (2009)	
6	Lednicer, D. The Organic Chemistry of Drug Synthesis; Vol. 1 - 7); John Wiley & Sons, INC. (2008)	
7	Silverman, R. B., Holladay, M. W. The Organic Chemistry of Drug Design and Drug Action; 3rd ed.; Elsevier (2014)	
8	Warren, S., Wyatt, P. Organic Synthesis: The Disconnection Approach; 2nd ed.; Wiley; (2008)	
Course Outcomes (students will be able to….)		
CO1	Understand and appreciate the molecular design principles by studying Structure-Activity Relationship (SAR) and molecular mechanism of action.	K2
CO2	Follow the unmet medical need for newer agents for treating various infectious diseases such as COVID-19 and multidrug-resistant microbial infections.	K3
CO3	Understand the discovery and development of central nervous system drugs including those for neurodegenerative diseases.	K2
CO4	Study the synthetic approaches for various APIs and New Chemical Entities (NCEs).	K4
CO5	Understanding synthesis of drugs	K2
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	3	3	3	3	3	3	2
CO2	3	3	2	3	2	1	3	2	3	1	3	3
CO3	3	2	3	1	3	2	3	2	3	3	2	2
CO4	3	3	2	2	2	3	3	3	3	3	3	1
CO5	3	3	2	3	2	3	3	3	3	3	3	2

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	3	3	2	2
CO2	3	2	2	1	2
CO3	3	3	2	1	3
CO4	3	3	2	1	2

CO5	1	2	3	1	2

VESC	Course Code: CEP1714	Course Title: Chemical Engineering Laboratory	Credits = 2		
			L	T	P
	Semester: VI	Total contact hours: 60	0	0	4

List of Prerequisite Courses

Process Calculations(CEP1720), Transport Phenomena(CET1105), Chemical Reaction Engineering (CET1806) Chemical Engineering Operations(CET1807)

List of Courses where this course will be prerequisite

Chemical engineering laboratory(CEP1714), Project-I (PHP1444), Process Technology of Drugs and Intermediates (PHP1447) and Project-II(PHP1449)

Description of relevance of this course in the B. Tech. Program

Chemical Engineering lab provides technology students the firsthand experience of verifying various theoretical concepts learnt in theory courses. It also exposes them to practical versions of typical chemical engineering equipment's and servers as a bridge between theory and practice. This particular lab focuses on fluid dynamics, distillation, filtration, drying and sedimentation.

	Course Contents (Topics and subtopics)	Required Hours
1	4 - 6 Experiments on fluid dynamics and heat transfer	24
2	3 - 5 Experiments on Chemical Engineering Operations	16
3	2 – 4 Experiments on Reaction Engineering	12
4	1 – 3 Experiments on process dynamics and control	8
	Total	**60**

List of Textbooks/ Reference Books

1	McCabe W.L., Smith J.C., and Harriott P. Unit Operations in Chemical Engineering, 2014
2	Bird R.B., Stewart W.E., and Lightfoot, E.N. Transport Phenomena, 2007
3	Coulson J.M., Richardson J.F., and Sinnott, R.K. Coulson & Richardson's Chemical Engineering: Chemical engineering design, 1996.
4	Green D. and Perry R. Perry's Chemical Engineers' Handbook, Eighth Edition, 2007.

Course Outcomes (students will be able to….)

CO1	Learn how to experimentally verify various theoretical principles	K3+P2
CO2	Visualize practical implementation of chemical engineering equipment	K4+P2
CO3	Perform statistical analysis of experimental data	K4+P2
CO4	Get hands on experience with various measurement devices	K2+P2
CO5	Develop empirical correlations based on the experimental data generated	K5+P2
CO6	Generate meaningful tables and graphs	K3+P2

K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating P1 – Imitate, P2 – Manipulate, P3 – Perfect, P4 – Articulate, P5 – Embody

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	2	1	3	3	2	1	3
CO2	3	3	3	2	1	1	1	2	3	1	1	3
CO3	3	3	2	3	3	1	1	3	3	1	1	3
CO4	3	3	2	2	3	1	1	2	3	1	1	3
CO5	3	3	3	3	3	1	1	1	3	1	1	3
CO6	3	3	3	2	3	1	1	2	3	1	1	3

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	3	2
CO2	2	1	1	2	3
CO3	3	3	1	3	3
CO4	2	2	2	3	2
CO5	2	1	1	2	1
CO6	3	3	3	3	3

PCC	Course Code: PHP1434	Course Title: PRA-6: Biotechnology Laboratory	Credits = 2		
			L	T	P
	Semester: VI	Total contact hours: 60	0	0	4

List of Prerequisite Courses

Standard XII Science

List of Courses where this course will be prerequisite

NIL

Description of relevance of this course in the B. Tech. Program

The course is designed to introduce the students to various biotechnology techniques such as isolation of nucleic acids, enzyme immobilization, etc., which are practiced industrially for manufacturing of specialty chemicals, macromolecular drugs and other useful products.

	Course Contents (Topics and subtopics)	Required Hours
1	Isolation of nucleic acids and quantitation	8
2	Enzyme immobilization and estimation	12
3	Study of enzyme kinetics	8
4	Fermentation of biomolecules	8
5	Bioconversions	8
5	Isolation and purification of biomolecules from crude source/fermentation broth	8
6	Demonstration: Advanced molecular biology techniques like electrophoresis, RT-PCR, etc.	8
	Total	**60**

List of Textbooks/ Reference Books

1. Glick and Paternak, Molecular Biotechnology: Principles and Applications of Recombinant DNA, 3rd edition, ASM Press (2003)
2. R. W. Old, S. B. Primrose, Principles of gene manipulation : An introduction to genetic engineering, 5th edition, Blackwell Scientific (1994)
3. T. A. Brown, Gene Cloning and DNA Analysis: An Introduction, 7th edition, Wiley-Blackwell (2015)

Course Outcomes (students will be able to….)

CO1	Understanding of isolation of Nucleic acid	K2+P3
CO2	Study kinetics of the diverse enzymes for their application in research	K3+P3
CO3	Perform microbial fermentation and recover and purify bio-products	K4+P3
CO4	Apply nucleic acid isolation techniques for advanced studies in research and other areas	K4+P3
CO5	Understanding of Bioconversion	K3+P3

K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating
P1 – Imitate, P2 – Manipulate, P3 – Perfect, P4 – Articulate, P5 – Embody

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	3	3	3	1	1	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3	3	3
CO3	3	2	1	2	2	2	1	1	3	1	3	2
CO4	2	1	3	2	1	3	2	1	3	2	1	2
CO5	2	1	3	2	1	3	2	1	3	2	1	2

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	2
CO2	3	3	3	3	3
CO3	3	1	3	1	1
CO4	1	3	1	3	2
CO5	2	1	3	2	1

PEC	Course Code: PHP1435	Course Title: PRA- 7: Medicinal Natural Products Laboratory	Credits = 2		
			L	T	P
	Semester: VI	Total contact hours: 60	0	0	4
List of Prerequisite Courses					
XII Chemistry, Medicinal Natural Products(PHT1431)					
List of Courses where this course will be a prerequisite					
Drug Synthesis Approaches(PHT1439)					
Description of relevance of this course in the B. Tech. Program					
The course is designed to train the students on the extraction, isolation and characterization of Medicinal Natural Products.					

Course Contents (Topics and subtopics)		Required Hours
1	Standardization of plant drugs using the following methods -	
2	Morphology, quantitative microscopy, detailed microscopic study of drugs	15
3	Physical constants like specific gravity, swelling factor, ash values, extractive values, refractive index, optical rotation, etc.	15
4	Chemical methods identification tests for various classes of phyto-constituents. Extraction and isolation of active principles such as alkaloids, glycosides, tannins, resin, essential oils, fats etc. from natural drugs (4-5 drugs) and evaluation of isolated material by chromatography and spectroscopy	30
	Total	60
List of Textbooks/ Reference Books		
1	Latest editions of Indian Pharmacopoeia, British Pharmacopoeia, United States Pharmacopoeia, and others	
2	Practical Pharmacognosy: C.K. Kokate, Purohit, Gokhlae	
3	Jackson B. P., D. W. Snowdon, Atlas of Microscopy of Medicinal Plants, Culinary Herbs and Spices, 1990, CBS Publishers	
4	Tyler V.E., Pharmacognosy	
5	Trease & Evans, Textbook of Pharmacognosy	
6	Publishers Wallis, Textbook of Pharmacognosy	
7	Wagner H., Plant Drug Analysis- A Thin Layer Chromatography Atlas 1984, Springer-Verlag	
Course Outcomes (students will be able to….)		
CO1	Standardize the medicinal plants using morphological and microscopic analyses.	K3+P3

CO2	Characterize the medicinal plants using various analytical techniques.	K4+P3
CO3	Identify the phytoconstituents in medicinal plants using various chemical tests.	K4+P3
CO4	Isolate phytoconstituents from the natural materials using chromatographic analyses and further characterize using spectroscopic and spectrometric techniques.	K5+P3
CO5	Analysis of medicinal natural products	K4+P3
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating P1 – Imitate, P2 – Manipulate, P3 – Perfect, P4 – Articulate, P5 – Embody		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	3	3	1	1	3	1	1	1	3
CO2	3	3	3	3	3	1	1	3	1	1	2	3
CO3	1	3	3	3	2	1	1	3	2	1	2	3
CO4	3	3	3	3	3	3	2	2	2	1	3	3
CO5	2	3	2	3	3	1	1	3	1	1	1	3

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	1	1	3	2
CO2	3	3	2	2	2
CO3	3	1	1	3	1
CO4	2	1	1	3	2
CO5	3	3	2	2	2

FINAL YEAR: SEMESTER-VII

-PCC	**Course Code: PHT1436**	**Course Title: SPL13: Pharmaceutical Formulation Technology-III**	**Credits = 3**		
			L	**T**	**P**
	Semester: VII	**Total contact hours: 45**	**2**	**1**	**0**
List of Prerequisite Courses					
Pharmaceutical Formulation Technology-I (PHT1417), Pharmaceutical Formulation Technology II(PHP1424)					
List of Courses where this course will be prerequisite					
Pharmaceutical Formulation Technology Laboratory -III(PHP1445), Novel Drug Delivery system(PHT1448)					
Description of relevance of this course in the B. Tech. Program					
The course is designed to train the students with respect to basics and application of technology of sterile pharmaceuticals, ophthalmic products, blood products and substitutes and sutures and ligatures.					

	Course Contents (Topics and subtopics)	**Required Hours**
1	**Sterile Pharmaceuticals** • Introduction to sterile dosage forms, routes of parenteral administration • Preformulation considerations for sterile dosage forms: small-volume parenterals, large volume parenterals	4
2	**Facility Design** for parenteral manufacture with focus on air systems HEPA filters, environmental classes for manufacture of parenterals	5
3	Methods of sterilization	2
4	**Water for Injection:** Monograph IP, methods of preparation, quality	3

	control tests, storage	
5	**Containers and Closures for Parenteral Formulations:** • Glass and plastic as a container material; ampoules, vials, bottles, rubber closures manufacturing, sterilization, quality control	5
6	**Small-volume Parenterals:** • Formulation (discuss various dosage forms like solutions, suspensions, emulsions, dry powders) • Quality control • Large scale manufacture and packaging with focus on equipment • Layout design and Unit operations	5
7	**Freeze-Drying:** Introduction, principle and equipment	2
8	**Large-Volume Parenterals:** • Formulation (discuss various dosage forms like solutions, suspensions, emulsions, dry powders) • Quality control • Large scale manufacture and packaging with focus on equipment • Layout design and Unit operations	4
9	**Ophthalmics:** • Introduction to Ophthalmic dosage form • Anatomy of eye, factors affecting ophthalmic drug absorption • Preformulation considerations for ophthalmic dosage forms • Dosage forms: discuss various dosage forms like solutions suspensions, ointments, gels, films, inserts, lenses etc. w.r.t advantages and limitations, excipients, methods, equipment's, advances, problems and solutions thereof • Quality control of ophthalmic • Large scale manufacture and packaging with focus on equipment • Layout design and Unit operations	5
10	**Blood Products and Glandular Products:** Blood products • Introduction, advantages and limitations • Collections and storage techniques for whole blood • Methods of blood and plasma fractionation into individual components • Quality control Plasma substitutes • Introduction, advantages and limitations • Methods of preparation • Quality control Insulin and insulin products	5
11	**Sutures and Ligatures** • Introduction, advantages and limitations Difference between sutures and ligatures • Types of material used for sutures and ligatures e.g. absorbable and non-absorbable • Methods of preparation • Quality control • Large scale manufacture and packaging with focus on equipment	5
	Total	**45**
List of Textbooks/ Reference Books		
1	Therapeutic Systems: Pattern-Specific Drug Delivery, Heilmann, Struttgart, G. Thiense Pub. (1978)	
2	Encyclopedia of Pharmaceutical Technology, J. Swarbrick, New York, Marcel Dekker (1993)	
3	Remington's Pharmaceutical Sciences, A. R. Gennaro Mac Pub. Co. Easton, Pennsylvania (1990)	
4	Indian Pharmacopoeia, British Pharmacopoeia, United States Pharmacopoeia.	

5	Theory & Practice of Industrial Pharmacy. L. Lachman, Herbert A. Lieberman& J. Kanig, Lea & Febiger, Philadelphia (1987)
6	Pharmaceutical Dosage Form: Dispersed Systems (Vol.1 & 2) Herber A. Lieberman, Martin A. Rieger, G. S. Ban, Marcel Dekker Inc. (1993)
7	Modern Pharmaceutics. Gilbert S.Banker, C.T. Rhodes, Marcel Dekker Inc. (1990)
8	Pharmaceutics: The Science of Dosage Form Design. Michael E.Aulton, Churchill-Livingstone (1998)
9	Pharmaceutical Dosage forms: Parenteral Medications in Three volumes, Kenneth E. Avis, Herbert A. Lieberman, Leon Lachman, Marcel Dekker Inc. (1993)

Course Outcomes (students will be able to….)		
CO1	Understand and Explore the concepts related to pre-formulation, formulation, evaluation, packaging, and large-scale manufacturing and remember the facility design of parenteral products	K3
CO2	Apply the principles of dosage form design to various sterile formulations, their evaluation, and packaging	K3
CO3	Apply the principles involved in the development of Ophthalmic dosage form, blood products, sutures and ligatures	K5
CO4	Explicate and employ quality control studies of the sterile pharmaceuticals	K4
CO5	Explicate and employ quality control studies of the Insulin products	K4
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	3	1	2	1	3
CO2	1	3	2	3	2	3	3	1	2	1	1	2
CO3	2	2	3	3	1	2	2	3	1	1	2	3
CO4	3	3	3	2	2	1	2	3	3	3	3	3
CO5	3	2	2	1	2	3	3	3	3	3	3	2

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	2	2	2
CO2	3	3	2	3	1
CO3	3	1	2	3	1
CO4	1	3	2	2	2
CO5	3	2	3	2	3

PCC	**Course Code: PHT1437**	**Course Title: SPL12: Pharmaceutical Chemistry-II**	**Credits = 2**		
			L	**T**	**P**
	Semester: VII	**Total Contact Hours: 30**	**1**	**1**	**0**
List of Prerequisite Courses					
Organic Chemistry (CHT1407), Medicinal Chemistry(PHP1421), Physiology and Pharmacology(PHT1422), Pharmaceutical Chemistry-II(PHP1437)					
List of Courses where this course will be prerequisite					
Drug synthesis approaches(PHT1439), Pharmaceutical chemistry-III(PHT1446)					

Description of relevance of this course in the B. Tech. Program		
To acquaint the students with Nomenclature, Classification, Molecular Mechanism of Action, Synthesis and Structure-Activity Relationship (SAR), New Drug Approvals, Drug Withdrawals, Marketed Formulations of the following therapeutic categories of drugs:		
Course Contents (Topics and subtopics)		**Required Hours**
1	***Introduction to Drugs Acting on Cholinergic Nervous System:*** Cholinergic receptors, Acetylcholine, Cholinergic agonists, Cholinergic Antagonists and Cholinesterase Inhibitors Pharmacotherapy of Alzheimer's Disease	6
2	***Introduction to Drugs Acting on Adrenergic Nervous System:*** Adrenergic receptors, Norepinephrine and Epinephrine, Adrenergic agonists, Adrenergic Antagonists and Cholinesterase Inhibitors Mixed Adrenergic agonists and antagonists	6
3	***Introduction to Drugs Acting on Central Nervous System:*** General anesthetics Sedatives and Hypnotics Anticonvulsants Antidepressants Antipsychotics Hallucinogens, Analeptics and Psychedelics Anxiolytics Central stimulants Miscellaneous agents – Antiparkinsonian agents, Antiemetics, Irritable Bowel Syndrome	10
4	***Introduction to Centrally-Acting Analgesics:*** Opioid or Narcotic analgesics: μ-Agonists, other analgesics Mixed agonist/antagonist analgesics μ-Antagonists Antidiarrheal agents Cough suppressants Antitussives	8
	Total	**30**
List of Textbooks/ Reference Books		
1	Lemke, T. L., Zito, S. W., Roche, V. F., Williams, D. A. Essentials of Foye's Principles of Medicinal Chemistry; Wolters Kluwer (2017)	
2	Lemke, T. L., Williams, D. A., Roche, V. F., Zito, S. W. Foye's Principles of Medicinal Chemistry; 7th ed.; Wolters Kluwer (2013)	
3	Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry; Beale, J. M., Jr., Block, J. H., Eds.; 12th ed.; Wolters Kluwer (2011)	
4	Burger's Medicinal Chemistry & Drug Discovery, Vol. 1- 6; Abraham, D. J., Ed.; 6th ed.; John Wiley & Sons - New Jersey (2003)	
5	Kleeman, A., Engel, J., Kutscher, B., Reichert, D. Pharmaceutical Substances: Syntheses, Patents and Applications of the Most Relevant APIs; 5th ed.; Thieme Medical Publishers Inc. (2009)	
6	Lednicer, D. The Organic Chemistry of Drug Synthesis; Vol. 1 - 7); John Wiley & Sons, INC. (2008)	
7	Silverman, R. B., Holladay, M. W. The Organic Chemistry of Drug Design and Drug Action; 3rd ed.; Elsevier (2014)	
8	Warren, S., Wyatt, P. Organic Synthesis: The Disconnection Approach; 2nd ed.; Wiley; (2008)	
Course Outcomes (students will be able to….)		
CO1	Understand and appreciate the molecular design principles by studying Structure-Activity Relationship (SAR) and molecular mechanism of action.	K3
CO2	Follow the unmet medical need for newer agents for treating various infectious diseases and multidrug-resistant microbial infections.	K3

CO3	Understand the discovery and development of central nervous system drugs including those for neurodegenerative diseases.	K3
CO4	Study the synthetic approaches for various APIs and New Chemical Entities (NCEs).	K4
CO5	Evaluation of Structure-Activity Relationship (SAR) for New Drug Approvals, Approved Drug	K5
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	3	0	1	0	0	0	0	1
CO2	2	3	1	1	1	0	2	1	0	0	0	1
CO3	1	2	3	3	1	0	2	0	0	0	0	0
CO4	2	2	3	1	1	0	2	0	0	0	0	1
CO5	3	1	2	0	0	0	0	0	0	0	0	1

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	3	1	3
CO2	1	1	1	2	1
CO3	2	1	2	1	1
CO4	3	1	3	1	3
CO5	1	1	2	1	1

RM_ 1	**Course Code: PHT1442**	**Course Title: Literature Review (Research Methodology-I)**	**Credits = 2**		
			L	**T**	**P**
	Semester: VII	**Total contact hours: 30**	**1**	**1**	**0**

List of Prerequisite Courses

Communication Skills (HUP1110B)

List of Courses where this course will be prerequisite

Project-I (PHP1444)and Project-II(PHP1449)

Description of relevance of this course in the B. Tech. Program

The formal exposure to various elements of research methods such as problem formulation, literature search, planning of various activities, documentation, budgeting, purchase, report/thesis compilation, manuscript writing, patent drafting, is critical for polishing the naïve research attitude and aptitude in the PG students of the programme. The course is designed to formally introduce various concepts of research methodology in stepwise manner to the students

	Course Contents (Topics and subtopics)	**Required Hours**
1	Introduction of Course Academic Honesty Practices General philosophy of science & Arguing About Knowledge Case studies in science history	2
2	Motivation and Background Motivation/Demotivation for Research, Building Background for Research and How to read research papers	2
3	Time Management (Academic and Non-academic time), Effort Management, Plan execution, Energy Management Issue, Role and expectation of research supervisor and student	3

4	Finding and Solving Research Problems What is Research, How to start?, Approaches to find research problems and psychological experiments Literature survey, Textbooks, Review and research papers How to ask Questions What is worthwhile research problem, Analytical and synthetic research approach	3
5	Finding and Solving Research Problems What is Research, How to start?, Approaches to find research problems and psychological experiments Literature survey, Textbooks, Review and research papers, critical review of research papers, how to write literature survey report, How to ask Questions, formulating research questions,	4
6	What is worthwhile research problem, Analytical and synthetic research approaches How to solve research problems, designing work plan, importance of objectives, activity and strategizing research work. Design of timeline for work plan (Gantt Chart etc), Grant Writing Guidelines	4
7	Experimental Research Inventory Management, Material Management Learning required skills for research, Documentation and lab notebook guidelines, Safety aspects in chemical/biological research	3
8	Methods and Tools used in Research: Qualitative studies; Quantitative studies; Simple data organization; Descriptive data analysis; Limitations and sources of error; Inquiries in form of Questionnaire, Opinionnaire or by interview; Statistical analysis of data including Variance, Standard deviation, Students 't' test and Analysis of variance (ANOVA), Correlation data and its interpretation, Computer data analysis	4
9	Scientific Writing Skeleton of research paper, author guidelines, good writing skills, importance of discussion, Macro-level discussion. Structure of the documents. General issues of presentability. Micro-level discussion. Stylistic issues. Examples of bad and good writings.	3
10	Publishing and Reviewing Publication process, How to publish papers, where to submit, Review process and reacting to a review report Reviewing scientific papers	3
11	Scientific Norms and Conventions Authorship. Plagiarism. Simultaneous submissions. Reviewing norms. Referring to other papers. Use of data. Collaborative Research Work	2
	Total	**30**
List of Textbooks/ Reference Books		
1	Menzel, D.; Writing a Technical Paper; McGraw-Hill, United States (1961).	
2	Best, J. W., Kahn, J. V., Jha, A. K.; Research in Education; 10th ed.; Pearson, New Delhi, India (2005)	
3	Davis R. M.; Thesis Projects in Science and Engineering: A Complete Guide from Problem Selection to Final Presentation; St. Martin's Press, (1980).	
4	Anderson, J., Durston, B. H., Poole, M. E.; Thesis and Assignment Writing; John Wiley, United States (1970).	
5	Menzel, D.; Writing a Technical Paper; McGraw-Hill, United States (1961).	
6	Brown, L.; Effective Business Report Writing; Prentice-Hall, United States (1973).	
7	WIPO Intellectual Property Handbook; WIPO Publication (2004).	
8	Carter, M.; Designing Science Presentations: A Visual Guide to Figures, Papers, Slides, Posters, and More; Academic Press, London (2013).	
9	Ranganathan, S. R.; Documentation : Genesis and Development; Ess Ess Publications, India (2006).	
Course Outcomes (students will be able to….)		

CO1	Understand the basic concepts of research and the components therein, formally	K2+P2
CO2	Understand and appreciate the significance of statistics in Chemical Technology	K3+P2
CO3	Understand and apply importance of literature survey in research design	K4+P3
CO4	Understand an in-depth knowledge on the documentation in research	K5+P3
CO5	Evaluate importance of various parts of a research report/paper/thesis in presentation of research results	K4+P3
CO6	Prepare and Deliver a model research presentation	K5+P3
CO7	Understand the significance of various types of IPRs in research	K3+P3
CO8	Create a model research project	K6+P4
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating P1 – Imitate, P2 – Manipulate, P3 – Perfect, P4 – Articulate, P5 – Embody		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	2	2	2	2	2	2	2	3
CO2	2	2	2	2	2	2	2	2	2	2	1	3
CO3	2	3	1	3	2	2	3	2	2	2	2	2
CO4	3	2	2	3	2	2	3	3	2	2	2	2
CO5	2	2	2	3	2	2	3	2	2	2	1	2
CO6	2	2	2	3	2	2	3	2	2	2	2	3
CO7	3	2	3	3	2	2	3	2	2	2	2	2
CO8	2	2	2	3	2	2	3	2	2	2	2	2

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	2	2	2
CO2	2	1	2	2	1
CO3	2	2	3	2	2
CO4	2	2	2	2	2
CO5	2	1	2	2	1
CO6	2	3	2	3	2
CO7	2	3	2	3	2
CO8	2	3	2	3	2

RM-II	**Course Code: PHT1443**	**Course Title: Design and Analysis of Experiments (Research Methodology – II)**	**Credits =2**		
			L	**T**	**P**
	Semester: VII	**Total contact hours: 45**	**1**	**0**	**2**
List of Prerequisite Courses					
Engineering Mathematics(MAT1301), Process Calculations(CEP1720)					
List of Courses where this course will be prerequisite					

This course is required for graduating students to function effectively in Industry, Academia and other professional spheres. Project-II(PHP1449)		
Description of relevance of this course in the B. Tech. Program		
Modern day manufacturing activities and R&D activities need decisions taken with a scientific rigor and should be well-supported by 'statistics'. Chemical Technologist graduates who will serve industry as well as postgraduate research students who will serve industry, R&D organizations, or academic research should have a reasonably good background of statistical decision making. This also involves extraction of meaningful data from well-designed minimal number of experiments at the lowest possible material costs. This course will also help the students in all domains of their life by imparting them a vision for critical appraisal and analysis of data.		
Course Contents (Topics and subtopics)		**Required Hours**
1	Fundamental principles of classical design of experiments Strategy of Experimentation, Typical applications of Experimental design, Basic Principles, Guidelines for Designing Experiments.	4
2	Review of Probability and basic statistical inference: Concepts of random variable, probability, density function cumulative distribution function. Sample and population, Measure of Central tendency; Mean median and mode, Measures of Variability, Concept of confidence level. Statistical Distributions: Normal, Log Normal & Weibull distributions, Hypothesis testing.	3
3	Experiments with a Single Factor: The Analysis of Variance Fixed effect model and Random effect model, Model adequacy checking, Contrasts, Orthogonal contrasts, Regression Models and ANOVA, Violation of Normality Assumption: Kruskal-Wallis test. Randomized block designs, Latin square designs, Balanced Incomplete Block Designs	6
4	Factorial designs: Definition, Estimating model parameters, Fitting response curves and surfaces.	3
5	The 2^k Factorial Design, Blocking and Confounding in the 2k Factorial Design; Focus of 2^2 and 2^3 designs, Blocking and Confounding in the 2^k Factorial Design.	6
6	Plackett Burman methods, Central Composite Design (CCD)	3
7	Descriptive Statistics, Probability Distribution and testing of Hypothesis using R	4
8	Regression techniques, diagnostic checks, ANOVA using R and implementation of contrasts.	4
9	Construction of Balanced Incomplete Block Designs and data analysis using R	4
10	Analysis of factorial designs using R, understanding output and interpretation.	4
11	Factorial designs, Data analysis and interpretation.	4
	Total	**45**
List of Textbooks/ Reference Books		
1	Douglas C. Montgomery, Design and Analysis of Experiments, 8th Edition, John Wiley & Sons, Inc. 2013	
2	Box, G. E., Hunter, W.G., Hunter, J.S., Hunter, W.G., Statistics for Experimenters: Design, Innovation, and Discovery, 2nd Edition, Wiley, 2005.	
3	John Lawson, Design and Analysis of Experiments with R, CRC Press, 2015	
4	Dieter Rasch, Jürgen Pilz, Rob Verdooren, Albrecht Gebhardt Optimal Experimental Designs with R. CRC Press, 2011.	
5	José Unpingco, Python for Probability, Statistics, and Machine Learning, Springer, 2019	
6	Response Surface Methodology: Process and Product Optimization using Designed Experiments: R. H. Myers, D. C. Montgomery.	
7	Introduction to Statistical Quality Control: D. C. Montgomery.	
8	Design of Experiments in Chemical Engineering: Živorad R. Lazić.	
Course Outcomes (students will be able to….)		
CO1	Students should be able to understand basic principles of design of experiments.	K3
CO2	Students should be able to perform statistical analysis of single experiments and do post hoc analysis.	K4

CO3	Students should be able to conduct experiment and analyze the data using statistical methods.	K5
CO4	Students should be able to choose an appropriate design given the research problem.	K4
CO5	Students should be able to perform statistical analysis of different designs using R and interpret the results.	K5
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	2	0	3	3	3	3	3	3	1
CO2	3	2	2	2	2	3	3	3	1	2	3	2
CO3	3	3	2	2	1	1	3	3	3	3	3	2
CO4	3	3	2	2	2	3	0	2	3	3	3	2
CO5	3	2	2	0	2	3	3	3	1	3	0	2

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	3	2	2
CO2	2	1	1	2	1
CO3	2	2	3	2	2
CO4	2	2	3	2	2
CO5	2	1	1	2	1

Project	**Course Code: PHP1444**	**Course Title: Project -I**	**Credits =4**		
			L	**T**	**P**
	Semester: VII	**Total contact hours: 120**	**0**	**0**	**8**

List of Prerequisite Courses

Communication Skills (HUP1110B)

List of Courses where this course will be prerequisite

Project -II (PHP1449)

Description of relevance of this course in the B. Tech. Program

The course is designed to help students develop a skill-set for solving a research problem related to Pharmaceutical Sciences and Technology. The course presents an opportunity to the students for fine-tuning their scientific communication skills, oral as well as written.

Course Contents (Topics and subtopics)		**Required Hours**
1	a) The Teachers will communicate various research topics of potential interest to the Pharmaceutical Sciences and Technology field to all the students based on the interest and facilities available. b) Each student, based on his/her interest and merit (CGPA) till Semester-V/VI and is allotted a supervisor. c) Student and Supervisor then selects the research topic The work involves detailed review of the literature, formulation of research project, hypothesis, objectives, methodology, and possible expected outcomes, planning for experimentation, experimental trials, data generation and analysis. d) Finally, the student will compile the report as per the communicated format and then present in front of the internal faculty Evaluators within the DPST.	120

	e) Ideally student should start initial experiments by end of this semester.	
	Total	**120**
List of Textbooks/ Reference Books		
1	Relevant research articles, patents, review articles, conference proceeding, book chapters and books	
Course Outcomes (students will be able to….)		
CO1	Develop critical thinking to identify the research gap for the project	K5+P4
CO2	Formulate a scientific question and approach to solve it	K5+P4
CO3	Plan the experimental methodology for the project	K5+P4
CO4	Develop skills to communicate the research plan effectively	K6+P4
CO5	Develop skills for writing a scientific document on the research work	K6+P4
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating P1 – Imitate, P2 – Manipulate, P3 – Perfect, P4 – Articulate, P5 – Embody		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	2	3	1	2	2	3	1	2	2	2
CO2	2	3	2	2	1	2	2	3	1	2	2	2
CO3	3	2	2	2	1	2	2	3	1	2	2	2
CO4	2	1	3	2	1	2	2	3	1	2	2	2
CO5	1	2	2	1	1	2	2	3	1	2	2	3

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	1	2	2
CO2	1	3	1	2	1
CO3	1	2	1	2	1
CO4	2	3	1	1	1
CO5	2	2	1	2	1

PCC	**Course Code:** **PHP1445**	**Course Title:** **Pr-8: Pharmaceutical Formulation Technology Laboratory – III**	**Credits = 2**		
			L	**T**	**P**
	Semester: VII	**Total contact hours: 60**	**0**	**0**	**4**
List of Prerequisite Courses					
Pharmaceutical Formulation Technology-I and II(PHT1417 and PHT1424)					
List of Courses where this course will be prerequisite					
Project-I and II(PHP1444 and PHP1449)					
Description of relevance of this course in the B. Tech. Program					
Course Contents (Topics and subtopics)			**Required Hours**		
1	Representative examples of small-volume parenterals (Preparation, packaging and evaluation)		16		
2	Representative examples of large-volume parenterals (Preparation, packaging and evaluation)		8		
3	Representative examples of ophthalmic formulations (Preparation, packaging		8		

	and evaluation)	
4	Evaluation of containers and closures for parenterals	8
5	Monographic testing of water for injection IP, containers and closures used for Parenterals	8
6	Scale-up of some formulations	12
	Total	**60**
List of Textbooks/ Reference Books		
1	Latest Editions of Indian Pharmacopoeia, British Pharmacopoeia, United States Pharmacopoeia	
2	Pharmaceutical Production Facilities: Design and Applications G. C. Cole	
3	The Theory and Practice of Industrial Pharmacy, Lachman Bombay, K. M. Warghese Co. (1976)	
4	Pharmaceutical Dosage Forms Vol. I & II, Liebermann, New York, Marcel Dekker (1996)	
5	Drug Delivery Devices: Fundamentals and Applications, Tyle New York, Marcel Dekker (1988)	
6	Indian Pharmacopoeia	
7	British Pharmacopoeia	
8	United States Pharmacopoeia	
Course Outcomes (students will be able to….)		
CO1	Formulate evaluate parenteral and ophthalmic products.	K4+P3
CO2	Evaluate primary packaging for sterile products.	K4+P4
CO3	Perform accelerated stability testing and calculate $t_{1/2}$.	K5+P4
CO4	Create skills related to working in an aseptic area	K6+P3
CO5	Evaluation of sterilization aspects	K5+P4
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	2	2	1	1	2	3	2	3	2
CO2	1	2	3	2	1	1	1	2	3	2	3	1
CO3	2	2	2	1	2	1	1	2	3	2	3	2
CO4	1	3	3	3	3	2	2	3	3	2	3	3
	2	3	2	3	3	3	2	2	2	3	2	3

Mapping of Course Outcomes (COs) with Specific Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	1	3	3	2
CO2	2	2	3	3	1
CO3	2	2	3	3	2
CO4	1	2	3	3	1
CO5	2	2	2	3	1

FINAL YEAR: SEMESTER – VIII

PCC	**Course Code: PHT1446**	**Course Title:**	**Credits = 3**

		SPL15: Pharmaceutical Chemistry-III	**L**	**T**	**P**
	Semester: VIII	**Total contact hours: 45**	**5**	**1**	**0**
List of Prerequisite Courses					
Organic Chemistry(CHT1407), Pharmaceutical Chemistry-I(PHT1432), Pharmaceutical Chemistry-II(PHT1437)					
List of Courses where this course will be prerequisite					
Project-II (PHP1449)					
Description of relevance of this course in the B. Tech. Program					
To acquaint the students with Nomenclature, Classification, Molecular Mechanism of Action, Synthesis and Structure-Activity Relationship (SAR), New Drug Approvals, Drug Withdrawals, Marketed Formulations of the following therapeutic categories of drugs:					
Course Contents (Topics and subtopics)					**Required Hours**
1	**a) Non-Steroidal Anti-inflammatory Agents:** Antipyretics, Analgesics, Salicylates, Arylalkanoic acids, N-Aryl-anthranillic acids, Oxicams, Selective Cyclo-oxygenase 2 (COX-2) inhibiotors, Microsomal Prostaglandin E Synthase-1 (mPGES-1) inhibitors and other Emerging chemical classes.				6
	b) Antihistaminic Agents: H_1-Receptor antagonists - Classical antagonists and Nonsedative H_1-antagonists, Overview of H_4-receptor antagonists as Antiasth-matic agents				4
	c) Antiulcer Agents: H_2-Receptor antagonists, Proton Pump Inhibitors (PPIs), Miscellaneous agents and Emerging approaches				4
2	**Drug Acting on Cardiovascular and Metabolic Disorders** **a) Cardiovascular Drugs:** i) *Drugs for Heart Failure* - Cardiac glycosides and non-glycosides ii) *Antianginal Agents* - Nitrates and nitrites, Nitric oxide donors Calcium-channel blockers iii) *Antiarrhythmic Drugs*: Class I to IV and other promising agents				6
	b) Diuretics: Osmotic diuretics, Carbonic anhydrase inhibitors, Thiazideand and thiazide-like diuretics, Loop diuretics, Aldosterone antagonists, Potassium-sparing diuretics and other emerging targets				3
	c) Antihypertensive Agents: Angiotensin-Converting Enzyme (ACE) Inhibitors, Angiotensin II Receptor Type 1 antagonists, Dihydropyridine calcium-channel blockers, Adrenergic blockers, Vasodilators, Miscellaneous agents, Approaches for treating pulmonary hypertension				3
	d) Antihyperlipidemic Agents: Hydroxymethylglutaryl-CoA (HMG-CoA) Reductase Inhibitors, Cholesterol-reducing agents, Others, Emerging targets in the management of dyslipidaemia				2
	e) Drugs affecting Primary and Secondary Hemostatis i) *Anticoagulants:* Oral anticoagulants, Heparin and related products, Direct thrombin inhibitors, Direct Factor Xa inhibitors ii) *Thrombolytics* iii) *Antiplatelet drugs* iv) *Anitfibrinolytic agents*				3
3	**Drugs Acting on Hormonal Systems** **a) Antidiabetic Drugs:** Insulin and analogs, Oral hypoglycemic agents and Emerging Approaches in the				3

	management of Type 2 diabetes, e.g., Glucagon-like peptide (GLP-1) analogs and agonists	
	b) Steroid Hormones: Adrenocorticoids, Steroidal Anti-inflammatory agents	3
	c) Sex steroids and antagonists Androgens, Estrogens and Progestins, Oral contraceptives, Anabolic steroids and Other agents	3
	d) Drugs for Hypo- and Hyperthyroidism Thyroid Hormones, Thyroid Replacement Therapy, Anti-thyroid agents, Radioisotopes for Thyroid cancer	2
4	**Miscellaneous Classes of Drugs** Drugs acting on calcium homeostatic, iron preparations	2
	Total	**45**
List of Textbooks/ Reference Books		
1	Lemke, T. L., Zito, S. W., Roche, V. F., Williams, D. A. Essentials of Foye's Principles of Medicinal Chemistry; Wolters Kluwer (2017)	
2	Lemke, T. L., Williams, D. A., Roche, V. F., Zito, S. W. Foye's Principles of Medicinal Chemistry; 7th ed.; Wolters Kluwer (2013)	
3	Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry; Beale, J. M., Jr., Block, J. H., Eds.; 12th ed.; Wolters Kluwer (2011)	
4	Burger's Medicinal Chemistry & Drug Discovery, Vol. 1- 6; Abraham, D. J., Ed.; 6th ed.; John Wiley & Sons - New Jersey (2003)	
5	Kleeman, A., Engel, J., Kutscher, B., Reichert, D. Pharmaceutical Substances: Syntheses, Patents and Applications of the Most Relevant APIs; 5th ed.; Thieme Medical Publishers Inc. (2009)	
6	Lednicer, D. The Organic Chemistry of Drug Synthesis; Vol. 1 - 7); John Wiley & Sons, INC. (2008)	
7	Silverman, R. B., Holladay, M. W. The Organic Chemistry of Drug Design and Drug Action; 3rd ed.; Elsevier (2014)	
8	Warren, S., Wyatt, P. Organic Synthesis: The Disconnection Approach; 2nd ed.; Wiley (2008)	
Course Outcomes (students will be able to….)		
CO1	Draw and understand the 2D and 3D structures of small-molecule drugs and write their IUPAC names.	K3
CO2	Understand and explain the molecular mechanism of action of drugs and biologics, with particular emphasis on the emerging trends and newer targets for varied therapeutic indications.	K2
CO3	Decipher the structure-activity relationship (SAR), metabolism, therapeutic indications, drug-drug interactions, adverse effects of drugs and/or biologics.	K5
CO4	Evaluate the logic behind the design of synthetic routes for small-molecule drugs and related compounds such as metabolites, impurities and prodrugs.	K4
CO5	Understand the molecular design principles based on the SAR, MoA, Off-traget effects and metabolic fate	K4
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	0	2	0	1	3	1	1	0	1	0	1	1
CO2	2	3	1	1	0	1	2	1	1	0	1	1
CO3	1	2	0	3	1	1	0	0	1	0	1	0
CO4	2	2	3	1	1	1	2	0	1	0	1	1
CO5	3	1	2	0	0	1	0	0	1	0	1	0

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	1	1	1
CO2	1	3	1	2	1
CO3	1	3	1	2	1
CO4	3	1	2	1	1
CO5	1	2	2	1	1

PCC	Course Code: PHP1449	Course Title: Project – II (Experiments)	Credits = 3		
			L	T	P
	Semester: VIII	Total contact hours: 120	0	0	16

List of Prerequisite Courses
All Pharmaceutical Chemistry and Pharmaceutical Formulation Technology subjects
List of Courses where this course will be prerequisite
Professional Career and future academic research
Description of relevance of this course in the B. Tech. Program
The course is designed to help students develop a skill-set for solving a research problem related to Pharmaceutical Sciences and Technology. The course presents an opportunity to the students for fine-tuning their scientific communication skills, oral as well as written.

	Course Contents (Topics and subtopics)	Required Hours
1	a) The topic of the research with clearly defined Objectives and Hypotheses should be explored systematically based on the initial experiments carried out in earlier semester, in a scientifically planned rational set of experiments under the supervision of guide. b) Students should have actual experimental data collected on the chosen research topic.	100
2	a) Oral presentation of the proposed research work with data generated during actual laboratory work along with computational studies, if any, targeted towards fulfilling the objectives. b) The outcome is submitted in the form of a report and Viva-voce examination will be conducted and will be evaluated by both internal and external subject experts.	20
	Total	**120**

List of Textbooks/ Reference Books	
1	Relevant review articles, research papers, patents, book chapter, books, etc.

Course Outcomes (students will be able to….)		
CO1	Perform experiments & troubleshoot to generate reliable data	K4+P5
CO2	Apply different statistical tools for scientific data analysis	K5+P5
CO3	Evaluate critically the experimental data and draw meaningful inferences	K6+P5
CO4	Develop skills to communicate the research outcome effectively	K6+P5
CO5	Develop skills for writing a complete document on the project work	K6+P5

K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating
P1 – Imitate, P2 – Manipulate, P3 – Perfect, P4 – Articulate, P5 – Embody

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	2	2	3	2	2	2	3
CO2	3	3	3	3	3	3	2	3	2	2	2	3
CO3	3	3	3	3	3	3	3	3	2	3	2	3
CO4	3	3	3	3	3	3	3	3	2	2	2	3
CO5	3	3	3	3	3	3	3	3	2	2	2	3

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

PEC	**Course Code:** **PHP1450**	**Course Title:** **Pr- 9: Process Technology Laboratory**	**Credits =2**		
			L	**T**	**P**
	Semester: VIII	**Total contact hours: 60**	**0**	**0**	**4**

List of Prerequisite Courses
All Pharmaceutical Chemistry subjects, Chemistry and Technology of Fine Chemicals(PHT1433)
List of Courses where this course will be prerequisite
Professional Career and future academic research
Description of relevance of this course in the B. Tech. Program
The course is designed to train the students with respect to scale-up, process development as well as the study of safe and green processes.

	Course Contents (Topics and subtopics)	**Required Hours**
1	Synthesis of drugs involving two or more steps with a) with analysis of raw materials and product synthesis and b) in-process control and reaction monitoring	30
2	Any innovative modifications in the process of drug synthesized (Two Examples); No repetition of the same from previous years	15
3	Scale-up and Green Chemistry route for synthesis (Two examples)	10
4	Bioconversions	5
	Total	**60**

List of Textbooks/ Reference Books	
1	Arthur, Vogel. Textbook of Practical Organic Chemistry, 5th edition, Longman Group Ltd., 1989.
2	F. G. Mann and B. C. Saunders, Practical Organic Chemistry, 4th edition, Orient Longman
3	Keese, R, Martin P. B, and Trevor P. Toube. Practical Organic Synthesis: A Student's Guide. John Wiley & Sons, 2006.

Course Outcomes (students will be able to….)		
CO1	Improvement and expertise in process development skills (K3).	K5+P4
CO2	Explore the innovation component in process development activities.	K6+P4

CO3	Process Evaluations	K5+P4
CO4	Scale-up- challenges	K6+P4
CO5	Reaction using enzymes	K4+P4
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

OJT	**Course Code:** **PHP1451**	**Course Title:** **Internship with Industry**	**Credits = 12**		
			L	**T**	**P**
	Semester: VIII	**Total contact hours: 12-16 weeks**	**0**	**0**	**0**
List of Prerequisite Courses					
All Special subjects and practical					
List of Courses where this course will be prerequisite					
Industrial career and Academic research					
Description of relevance of this course in the B. Tech. Program					
The course is designed to – 1. Develop a systematic thinking about an industrial problem; 2. Develop skills for communication, networking, personal grooming & professional conduct within an industrial environment, and 3. Develop the attitude for individual and teamwork.					
Course Contents (Topics and subtopics)					**Required Hours (weeks)**
1	In the **Eighth semester**, every student will have to undergo an internship and/or On Job Training. The Internship would be of **12 credits**. 1. The internship would be assigned to the student by the Departmental Internship Coordinator, with the approval of Head of the Department. 2. The total duration of the internship would be for a period equivalent to 12 Calendar weeks. The internship may be completed in one or more organizations as described below. 3. The internship could be of the following forms: 4. Industrial internship in a company (within India or Abroad) involved in R&D / Project design / manufacturing (QA/QC/Plant Engineering/Stores and				12

	Purchase) / marketing / finance / consultancy / Technical services / Engineering/Technology / Projects, etc. 5. At the end of the internship, each student will submit a written report based on the work carried out during the Internship. The report will be countersigned by the Supervisor from Industry / Institute as the case may be. 6. Performance of the student will be assessed based on the written report and a presentation to a committee consisting of two faculty members from the Department of Pharmaceutical Sciences and Technology. 7. Students will be assigned a grade based on the written report and a presentation; evaluated by a committee of faculty members. 8. Feedback will be taken from Industry mentors and this will used while assigning the grades.	
	Total	**12 Weeks**

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

……

PROGRAM ELECTIVES

PEC-1	Course Code: PHT1425	Course Title: SPL8: Pharmaceutical Chemistry and Catalytic Process	Credits = 4		
			L	T	P
	Semester: V	Total Contact Hours: 60	3	1	0

List of Prerequisite Courses

Basic understanding of metal complexes and co-ordination chemistry; Physical chemistry of surfaces and isotherms; Elementary chemical reaction engineering; Basic knowledge of organic chemistry ; Basic knowledge of enzymes and protein structure

List of Courses where this course will be prerequisite

All courses involving chemical processes

Description of relevance of this course in the B. Tech. Program

The course is designed to train the students in the basics of various catalytic processes and their importance in optimization of the chemical processes

Sr. No	Course Contents (Topics and subtopics)	Required Hours
	A. Pharmaceutical Chemistry	
1	Importance of Organic synthesis, linear vs telescopic synthetic strategies, concept of retrosynthetic analysis; construction of simple carbon-hetro bonds	2
2	Understanding of molecular complexity, identification of building blocks and strategies of building molecules by joining the blocks, chemo selectivity issues	2
3	Building block based carbon-hetero bond disconnection based retrosynthetic analysis of larger drug and natural product molecules and synthetic strategies	4
4	Heterocyclic ring construction analysis with illustrative examples	4
5	Retrosynthetic analysis of different drug molecules with combined approaches studies as above	4
6	C-C bond disconnections and selection of synthons and corresponding reagents, analysis of synthesis of simple drug molecules	4
7	Organometallic chemistry based strategies in retrosynthesis and construction of molecules	4
8	Wittig, Aldol, Michael, organo-palladium, metathesis based retrosynthetic Strategies	4
9	Asymmetric transformations and retrosynthesis	2
	B. Catalytic Process	
10	Overview of Pharmaceutical Technology and current trends in process Research. Importance of catalytic process in organic synthesis and processes	2
11	Catalysis: Basic principles of catalysis, Classifications of catalytic processes, Energy profile diagrams and kinetics. Specific acid and specific base catalysis	4
12	General acid and base catalysis, homogeneous catalysts and Catalysis	4
13	Heterogeneous catalysts and catalysis, types of catalysts, characterization of catalysts - outline, kinetics, catalyst poisoning, Supported catalysts and	4

	catalysis	
14	Bio-catalysis, bio-catalytic systems, Enzyme catalyzed reactions, principles, details studies on Lipases and catalyzed reactions	4
15	Immobilized bio-catalytic systems and different approaches of immobilization chemistry, merits and demerits	4
16	Manufacture of chiral drugs through catalytic processes	3
17	Phase-transfer catalysis	2
18	Basics of mixing and understanding, implication on catalytic processes, suspension of solids particles	3
	Total	**60**
List of Textbooks/ Reference Books		
1	Modern Physical Organic Chemistry; E.V. Anslyn, D.A. Dougherty; University Book Press (2006)	
2	Biotechnology, Vol 4, H. J. Rahm, G. Reed; Weinheim Verlag Chemie (1985)	
3	Principles of Process Research and Chemical Development in the Pharmaceutical Industry; O. Repic; Wiely & Sons Inc. (1998)	
4	Recent review articles on specific topics	
Course Outcomes (students will be able to….)		
CO1	Comprehend fundamental knowledge of catalysis and its characterization.	K4
CO2	Appreciate the role of bio-catalytic processes and issues concerned with APIs.	K3
CO3	Design synthetic pathways for heterocycles by logical disconnection route.	K5
CO4	Map organic molecules with respect to functional group clusters, building-block identification.	K4
CO5	Logical disconnection of molecules at strategic bonds and identification of synthons with known chemistry.	K5
CO6	Logical design of synthesis of drug and biological molecules.	K5
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	3	3	3	3	3	3	2
CO2	3	2	2	2	2	2	3	2	2	3	3	1
CO3	3	2	3	3	3	3	2	3	3	1	2	3
CO4	3	3	2	1	2	3	3	2	1	3	1	2
CO5	3	3	2	3	2	3	3	2	3	3	2	2
CO6	3	3	2	3	2	3	3	2	3	3	2	2

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	2	2	3
CO2	3	3	3	3	2
CO3	2	1	2	3	3
CO4	2	3	2	3	3
CO5	2	2	2	2	3
CO6	3	3	2	3	2

PEC-2	**Course Code:** **PHT 1431**	**Course Title:** **SPL11: Medicinal Natural Products**	**Credits = 4**		
			L	**T**	**P**

	Semester: VI	Total Contact Hours: 60	3	1	0
List of Prerequisite Courses					
XII Science, Industrial Chemistry (CHT1408) Introduction to Technology of Pharmaceuticals and Fine Chemicals(PHT1415)					
List of Courses where this course will be a prerequisite					
Drug synthesis Approaches (PHT1439), Project-II(PHP1449)					
Description of the relevance of this course in the B. Tech. Program					
The course is designed to train the students in the basics of Medicinal Natural Products and Phytochemistry.					
Course Contents (Topics and subtopics)			**Required Hours**		
1	Scope of the subject, Sources of the drug of natural origin, Classification of drug		8		
2	Organized and unorganized drugs; study of various plant parts and tissues; Adulterants and Substitutes		8		
3	Biosynthesis approach: Building blocks and metabolic pathways for the formation of secondary metabolites		7		
4	Phytochemistry: Chemical constituents from plants (carbohydrates, proteins, enzymes, lipids, alkaloids, glycosides, steroids, tannins, terpenoids, flavonoids, plant pigments, etc.)		8		
5	Preparation of drugs for commerce and quality control, application of spectroscopy and chromatography techniques for isolation, identification and analysis of phytoconstituents.		8		
6	Extraction and isolation of plant drugs: conventional and modern techniques used in extraction and separation of phytoconstituents		7		
7	Detailed study of one representative from each of the above-mentioned chemical class (10 drugs)		10		
8	Recent advances in phytopharmaceuticals (topic of current interest)		4		
	Total		**60**		
List of Textbooks/ Reference Books					
1	Dewick P.M., Medicinal Natural Products- A Biosynthetic Approach, 2nd edition/2002, John Wiley & Sons Ltd				
2	Bruneton J. Pharmacognosy &Phytochemistry Medicinal Plants, 1999, Lavoisier Publishing Inc.				
3	Harborne J. B. Phytochemical Methods - A Guide to modern techniques of Plant analysis				
4	Ikan R., Natural Products- A Laboratory Guide				
5	Tyler V.E., Pharmacognosy				
6	Trease & Evans, Textbook of Pharmacognosy				
7	Publishers Wallis, Textbook of Pharmacognosy				
8	Wagner H., Plant Drug Analysis- A Thin Layer Chromatography Atlas 1984, Springer-Verlag				
9	Wealth of India (11 volumes), Publications and Information Directorate				
10	Jackson B. P., D. W. Snowdon, Atlas of Microscopy of Medicinal Plants, Culinary Herbs and Spices, 1990, CBS Publishers				
Course Outcomes (students will be able to….)					
CO1	Understand and identify drugs of natural origin.		K3		
CO2	Comprehend the steps involved in the preparation, and evaluation of herbal drugs and phytoconstituents for commerce.		K4		
CO3	Identify the sources, understand the biosynthesis, and application of different classes of phytoconstituents		K4		
CO4	Understand and undertake extraction, isolation, and characterization of phytoconstituents		K3		
CO5	Learn from Case Studies and Examples the importance of secondary metabolites as therapeutic agents.		K4		

CO6	Understand and appreciate various biosynthetic pathways leading to production of secondary metabolites	K3
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	3	2	3	1	2	3	2	1	2	3
CO2	3	3	3	3	3	1	3	3	1	1	2	3
CO3	1	2	2	2	2	1	2	1	1	1	1	3
CO4	3	3	3	3	3	1	3	2	2	1	3	3
CO5	2	2	1	2	1	2	2	1	2	1	2	2
CO6	3	3	1	3	2	3	3	2	3	2	3	3

Mapping of Course Outcomes (Cos) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	2	3	2
CO2	3	3	3	3	3
CO3	3	2	2	3	1
CO4	3	3	3	3	3
CO5	3	2	2	2	1
CO6	3	3	1	3	3

PEC-3	**Course Code: PHT1438**	**Course Title: Structural Analysis by Spectroscopy**	**Credits = 3**		
			L	**T**	**P**
	Semester: VII	**Total contact hours: 45**	**2**	**1**	**0**

List of Prerequisite Courses

Analytical Chemistry (CHT1406) Pharmaceutical Analysis(PHT1416)

List of Courses where this course will be prerequisite

Project-II(PHP1449)

Description of relevance of this course in the B. Tech. Program

To train the students in the structural analysis of organic compounds using spectroscopic and spectrometric methods such as ^{1}H-, ^{13}C-NMR, FT-IR, UV/Vis, Raman, etc.

Course Contents (Topics and subtopics)		**Required Hours**
1	UV-VIS spectroscopy and identification of chromophore	5
2	IR spectroscopy - correlation of absorption frequencies and functional groups. General analysis of IR spectrum	5
3	Proton NMR spectroscopy correlation of chemical shift of a proton with respect to structure. H-H Coupling and J values, On the basis of chemical shift, coupling constants, IR and UV information elucidation of structure of simple molecules	5
4	Mass spectrometry, fragmentation, isotope mass	5
5	Problem-solving using the above spectroscopic and spectrometric methods	5
6	^{13}C-NMR, Chemical Shift correlation, C-H coupling, NOE, DEPT, other techniques to identify p,s,t, and quaternary carbon	5
7	Problem-solving using all the spectroscopic techniques studied above	5
8	Multidimentional NMR COESY, NOESY, and other and structure information generation. With illustrative examples; ^{31}P, ^{15}N, and ^{19}F NMR introduction	5
9	Problem-solving	5

	Total	**45**
List of Textbooks/ Reference Books		
1	Application of absorption spectroscopy of organic Compounds, John R. Dyer, Prentice Hall, India 1987.	
2	Organic Spectroscopy, W. Kemp.	
3	Spectroscopic Identification of Organic Compounds by R. M. Silverstein, G. C. Basslrer, Morill T. C.; John Wiley and Sons, 1991	
4	There are many Websites where structural problem are discussed. Teacher to identify time to time and guide the students.	
5	Jackman, L. M., Sternhell, S.; International Series in Organic Chemistry: Application of Nuclear Magnetic Resonance Spectroscopy in Organic Chemistry; 2nd ed.; Barton, D. H. R., Doering, W., Eds.; Pergamon Press, London (1969).	
6	F.W. McLafferty and F. Turecek- Interpretation of Mass Spectra.	
Course Outcomes (students will be able to….)		
CO1	Revise basic principles of absorption spectroscopy to equip for advanced applications.	K2
CO2	To interpret UV and IR spectra for identification of functional groups in organic molecules.	K4
CO3	Identify proton location at various chemical environments, origin of coupling and coupling constants. Application in structural elucidation, exposure to concept of multidimensional NMR and its value in structure analysis.	K3
CO4	Understand the principle of mass spectrometry, fragmentation pattern and combining fragments to arrive at the structure.	K2
CO5	Hone their structural elucidation skills by combining information from different sources.	K4
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	3	3	3	3	3	3	2
CO2	3	3	2	1	3	3	3	3	3	3	3	1
CO3	3	3	3	3	3	3	2	1	3	3	2	3
CO4	3	3	1	3	2	2	3	3	2	1	3	3
CO5	3	2	3	3	3	3	3	3	3	3	3	2

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	2	3	3
CO2	2	1	3	3	3
CO3	3	3	3	3	2
CO4	1	3	2	2	3
CO5	3	3	3	3	3

PEC-4	**Course Code:** **PHT1439**	**Course Title:** **PEC: Drug Synthesis Approaches**	**Credits = 2**		
			L	**T**	**P**
	Semester: VII	**Total contact hours: 30**	**1**	**1**	**0**

List of Prerequisite Courses		
Organic Chemistry(CHT1408), Medicinal Chemistry(PHT1421) and Pharmaceutical Chemistry-I(PHT1432), Pharmaceutical Chemistry-II(PHT1437), Pharmaceutical Chemistry-III(PHT1446)		
List of Courses where this course will be prerequisite		
Profession career to experience the various aspects in drug synthesis, Project-II(PHP1449)		
Description of relevance of this course in the B. Tech. Program		
To train the students with respect to organic, catalytic and biocatalytic techniques for the synthesis of drug and intermediate; routes for chiral synthesis/chiral separation, use of protecting groups in synthesis and derivatization of natural products		
Course Contents (Topics and subtopics)		**Required Hours**
1	Retrosynthetic Approaches	
	Recap of basic concepts of retrosynthetic analysis	2
	Building blocks in drug synthesis	2
	Cabon-heteroatom bond disconnections, with examples	2
	Carbon-carbon bond disconnections, with examples	2
2	Synthesis of drug molecules by multiple approaches in the following classes of drugs (involving three or more steps):	
	Anti-infective (Two molecules)	2
	CNS drugs (Two molecules)	2
	CVS drugs (Two molecules)	2
	Anti-diabetic drugs (Two molecules)	2
	Anti-histaminics (Two molecules)	2
	Anticancer compounds (Two molecules)	2
	NSAIDs (Two molecules)	2
3	Asymmetric synthesis, resolution of enantiomers applicable to drug synthesis	2
4	Biocatalysis	2
5	Catalytic synthesis	2
6	Protecting groups in organic synthesis	2
	Total	**30**
List of Textbooks/ Reference Books		
1	Warren S. and Wyatt P., Organic Synthesis- The Disconnection Approach, 2nd edition; John Wiley & Sons, Chichester, 2008	
2	Louden M., Organic Chemistry, 5th edition, Roberts and Company Publishers, 2009	
3	Carey F., Organic Chemistry, 9th edition, McGraw-Hill Education, 2013	
4	Corey E. J., Logic of Chemical Synthesis, Wiley-Blackwell; Revised ed., 1995	
5	Iyer RP and Degani M.S, Synthesis of Drugs: A synthon Approach Vol-1, 2nd Ed. Sevak publications Pvt. Ltd	
Course Outcomes (students will be able to….)		
CO1	Apply organic synthesis principles for drug and intermediate synthesis.	K4
CO2	Predict methods and routes for chiral synthesis/chiral separation.	K4
CO3	Explore catalytic and bio-catalytic techniques for the synthesis of drugs and intermediates.	K5
CO4	Create how to derivatize natural products.	K6
CO5	Apply the use of protecting groups in synthesis.	K4
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	3	3	3	3	3	3	3	3	3

CO2	3	3	2	3	2	3	3	3	2	3	3	2
CO3	3	3	3	3	3	2	2	3	3	1	3	2
CO4	3	3	2	3	3	2	3	3	3	3	2	3
CO5	3	3	3	3	2	3	3	3	3	3	3	3

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	2	3	3
CO2	2	1	3	3	3
CO3	3	3	3	3	2
CO4	1	3	2	2	3
CO5	3	3	3	3	3

PEC-4	**Course Code: PHT1440**	**Course Title: Intellectual Property Rights**	**Credits = 2**		
			L	**T**	**P**
	Semester: VII	**Total contact hours: 30**	**1**	**1**	**0**

List of Prerequisite Courses

Validation and regulatory Aspects(PHT1430)

List of Courses where this course will be prerequisite

Project work-II(PHP1449)

Description of relevance of this course in the B. Tech. Program

To train the students with respect to basics of Intellectual Property Rights (IPR) and its application in evaluation of patents, infringements of the drug products and drug substance etc.

Course Contents (Topics and subtopics)		**Required Hours**
1	Introduction to Intellectual Property: overview describing definition, need and evolution	2
2	IPR related laws: Biodiversity	2
3	Introduction to WIPO and Treaties under WIPO	2
4	**Type of Intellectual Property: Copyright** Introduction, Process of filing, rights achieved	2
5	**Type of Intellectual Property: Trademarks** Introduction, Process of filing, rights achieved	2
6	**Type of Intellectual Property: Geographical Indications** Introduction, Process of filing, rights achieved	2
7	**Type of Intellectual Property: Industrial Design** Introduction, Process of filing, rights achieved	2
8	**Type of Intellectual Property: Trade Secret** Introduction, Process of filing, rights achieved	3
9	**Type of Intellectual Property: patent** Introduction Patent and traditional knowledge Indian patent Act Process of filing Rights achieved	4
10	Patentability w.r.t. regional requirements	2
11	Patent filing under Paris Convention Treaty (PCT)	3

12	Role of IPR in Pharmaceuticals	4
	Total	**30**
List of Textbooks/ Reference Books		
1	All documentation from World Intellectual Property Organization (www.wipo.int)	
2	Indian Patent Act (www. ipindia.nic.in)	
3	Pharmaceutical Product Development: Insights into Pharmaceutical Processes, Management and Regulatory Affairs, Patravale V, Rustomjee M, Dsouza J. 2016, CRC press	
Course Outcomes (students will be able to….)		
CO1	Explain various types of Intellectual Property Rights.	K2
CO2	Explain the importance of Intellectual Property Rights in relevance to pharmaceutical inventions.	K3
CO3	Implement the desired practices during professional activities for preserving IPRs.	K4
CO4	Interpret and analyze reactions having different functionalities, deduce and solve problems related to the reactions as well as apply them, if need be.	K4
CO5	Patent drafting	K6
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	3	3	3	3	3	2	2	2	2	2	3
CO2	3	3	3	3	3	1	1	1	2	2	3	3
CO3	2	3	3	3	3	2	2	2	2	2	3	3
CO4	2	3	3	3	3	2	2	3	2	2	3	3
CO5	1	2	2	3	1	2	2	3	2	2	2	3

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	2	3	3	3
CO3	3	2	3	3	3
CO4	3	3	3	3	3
CO5	2	2	2	3	2

PEC-4	**Course Code: PHT1458**	**Course Title: Molecular Biology**	**Credits = 2**		
			L	**T**	**P**
	Semester: VII	**Total contact hours: 30**	**1**	**1**	**0**
List of Prerequisite Courses					
Physiology and Pharmacology(PHT14220)					
List of Courses where this course will be prerequisite					
Project-II(PHP1499)					
Description of relevance of this course in the B. Tech. Program					

To Introduce students to advanced genetic techniques employed to design molecular diagnostic kits and protein therapeutics and to familiarize students with the procedures involved in genetic engineering of plants and animals		
Course Contents (Topics and subtopics)		**Required Hours**
1	Molecular diagnostics: Immunological diagnostic procedures, nucleic acid diagnostic systems, molecular diagnosis of genetic disease	5
2	Protein therapeutics: Biopharmaceuticals, enzymes, monoclonal and recombinant antibodies	5
3	Nucleic acids as therapeutic agents	5
4	**Vaccines:** Subunit vaccines, peptide vaccines, DNA vaccines, attenuated vaccines	5
5	Synthesis of commercial products by recombinant microorganisms: Enzymes, antibiotics, biopolymers; synthetic biology routes for biopharmaceuticals	5
6	Large-scale production of proteins from recombinant microorganisms	5
7	Bioremediation and biomass utilization: Microbial degradation of xenobiotics, genetic engineering of biodegradative pathways, utilization of starch, sugars and cellulose	5
8	Genetic engineering of plants	5
9	Transgenic animals	5
	Total	**30**
List of Textbooks/ Reference Books		
1	Molecular Biotechnology: Principles and Applications of Recombinant DNA, by Glick and Paternak 3rd edition, 2003, ASM Press	
2	Principles of gene manipulation : an introduction to genetic engineering / R.W. Old, S.B. Primrose, 5th edition, 1994, Blackwell Scientific.	
3	Gene Cloning and DNA Analysis: An Introduction, T A Brown, 7th edition, 2015, Wiley-Blackwell	
Course Outcomes (students will be able to….)		
CO1	Describe the procedures involved in designing molecular diagnostic kits.	K3
CO2	Design strategies to synthesize biological products using recombinant microbial host cells.	K5
CO3	Use the knowledge of microbial metabolic processes to carry out genetic engineering of microbes to degrade recalcitrant material.	K5
CO4	Apply different protocols available for genetic engineering of plants and animals.	K3
CO5	Evaluate biodegradable pathways	K5
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	3	3	3	3	3	3	3	2
CO2	3	3	3	3	2	1	3	3	1	3	2	3
CO3	2	2	2	2	2	3	3	2	3	3	3	1
CO4	3	3	3	3	3	3	3	3	3	1	2	3
CO5	2	3	3	3	3	3	3	3	3	3	3	3

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	3
CO2	3	1	2	2	1
CO3	3	3	3	2	3
CO4	3	3	3	2	3
CO5	3	1	2	1	1

HONORS

PCC	Course Code: PHT1426	Course Title: Honors Course-I: Reagents in API Process Industry	Credits =4		
			L	T	P
	Semester: V	Total Contact Hours: 60	3	1	0
List of Prerequisite Courses					
Organic Chemistry(CHT1407), Industrial Chemistry(CHT1408), and Medicinal Chemistry (PHT1421)					
List of Courses where this course will be prerequisite					
Chemistry and Technology of Fine Chemicals (PHT1433) and Process Technology of Drugs and Intermediates(PHT1447)					

Description of relevance of this course in the B. Tech. Program		
Students will be identify the cost effective and green reagents required in the research lab process development and Industry.		
Course Contents (Topics and subtopics)		**Required Hours**
1	**Oxidizing Agents in Organic Transformations:** Various oxidizing reagents will be discussed along with application in Pharmaceutical synthesis	12
2	**Reducing Agents in Organic Transformations** Various reducing reagents will be discussed along with application in Pharmaceutical synthesis	12
3	Organic Transformations-Using Transition Metals	12
4	Organic Transformations-Using Non-Transition Metals	12
5	Organic Transformations-Using Lanthanides Reagents	12
	Total	**60**
List of Textbooks/ Reference Books		
1	P. Wyatt and S. Warren, Organic Synthesis Strategy and Control, Wiley, 2007.	
2	J. J. Li, Name Reaction, Springer, 2nd Edition, 2003	
3	Lanthanides in Organic Synthesis, T. Imamoto, Academic Press, 1994	
4	W. Carruthers, Modern Methods of Organic Synthesis, Cambridge, 4th Edition, 2015.	
5	J. Clayden, Organic Chemistry, Oxford. 2nd Edition, 2014	
Course Outcomes (students will be able to….)		
CO1	Understanding of various organic and inorganic reagents	K3
CO2	Application of reagents in organic synthesis	K4
CO3	Designing of various catalyst for organic transformation and	K5
CO4	Knowledge of important reagents used in chemical/Pharmaceutical industries.	K4
CO5	Evaluating the possible Mechansm of catalyst in the synthesis	K5
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	3	3	3	3	3	3	2
CO2	3	2	2	2	2	2	3	2	2	3	3	1
CO3	3	2	3	3	3	3	2	3	3	1	2	3
CO4	3	3	2	1	2	3	3	2	1	3	1	2
CO5	3	3	2	3	2	3	3	2	3	3	2	2

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	3
CO2	1	2	3	3	2
CO3	3	2	3	3	2
CO4	3	3	3	2	3
CO5	1	2	3	3	2

PCC	Course Code: PHT1433	Course Title:	Credits = 4		
			L	T	P

		Honors Course-II: Chemistry and Technology of Fine Chemicals			
	Semester: VI	**Total contact hours: 60**	**3**	**1**	**0**

List of Prerequisite Courses
Organic Chemistry(CHT1407) Pharmaceutical Chemistry-I(PHT1432), Pharmaceutical Chemistry-II(PHT1437) and Pharmaceutical Chemistry-III(PHT1446)
List of Courses where this course will be prerequisite
Project-I (PHP1444), Process Technology of Drugs and Intermediates (PHP1447) and Project-II(PHP1449)
Description of relevance of this course in the B. Tech. Program
The course is designed to provide the learner a foundation for understanding of both Basic and Applied Chemistry. It gives the learner a bridge between Industrial Chemistry and Pure Chemistry. This course helps to develop a strong thinking process amongst the learners both in technical and applied chemistry which will prepare them for employment and advanced study

	Course Contents (Topics and subtopics)	**Required Hours**
1	**The Chemical Industry:** A Brief History, Fine vs Bulk Vs specialty Chemicals	2
2	**Production of Fine Chemicals** Introduction, Role of Catalysis, Atom Economy, Alternative Reagents and Catalysts, Novel Reaction Routes, Selectivity, Solvents, Conventional Solvents, Alternative Solvent, Production Plants, Multiproduct and Multipurpose Plants (MMPs) , Dedicated Continuous Plants, Batch Reactor Selection, Reactors for Liquid and Gas–Liquid Systems, Reactors for Gas–Liquid–Solid Systems, Batch Reactor Scale-up Effects, Temperature Control, Summary of the Scale-up of Batch Reactors, Safety Aspects of Fine Chemicals, Thermal Risks, Safety and Process Development.	18
3	**Understanding Fine Chemicals:** Selected Fine Chemical Technologies with examples: Alkylation, Halogenation, Oxidation, Reduction, Esterification, Nitration, and Hydrogenation	28
4	**Process Intensification and Process Development:** Introduction and important aspects of it	12
	Total	**60**

List of Textbooks/ Reference Books	
1	UNIT PROCESSES IN ORGANIC SYNTHESIS P. H. Groggins, Editor-in-Chief, Fifth Edition. McGraw-Hill Book Co., Inc., New York (1952)
2	Chemical Process Technology SECOND EDITION JACOB A. MOULIJN MICHIEL MAKKEE ANNELIES E. VAN DIEPEN
3	Fine Chemicals: The Industry and the Business, 2nd ed., Peter Pollak, Wiley

Course Outcomes (students will be able to….)		
CO1	Explain the very basics of small scale industry right from its setting to the various operations and processes used in different chemical manufacturing processes.	K2
CO2	Differentiate between heavy and fine chemicals and state their various applications in industry and daily life.	K3
CO3	Explore the process of manufacture of variety of fine chemicals.	K5
CO4	Demonstrate the process of preparation of solutions and adapt a method of the planning and implementation of organic and inorganic reactions.	K4
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	3	3	3	3	3	3	3
CO2	3	2	2	2	2	3	3	3	1	2	3	3
CO3	3	3	2	2	1	1	3	3	3	3	3	3

CO4	3	3	2	2	2	3	1	2	3	3	3	3
CO5	3	3	2	2	2	3	3	3	3	3	3	3

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	3	3	2
CO2	2	2	3	2	2
CO3	2	2	3	3	2
CO4	2	2	3	2	2
CO5	2	2	3	2	2

PCC	**Course Code:** **PHT 1441**	**Course Title:** **Honors Course-III: Chemistry of Natural Products**	**Credits = 4**		
			L	**T**	**P**
	Semester: VII	**Total contact hours:**	**3**	**1**	**0**

List of Prerequisite Courses

Organic Chemistry(CHT1407) Pharmaceutical Chemistry-I(PHT1432), Pharmaceutical Chemistry-II(PHT1437) and Pharmaceutical Chemistry-III(PHT1446)

List of Courses where this course will be prerequisite

Project-I (PHP1444), Process Technology of Drugs and Intermediates (PHP1447) and Project-II(PHP1449)

Description of relevance of this course in the B. Tech. Program

The course aims to acquaint the students to various classes of bioactive natural products and their biosynthetic routes. A large number of natural products are used as therapeutic agents for varied indications. Understanding the chemistry of natural products will help design their semisynthetic analogs for improving their pharmacokinetic, pharmacodynamic and toxicity profiles.

	Course Contents (Topics and subtopics)	**Required Hours**
1	**General Classification of Natural Products** **Vitamins:** Classification, Structural chemistry and stability of fat-soluble vitamins Organic chemistry of biochemical role	10
2	**Structural chemistry and stability of water-soluble vitamins** and Organic Chemistry of biochemical role. ω3 fatty acids	10
3	**Hormones** (other than steroids and those not covered in detail under Medicinal Chemistry) Classification, structural chemistry, Organic Chemistry of biological role, Organic chemistry of biosynthesis. Synthesis of peptides: protecting groups	5
4	**Coupling Agents**, solid-phase synthesis, Synthesis of some synthetic Peptide hormones. Structures of poisonous peptides	4
5	**Terpenes:** classification; organic chemistry of biosynthesis, Wagner-Meerwein and other rearrangements, Terpenes as pharmaceutical raw Materials	4
6	**Terpenoids of Biological Importance:** form neem, texanes, artemisinin, terpinoid, iridoids, alkaloids, structure and biological activity	1
7	**Pyrethroids and Retinones:** Occurrence, structure and reactions, biological activity and unique features	3
8	**Plant Pigments:** Occurrence, classifications, nomenclature, structure and characteristic features, Pharmaceutically important flavonoids, polyphenols, organic chemistry of biosynthesis, organic chemistry of Biological anti-oxidant activity. Carotenoids,	5

9	**Porphyrins:** Structure, general chemistry, and properties, Some examples to be discussed Hemoglobin, chlorophyll, and cytochromes	3
10	**Eicosanoids:** Classification, nomenclature, and chemical properties	8
11	**Alkaloids** (details will be covered elsewhere): only organic chemistry of biosynthesis of any three classes to be covered	2
12	**Marine Natural Products:** Classification, unique structural features and biological , organic chemistry of biosynthetic path way of any one	2
13	**Antibiotics** not covered elsewhere, structure and organic chemistry of Their biological activity, importance as new lead molecules.	2
14	**Carbohydrate-derived Natural Products**, nojirimycins, glycosides, biological activity	1
	Total	**60**

List of Textbooks/ Reference Books	
1	Chemistry of Natural Products, R.H. Thopson, Springer International Edition (2008)
2	Insecticides of Plant Origin, J. T. Arnason et al, American Chemical Society (1989)
3	Biochemistry, D.E. Metzler, Academic Press (2001)
4	Organic Chemistry, G. M. Loudon, Oxford University Press (2002)
5	Introduction to Flavonoids, B.A. Bohm, Harwood Academic Publisher (1998)
6	Studies in Natural Product Chemistry: Structure and Chemistry – Series Atta-ur Rahman; Elsevier
7	Recent Review articles on specific topics

Course Outcomes (students will be able to….)		
CO1	Appreciate organic chemical reaction types that play a role in enzymatic transformations, biosynthesis and synthesis	K3
CO2	Understand biosynthetic pathways leading to natural products and the enzymes involved therein.	K3
CO3	Know characteristic features and typical biological activity with respect to structural features and synthetic routes.	K4
CO4	Evaluate the potential of natural products for therapeutic applications.	K5
CO5	Creative Approaches in the synthesis	K6

K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	3	3	3	3	2	3	2
CO2	3	2	2	2	1	3	3	3	2	3	3	1
CO3	3	1	1	3	1	2	2	3	2	3	2	1
CO4	3	2	1	2	2	3	3	2	3	3	3	2
CO5	3	3	2	2	2	3	3	3	2	3	3	2

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	3
CO2	2	2	3	2	3
CO3	3	3	2	3	3
CO4	3	3	3	2	3
CO5	3	3	3	2	3

PCC	Course Code: PHT1447	Course Title: Honors Course-IV: Process Technology of Drugs and Intermediates	Credits = 3		
			L	T	P
	Semester: VIII	Total contact hours: 45	2	1	0

List of Prerequisite Courses

Organic Chemistry(CHT1408), Introduction to Technology of Pharmaceuticals and Fine Chemicals (PHT1415), Medicinal Chemistry(PHT1421) and Pharmaceutical Chemistry-I(PHT1432), Pharmaceutical Chemistry-II(PHT1437), Pharmaceutical Chemistry-III(PHT1446)

List of Courses where this course will be prerequisite

Project-II(PHP1449), Professional Career and future academic research

Description of relevance of this course in the B. Tech. Program

To train the students with respect to process development, basic requirements for safe plant design and unit operations. Scale up of process.

	Course Contents (Topics and subtopics)	Required Hours
1	**Concept of Fine Chemicals and Bulk Drugs** and their salient features Research and Development strategies in Pharmaceutical Industry Flow Sheets – Types, Flow symbols, Line symbols	4
2	**Concept of All-purpose and Multipurpose Plants** Plant Design, Effluent treatment, Solvent recovery for fine chemicals and Bulk Drugs	5
3	**Introduction, Chemical Process Life-cycle** Legislative requirements for safe process development and scale-up	4
4	**Development Techniques for Safe Process Design** Unit operations posing particular hazards during development	5
5	**Strategies for Chemical Hazards Assessment**, Hazards of gas and vapor generation, Identification of highly-energetic materials, Small-scale screening tests Case Studies	5
6	**Introduction to the Purpose of Chemical Development**, Discovering the best synthetic route Selecting the best route for scale-up, Choice of raw materials, reagents, etc. Case Studies	5
7	**Investigative Approach to Chemical Development**, Effect of process variables on yield and quality of products Quality Control in Process Analysis as an aid to optimization	4
8	**Designing a Robust Process** and preventing scale-up problems, Solvent effects, Work-up and product isolation, Selecting the parameters to vary, Planning for scale-up	7
9	**Design of Environment-friendly Processes**, Effluent minimization and control, Statistical methods of optimizations	6
	Total	**60**

List of Textbooks/ Reference Books

1	Mahmound M. “Pollution Prevention Through Process Integration (Systematic Design Tools)” Academic Press (1997)
2	Neal G. Andreson, Practical Process Research and Development, Academic Press (2000)
3	A. Cybulski, Fine Chemicals Manufacture- Technology and Engineering Elsevier Publication, (2000)
4	Chemical Process Quantitative Risk Analysis. AIChE Publication (2000)
5	Gopal Rao, M. and Sittig, M., Dryden’s Outlines of Chemical Technology, 3 Affiliated East West Press Pvt. Ltd. (2001)
6	Austin, G.T., “Shreve’s Chemical Process Industries”, 5th edition, McGraw Hill Book Company (1984)

Course Outcomes (students will be able to….)

CO1	Understand the principles of process design along with presentation and selection of different routes.	K4
CO2	Follow the impact of regulatory statutes on process development.	K5

CO3	Analyze the importance of process variables and their influence in scale-up	K4
CO4	Acquire the knowledge of Green Chemistry, hazards, effluents and statistical methods.	K4
CO5	Create the process flow diagram for the drug and intermediates	K6
K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating		

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	3	3	3	3	3	3	3	3	3
CO2	3	3	2	3	2	3	3	3	2	3	3	2
CO3	3	3	3	3	3	2	2	3	3	1	3	2
CO4	3	3	2	3	3	2	3	3	3	3	2	3
CO5	3	3	3	3	2	3	3	3	3	3	3	3

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	2	3	3
CO2	2	1	3	3	3
CO3	3	3	3	3	2
CO4	1	3	2	2	3
CO5	3	3	3	3	3

PCC	**Course Code: PHT1448**	**Course Title: Honors Course-V : Novel Drug Delivery System**	**Credits = 3**		
			L	**T**	**P**
	Semester: VIII	**Total contact hours: 45**	**2**	**1**	**0**

List of Prerequisite Courses

Pharmaceutical Formulation Technology-I (PHT1417), Pharmaceutical Formulation Technology II(PHP1424), Pharmaceutical Formulation Technology Laboratory-III (PHP1445)

List of Courses where this course will be prerequisite

Research Project-II(PHP1449)

Description of relevance of this course in the B. Tech. Program

To train the students on technological aspects of drug delivery systems

Course Contents (Topics and subtopics)		**Required Hours**
1	**Oral drug delivery systems** Oral controlled release drug delivery, Gastro-retentive drug delivery, Osmotic drug delivery, Ionexchange controlled drug delivery, Pulsatile drug delivery, Pelletization, Hydrodynamically balanced DDS including recent advances	**8**
2	**Nano drug delivery systems** Colloidal DDS: Specialized DDS like micro / nano emulsions, SMEDDS, Multiple emulsions,sub-micron emulsions, liposomes, niosomes, and other vesicular DDS, nanoparticles, their design and development into final dosage forms, issues and consideration	**7**
3	**Mucosal drug delivery systems** Bioadhesion and bioadhesive polymers, Formulation considerations for mucosal administration	**7**

4	**Pulmonary drug delivery systems** Design of Pressurized aerosols, Inhaler (dry powder and metered dose), Devices foradministration and evaluation	**7**
5	**Transdermal drug delivery system** Percutaneous absorption and penetration enhancers, development of transdermal gels, patches with reference to manufacturing equipment, components and evaluation.Iontophoretic and Sonophoretic DDS.	**8**
6	**Miscellaneous** Injectable: Preformulation factors and essential requirements, vehicles, additives, Formulationsof injections sterile powders, large volume parenterals, and lyophilization. Ophthalmic drug delivery system: Design of controlled release ophthalmic DDS including gels,inserts, novel DDS and evaluation.	**8**
	Total	**45**

List of Textbooks/ Reference Books

1	Handbook of Pharmaceutical Controlled Release Technology, edited by Donald Wise MarcelDekker, 2000.
2	Bioadhesive Drug Delivery Systems Fundamentals, Novel Approaches, and Development Series Volume: 98 Edited By: Edith Mathiowitz; Don E. Chickering; Claus-Michael Lehr 1999.
3	Nasal Systematic Drug Delvery Series Volume: 39 Yie W. Chien; Kenneth S. E. Su; Shyi-FeuChang 1989.
4	Transdermal Drug Delivery by Richard H. Guy (Editor), Jonathan Hadgraft (Editor), MichikoElizabeth BarroYusa Marcel Dekker; 2nd edition (January 2003)
5	Ophthalmic Drug Delivery Systems, edited by AshimMitra, Marcel Dekker, 1993.
6	Novel Drug Delivery Systems Second Edition, Revised and Expanded Series Volume: 50 Yie W.Chien, 1991
7	Controlled Release Veterinary Drug Delivery by Michael J. Rathbone (Editor), Robert Gurny (Editor)Elservier Science; 1st edition (July 1, 200)
8	Polymeric Drugs and drug Delivery Systems Raphael M. Ottenbrite and Sung Wan Kim, eds. Technomic, 2001.
9	Controlled Drug Delivery – Foudamentals& applications by J. R. Robinson-2nd edition – Marcel Dekker, 1987
10	Dermatological Formulations: Percutaneous absorption by Brian W. Barry
11	Electricity Assisted Transdermal and Topical Drug Delivery by Ajay K. Banga, Tayior and Francis; (September 1998)
12	Mechanisms of Transdermal Drug Delivery Volume: 83 Edited By: Russell O. Potts; Richard H. Guy. 1997.
13	Transdermal Controlled Systemic medications by Y. W. Chien, Marcel Dekker, 1987
14	Biopharmaceutics of Ocular Drug Delivery by Peter Edman CRC Press: (November 18, 1992)

Course Outcomes (students will be able to….)

CO1	Understand and appreciate the basics of oral and nano drug delivery systems	K3
CO2	Gain an in-depth understanding of specialized drug delivery systems such as mucosal and pulmonary.	K6
CO3	Follow the underlying principles of transdermal drug delivery systems and their industrial-scale manufacturing	K6
CO4	Gain an overview of the parenteral and ophthalmic drug delivery systems including their manufacturing aspects	K4
CO5	Detail understanding of characterization and evaluation techniques for the above drug delivery systems	K5

K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (POs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	2	2	3	2	2	2	3
CO2	3	3	3	3	3	3	2	3	2	2	2	3
CO3	3	3	3	3	3	3	3	3	2	3	2	3
CO4	3	3	3	3	3	3	3	3	2	2	2	3
CO5	3	3	3	3	3	3	3	3	2	2	2	3

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3