Syllabus for Bachelor of Technology

(B.Tech. in Pharmaceutical Chemistry and Technology)

(Under the New Education Policy-NEP 2020)

in (2023-2024)

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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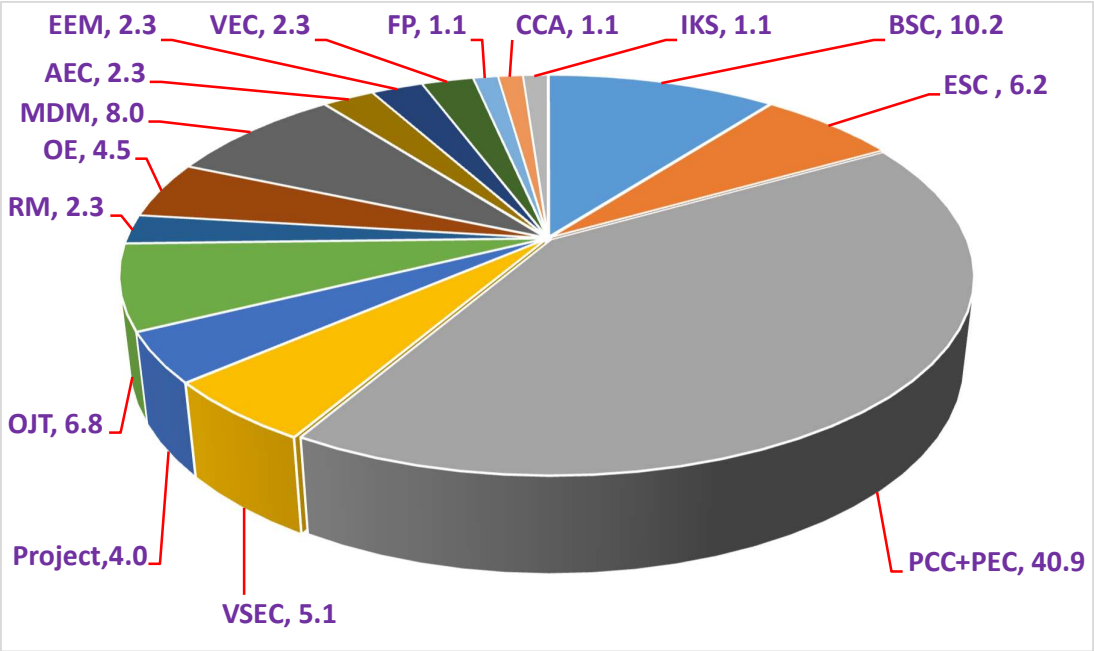
Department of Pharmaceutical and Sciences and Technology

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 Organisations 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 following Credit Distribution



This does not include Honors courses of 18 credits.

All the courses are credit based and the evaluation 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. Teacher can have the freedom to interchange lectures / tutorials depending upon the topic. Institute gives emphasis on continuous evaluation with considerable freedom to the teacher in deciding the mode of evaluation.

B. Tech. (Pharmaceuticals Chemistry and Technology)

PROGRAMME EDUCATIONAL OBJECTIVES for B. Tech. (Pharm. Chem. Tech.)

PEO-1:	To generate excellent trained undergraduates with state of art knowledge in pharmaceutical technology and allied subjects in an ambience of motivation that could stimulate growth and excellence.
PEO-2:	To create undergraduates who are trained in sync with the requirements of the pharmaceutical industry and adapt readily to national healthcare programmes.
PEO-3:	To create professionals of standing who would spread across the country and the globe in various areas including education, research, industry and government.
PEO-4:	To mold students to emerge as future leaders of the pharmaceutical industry and as entrepreneurs.
PEO-5:	To sensitize students to local and global needs of environment protection and sustainability.

Programme Outcomes (POs) for B. Tech. (Pharm. Chem. & Tech.)

PO1	Pharmaceutical Technology Knowledge: Apply the knowledge of mathematics, science, chemical engineering and Pharmaceutical technology fundamentals, and Pharmaceutical technology specialization to the solution of complex problems in Pharmaceutical technology.
PO2	Problem Analysis: Identify, formulate, review research literature, and analyze complex Pharmaceutical technology problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and Pharmaceutical engineering sciences
PO3	Design/Development of Solutions: Design solutions for complex Pharmaceutical technology 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 modelling to complex Pharmaceutical technology 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 practice of Pharmaceutical technology
PO7	Environment and Sustainability: Understand the impact of the professional Pharmaceutical technology 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 practice of Pharmaceutical technology.
PO9	Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings
PO10	Communication: Communicate effectively on complex Pharmaceutical technology activities with the Pharmaceutical 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 Pharmaceutical technology 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 life-long learning in the broadest context of technological change.
(B) Programme Specific Outcomes (PSOs)	
PO13	Pursue higher studies/research with high level of motivation, in institutes of international repute.
PO14	Apply the knowledge and training in Pharmaceutical technology to emerge as entrepreneurs.
PO15	Evolve as technocrats who could influence major policy decisions related to pharmaceutical and allied industries

Graduate Attributes

1. Problem analysis and solving skills
2. Familiar with usage of modern tools, techniques

3. Communication Skills
4. Capacity to analyze new concepts
5. Capacity to analyze and interpret experimental data Capacity to analyze business trends
6. Capacity to design, optimize and operate equipment and plants safely, economically and effectively
7. Design and Development of solutions to industrial and societal needs
8. Skills related to Project Management and Economics
9. Skills to analyze scientific literature including patents
10. Ethics

Syllabus Structure for B. Tech Course

SEMESTER- I

Course Code	Subjects	Course Type	Credits	Hrs/Week			Marks for various Exams			
				L	T	P	C.A.	M.S.	E.S.	Total
CHT1405	Physical Chemistry	BSC	3	2	1	0				
CHT1406	Analytical Chemistry	BSC	3	2	1	0				
MAT1301	Engineering Mathematics	ESC	3	2	1	0				
PYT1205	Applied Physics	BSC	2	1	1	0				
GET1305	Engineering Graphics and Computer Aided Drawing	VSEC	3	1	0	4				
PHT1415	**SPL-1:** Introduction to Technology of Pharmaceuticals and Fine Chemicals	ESC	2	1	1	0				
PYP1101	Physics Laboratory	BSC	2	0	0	4				
HUT1110B	Communication Skills(English)	AEC	2	0	0	4				
	OPEN Activity - Sports/ Fine arts/Yoga/ Music/NSS**	CCA	2	0	0	4				
	TOTAL:		**22**	**9**	**5**	**16**				

SEMESTER- II

Subject Code	Subjects	Course Type	Credits	Hrs/week			Marks for various Exams			
				L	T	P	C.A.	M.S.	E.S.	Total
CHT1407	Organic Chemistry	BSC	3	2	1	0				
CHT1408	Industrial Chemistry	BSC	3	2	1	0				
PHT1416	**SPL-2**: Pharmaceutical Analysis	PCC	2	1	1	0				
GET1306	Basic Mechanical Engineering	ESC	2	1	1	0				
GET1125	Electrical Engineering and Electronics	ESC	2	1	1	0				
CEP1720	Process Calculations	ESC	2	0	0	4				
CHP1343	Physical and Analytical Chemistry Laboratory	BSC	2	0	0	4				
CHP1132	Organic Chemistry Laboratory	VSEC	2	0	0	4				
	OPEN Activity- Sports/ Fine Arts/Yoga/ Music/NSS**	CCA	2	0	0	4				
	MOOC- Indian Knowledge System (NPTEL - Introduction to Ancient Indian Technology)	IKS	2	0	0	4				
	TOTAL:		**22**	**7**	**5**	**20**				

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	**Subjects**	**Course Type**	**Credits**	**Hrs /week**			**Marks for various Exams**			
				L	**T**	**P**	**C.A.**	**M.S.**	**E.S.**	**Total**
PHT1417	**SPL-3:** Pharmaceutical Formulation Technology-I	PCC	4	3	1	0				
PHT1418	**SPL-4:** Pharmaceutical Green Chemistry	PCC	2	1	1	0				
OE	From Basic Sciences (Chemistry/ Physics/Biology / Maths / Humanities)	OE	4	3	1	0				
	Communication Skills – (Marathi / Hindi or Any other language will be chosen using MOOCS)	AEC	2	1	1	0				
HUT1205	Basic Economics and Finance	EEM	2	1	1	0				
	Digital Computation in Emerging Areas **(NPTEL course: Introduction To Industry 4.0 & Industrial Internet of Things)**	VEC	2	1	1	0				
	MDM-I: From Sciences and/or any other Engineering / Humanities Discipline	MDM	2	1	1	0				
PHP1419	**Pr 1**: Lab-1: Pharmaceutical Formulation Technology Laboratory-I	PCC	2	0	0	4				
PHP1420	**Pr 2**: Lab 2: Pharmaceutical and Biochemistry Analysis	PCC	2	0	0	4				
	TOTAL:		**22**	**11**	**7**	**8**				
	SEMESTER- IV									
Subject Code	**Subjects**	**Course Type**	**Credits**	**Hrs/week**			**Marks for various Exams**			
				L	**T**	**P**	**C. A.**	**M.S.**	**E. S.**	**Total**
CET1105	Transport Phenomena	PCC	4	3	1	0				
PHT1421	**SPL-5:** Medicinal Chemistry	PCC	3	2	1	0				
PHT1422	**SPL-6**: : Physiology and Pharmacology	PCC	3	2	1	0				
OE	From Basic Sciences (Chemistry/ Physics/ Biology / Maths) or Humanities Discipline(Biochemistry and Micro)	OE	2	1	1	0				
CET1805	Chemical Process Economics	EEM	2	1	1	0				
HUT1206	Environmental Sciences and Technology	VEC	2	1	1	0				
	MDM II: From Sciences and/or any other Engineering /Humanities	MDM	2	1	1	0				
	Community Projects#	CEP/FP	2	0	0	4				
PHP1423	**Pr 3**: Lab-3: Pharmaceutical Chemistry Laboratory-1	VSEC	2	0	0	4				
	TOTAL:		**22**	**11**	**7**	**8**				

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	**Subjects**	**Course Type**	**Credits**	**Hrs /week**			**Marks for various Exams**			
				L	**T**	**P**	**C. A.**	**M.S.**	**E. S.**	**Total**

CET1806	Chemical Reaction Engineering	PCC	2	1	1	0				
CET1807	Chemical Engineering Operations	PCC	2	1	1	0				
PHT1424	**SPL-7**: Pharmaceutical Formulation Technology-II	PCC	4	3	1	0				
	Offered by the department/MOOCs (one of the electives can be **PHT1425**) **SPL-8** : Pharmaceutical Chemistry and Catalytic Processes	PEC	4	3	1	0				
OE	**MOOCs**- From Other Science Disciplines and Humanities	OE	2	1	1	0				
PHT1426	**Honors Course-I (Reagents in API Process Industry)**	PCC	4	3	1	0				
	MDM III: From Sciences and/or any other Engineering / Humanities Discipline	MDM	4	2	0	4				
PHP1427	**Pr 4**: Lab 4: Pharmaceutical Chemistry Laboratory	PCC	2	0	0	4				
PHP1428	**Pr 5**: Lab 5 : Pharmaceutical Formulation Technology laboratory-II	PCC	2	0	0	4				
	TOTAL:		**26**	**14**	**6**	**12**				
	SEMESTER- VI									
Subject Code	**Subjects**	**Course Type**	**Credits**	**Hrs/week**			**Marks for various Exams**			
				L	**T**	**P**	**C.A.**	**M.S.**	**E. S.**	**Total**
PHT1429	**SPL-9**: Pharmaceutical Biotechnology	PCC	3	2	1	0				
PHT1430	**SPL-10** : Validation and Regulatory Requirements	PCC	3	2	1	0				
	Offered by the department/MOOCs (one of the electives can be **PHT1431**) **SPL-11**: Medicinal Natural Products	PEC	4	3	1	0				
PHT1432	**SPL-12**: Pharmaceutical Chemistry-I	PCC	4	3	1	0				
PHT1433	**Honors Course-II (Chemistry and Technology of Fine Chemicals)**	PCC	4	3	1	0				
	MDM IV: From Sciences and/or any other Engineering / Humanities Discipline	MDM	2	1	1	0				
CEP1714	Chemical Engineering Laboratory	VSEC	2	0	0	4				
PHP1434	**Pr 6**: Lab-6 Biotechnology Laboratory	PCC	2	0	0	4				
PHP1435	**Pr 7**: Lab -7 : Medicinal Natural Products Laboratory	PEC	2	0	0	4				
	TOTAL:		**26**	**14**	**6**	**12**				
	SEMESTER- VII									
Subject Code	**Subjects**	**Course Type**	**Credits**	**Hrs/week**			**Marks for various Exams**			
				L	**T**	**P**	**C. A.**	**M.S.**	**E.S.**	**Total**
PHT1436	**SPL-13**: Pharmaceutical Formulation Technology-III	PCC	3	2	1	0				
PHT1437	**SPL-14**-Scale Up in Pharma Industry	PCC	2	1	1	0				
	Offered by the department/MOOCs (one of the electives can be **PHT1438)** Structure Analysis by Spectroscopy	PEC	3	2	1	0				

	Offered by the department/MOOCs (one of the electives can be **PHT1439** Drug Synthesis Approaches / **PHT1440** Intellectual Property Rights	PEC	2	2	0	0				
PHT1441	**Honors-III (Chemistry of Natural Products)**	PCC	4	3	1	0				
	MDM V: From Sciences and/or any other Engineering / Humanities Discipline	MDM	2	1	1	0				
PHP1442	Literature Review (Research Methodology - I)	RM-1	2	1	0	2				
PHT1443	Design and Analysis of Experiments (Research Methodology - II)	RM-2	2	1	0	2				
PHP1444	Project –I (Literature search+ Expt)	Project	4	0	0	8				
PHP1445	**Pr 8**: Lab-8: Pharmaceutical Formulation Technology Laboratory-III	PCC	2	0	0	4				
	TOTAL:		**26**	**13**	**5**	**16**				
	SEMESTER- VIII									
Semester-VIII (10 weeks)										
Subject Code	**Subjects**	**Course Type**	**Credits**	**Hrs /week**			**Marks for various Exams**			
				L	**T**	**P**	**C.A.**	**M.S.**	**E. S.**	**Total**
PHT1446	**SPL-15**: Pharmaceutical Chemistry-II	PCC	3	5	1	0				
PHT1447	**Honors Course-IV: (Process Technology of Drugs and Intermediates)**	PCC	3	5	1	0				
PHT1448	Honors Course-V **(Novel Drug Delivery System)**	PCC	3	5	1	0				
	MDM VI: From Sciences and/or any other Engineering / Humanities Discipline	MDM	2	2	1	0				
PHP1449	Project-II(Experiments)	PCC	3	0	0	12				
PHP1450	**Pr 9**: Lab-9: Process Technology Laboratory	PEC	2	0	0	6				
Semester-VIII (12-16 weeks)										
PHP1451	Internship with Industry	OJT	12	0	0					
	Total		**28**	**17**	**4**	**18**				

Internship

- In the Eighth semester, every student will have to undergo an internship and/or On Job Training. The Internship would be of 12 credits.
- The internship would be assigned to the student by the Departmental Internship Coordinator, with the approval of Head, of the Department.
- 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.
- The internship could be of the following forms:
- Industrial internship in a company (within India or Abroad) involved in R&D / design / manufacturing (QA/QC/Plant Engineering/Stores and Purchase) / marketing / finance / consultancy / Technical services / Engineering / Projects, etc.
- 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.
- 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 Head of the Department.
- Students will be assigned a grade based on the written report and a presentation; evaluated by a committee of faculty members.

	Feedback will be taken from Industry mentors and this will used while assigning the grades

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 Education 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

EXIT Policy

Based on the National Education Policy guidelines, the students have an option of exiting at each level of their four year program. Student will get certificate after 1st year, diploma after second year and BSc (Tech) after third year.

Sr. No.	Exit Year	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 (CCPCT)	8	8 weeks
3	3rd Year (After Semester VI)	In-plant training	8	8 weeks

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, other multidisciplinary courses on Chemistry / Chemical Technologist.

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

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, etc.

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
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 Text Books/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	*Elements of Physical Chemistry* (7th edition) by P. W. Atkins and J. de Paula, Oxford University Press, 2016.
CO2	*Physical Chemistry* (6th edition) by Ira Levine, McGraw-Hill Education, 2009
CO3	Elucidate the effect of thermodynamic quantities on chemical equilibria and relate it to properties of chemical systems
CO4	Comprehend fundamental knowledge in chemical kinetics with basics of order, molecularity and temperature effect
CO5	Examine kinetics for complex, fast as well as surface reactions and comprehend different theories in kinetics

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO2	K3	3	3	2	2	2	3	1	3	0	3	2	2	2	3
CO3	K3	3	3	1	2	2	0	3	3	2	3	3	2	3	3
CO4	K2	2	2	0	2	0	3	3	3	3	3	3	1	2	2
Course	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

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 , other Chemistry Courses

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.

Sr. No.	**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	Apply the knowledge of sampling, data analysis and select proper analytical method. (K3)
CO2	Explain the principles of UV Visible and Fluorescence spectroscopic methods. (K2)
CO3	Explain the principles of electrochemical methods. (K2)
CO4	Understand the principles of chromatographic separations. (K2)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	2	2	3	3	0	3	3	0	2	3	3
CO2	K2	3	1	0	1	1	0	3	3	2	3	3	0	2	2
CO3	K2	3	2	1	2	0	3	3	3	3	2	3	1	3	2
CO4	K2	3	2	1	1	1	3	2	3	3	3	3	1	1	2
Course	K3	3	2	2	2	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge-level from cognitive domain; A, Affective domain; P, Psychomotor domain

ESC	**Course Code: MAT 1301**	**Course Title: Engineering Mathematics**	**Credits = 3**		
			L	**T**	**P**
	Semester: I	**Total contact hours: 45**	**2**	**1**	**0**

List of Prerequisite Courses	
HSC Standard Mathematics	
List of Courses where this course will be prerequisite	
This is a basic Mathematics course. This knowledge will be required in almost all subjects later.	
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 concepts in the later part of the technology programs in ICT Mumbai. This course will also introduce probability distributions and basic statistics will be helpful to understand various data science studies in different engineering 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.	15

	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	
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 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	15
	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(K2, K3)
CO2	Understand the computational and geometrical concepts related to linear transformations, eigenvalues and eigenvectors and apply them to solve computational problems(K1, K2, K3)
CO3	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 Engineering especially in AI and ML.(K2, K3, K5)
CO4	Understand the concepts of various probability distributions and apply them to analyze various engineering problems and make inference about the system (K2, K3, K4)
CO5	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 engineering disciplines (K3, K4, K5)

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

		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	0	2	3	3	2	3	3	3	2	3	3
CO2	K3	3	3	2	2	2	3	1	1	3	3	2	1	3	3
CO3	K2	3	2	1	2	1	2	3	3	3	3	3	0	3	2
CO4	K3	3	3	2	1	2	3	2	0	0	0	3	2	3	3
CO5	K3	3	3	1	2	2	3	3	2	3	3	1	2	3	3
Course	K3	3	3	2	2	2	3	3	2	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

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

	List of Prerequisite Courses
1	Standard XI and XII Physics course, Standard XII Chemistry course
	List of Courses where this course will be prerequisite
1	Applied Physics Laboratory (Sem-II) Materials Science Minor program courses (Sem-III, IV, V, VI, VII, VIII), Open Elective courses from Physics Department (Sem-II, IV, V)
	Description of relevance of this course in the B. Chem.Tech. Program
The physics of solids and fluids play a key role in the various areas of chemical technology. The Applied Physics course will provide the students with the necessary fundamentals to develop a broad understanding of various aspects related to solids and fluids, and thereby equip them with the ability to apply it wherever required in their course of study.	

	Course Contents (Topics and subtopics)	Reqd. hours
	Solid State Physics	
1	**Crystal Structure of Solids**: A revision of concepts of a lattice, a basis, unit cell, different crystal systems (SC, BCC, FCC, HCP), co-ordination number 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
6	An introduction to Rheology: Parameters of viscous flows, Newtonian and non-Newtonian behaviour, 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 understand periodicity in the crystal lattice.
CO2	Analyze a given x-ray diffraction pattern to deduce the crystal structure of the material and calculate the values of the basic structural parameters.
CO3	Classify solids, and in turn semiconductors, based on electron occupancy and calculate basic quantities related to charge transport in them. Analyze simple ideal fluid flows by applying the continuity equation and Bernoulli's equation.
CO4	Describe the basic behaviour of viscous flows and the relationships between various flow parameters. Understand simple models that are used to describe viscoelastic flows.
CO5	Assign Miller indices to various crystallographic planes and directions in a crystal lattice, thereby understand periodicity in the crystal lattice.

CO6	Analyze a given x-ray diffraction pattern to deduce the crystal structure of the material and calculate the values of the basic structural parameters.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	2	2	1	1	3	3	3	3	2	3	3
CO2	K3	3	1	2	1	2	3	3	3	3	3	0	2	1	3
CO3	K2	3	2	1	2	0	3	3	3	3	2	3	1	3	2
CO4	K3	2	3	2	1	2	2	0	2	3	3	3	2	0	3
CO5	K2	3	2	1	2	0	0	3	3	1	3	1	1	3	2
CO6	K3	2	3	2	1	2	2	0	2	3	3	3	2	0	3
Course	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

VSEC	Course Code: GET1305	Course Title: Engineering Graphics and Computer Aided Drawing	Credits = 3		
			L	T	P
	Semester: I	Total Contact Hours: 75	1	0	4

List of Prerequisite Courses

Mathematics, Geometry, basic drawing and visualization

List of Courses where this course will be prerequisite

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 engineers and technologists. A student is required to know the various processes and the equipment 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 equipments. The subject of "drawing" is a medium through which, one can learn all such matter, because the "drawings" are used to represent objects and various processes on the 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.	20
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
3	**Isometric projections**: Concept of isometric views, isometric projections and isometric scale, Iso metric projections of different solids and machine components	15
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.	25
	Total	**75**

List of Textbooks/Reference Books

1	Engineering Drawing by N.D.Bhat
2	Engineering Drawing by N.H.Dubey
3	CAD/CAM: Theory and Practice by Ibrahim Zeid and R Sivasubramanian

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

CO1	Draw Orthographic and Sectional Orthographic Views from Pictorial View 2 Draw isometric view when Front View and either top view or side view is given. 3 Understand basics of Assembly Drawing 4 Understand basics of CAD and Prepare 2D,3D drawings using CAD.
CO2	Draw Orthographic and Sectional Orthographic Views from Pictorial View 2 Draw isometric view when Front View and either top view or side view is given. 3 Understand basics of Assembly Drawing 4 Understand basics of CAD and Prepare 2D,3D drawings using CAD.
CO3	Draw Orthographic and Sectional Orthographic Views from Pictorial View 2 Draw isometric view when Front View and either top view or side view is given. 3 Understand basics of Assembly Drawing 4 Understand basics of CAD and Prepare 2D,3D drawings using CAD.
CO4	Draw Orthographic and Sectional Orthographic Views from Pictorial View 2 Draw isometric view when Front View and either top view or side view is given. 3 Understand basics of Assembly Drawing 4 Understand basics of CAD and Prepare 2D,3D drawings using CAD.

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

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO2	K3	3	2	2	2	2	3	3	3	1	2	3	2	3	1

CO3	K3	3	3	2	2	1	1	3	3	3	3	3	2	2	3
CO4	K3	3	3	2	2	2	3	0	2	3	3	3	2	3	1
Course	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution
K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

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:**	**1**	**1**	**0**

List of Prerequisite Courses

XXI and XXII Chemistry, Physics and Mathematics

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	Principles of Pharmacology, HL Sharma, KK Sharma, Paras Medical Publisher
2	An introduction to pharmaceutical sciences: Production, chemistry, techniques, and technology, Jiben Roy, Woodhead Publishing Series in Biomedicine
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	Remington - The Science And Practice Of Pharmacy (Vol.1& 2), David B. Troy, 21st edition, 2006, Lippincott Williams &Wilkins
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 (K4)
CO3	Explain role of Pharmacology and importance of Phyto-constituents Pharmaceutical Industry (K3)
CO4	Describe aspects of various dosage forms(K5)
CO5	Describe role of biotechnology in Pharmaceutical Industry(K6)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO2	K3	3	2	2	2	2	3	3	3	1	2	3	2	3	1
CO3	K3	3	3	2	2	1	1	3	3	3	3	3	2	2	3
CO4	K3	3	3	2	2	2	3	0	2	3	3	3	2	3	1
CO5	K3	3	2	2	0	2	3	3	3	1	3	0	2	3	3
CO5	K3	3	2	2	0	2	3	3	3	1	3	0	2	3	3
Course	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

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

Applied Physics

List of Courses where this course will be prerequisite

Independently set up, handle, and use basic setups to measure and obtain various physical quantities.
Use basic instruments like vernier-caliper, screw-gauge, travelling microscope, thermometer, etc. to make accurate measurements. 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. Preliminarily treat the obtained datasets statistically to obtain errors in the experiments.

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 specialization.

Sr. No.	**Course Contents (Topics and Subtopics)**	**Required Hours**
1	Determination of Co-efficient of Viscosity by Poiseuille's method	5
2	Thermistor characteristics: Determination of Bandgap of a semiconductor	6
3	Determination of compressibility of liquids using an Ultrasonic Interferometer	5
4	Measurement of thermal conductivity of a solid: Lee's disc method	6

5	Photoelectric effect: Determination of h/e	5
6	Hall effect: Determination of carrier type and concentration in a semiconductor	6
7	Newton's rings: Determination of wavelength of light	5
8	Laser Diffraction: Determination of particle size	8
9	Determination of Co-efficient of Viscosity by Poiseuille's method	8
10	Thermistor characteristics: Determination of Bandgap of a semiconductor	6
Total		**60**

List of Text Books/ 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	Engineering Physics - V Rajendran - 6th Edition - McGraw Hill Publishers
5	Concepts of Modern Physics - A. Beiser, McGraw-Hill.
6	Ultrasonics: Methods and Applications - J. Blitz, Butterworth.
7	Optics - Ajoy Ghatak - 7th Edition - McGraw Hill
8	Fundamentals of Optics - F. Jenkins and H. White - 4th Edition McGraw Hill
9	ICT Physics Laboratory Manual (supplied to students)

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

CO1	Apply various laws which they have studied through experiments (K3)
CO2	Measure transport properties like viscosity, conductivity, etc.(K4)
CO3	Explain the application of acoustic cavitation (K2)

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

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	2	1	3	3	3	3	3	3	2	3	3
CO2	K4	3	3	2	3	2	3	3	2	3	3	3	0	2	3
CO3	K2	3	2	1	2	0	3	3	3	3	1	3	1	3	2
Course	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

AEC	**Course Code:** HUT1110B	**Course Title:** Communication Skills-English	**Credits = 2**		
			L	**T**	**P**
	Semester: I	**Total Contact Hours: 60**	**0**	**0**	**4**

List of Prerequisite Courses

Standard XIIth English

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.

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	Development of communication skills in oral as well as writing	10
2	The writing skills should emphasize technical report writing, scientific paper writing, letter drafting, etc.	14
3	The oral communication skills should emphasize presentation skills.	10
4	Use of audio-visual facilities like powerpoint, LCD. for making effective oral presentation	14
5	Group Discussions	12
	Total	**60**

List of Text Books/ Reference Books

1	Elements of Style – Strunk and White
Course Outcomes (students will be able to…..)	
CO1	write grammar error free technical reports in MS Word or equivalent software.(K3)
CO2	make power point slides in MS PowerPoint or equivalent software.(K3)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	2	2	3	3	3	3	3	1	2	3	3
CO2	K3	3	3	2	0	2	3	1	3	3	2	3	2	3	3
Course	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

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

This is a Basic Organic Chemistry course. The Organic Chemistry studied at HSC is the basis for building up Advanced Organic Chemistry knowledge.

List of Courses where this course will be Prerequisite

Organic Chemistry, Biochemistry and several Special Subjects of Chemical Technology Departments

Description of relevance of this course in the B. Tech. (Pharm. Chem. Tech.) Programme

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

Sr. No.	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** IUPAC nomenclature, structures and common names, comparison with benzenoid compounds, reactivity and synthesis – pyrroles, furans, thiophenes and pyridines	**8**
5	**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**
6	**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 Text Books/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	be well versed with 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).
CO4	Apply the knowledge obtained through the course to predict the outcome of reactions and devise solutions to unknown problems (K3).
CO5	Appreciate the stereo-chemical implications of organic compounds and visualize and appreciate the chirality concept (K2).
CO6	Understand organic chemistry reactions related to aliphatic as well as aromatic compounds as well as decipher the outcome of a given organic transformation (K3).
CO7	Interpret and analyze reactions having different functionalities, deduce and solve problems related to the reactions as well as apply them, if need be (K4).

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

		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K2	3	2	0	2	1	3	3	2	3	3	3	1	3	2
CO2	K2	3	2	0	1	0	3	3	1	2	3	2	0	3	2
CO3	K3	3	3	1	2	2	3	1	3	3	2	3	2	3	3
CO4	K4	3	3	1	3	2	3	2	3	2	3	3	2	3	3
CO5	K4	3	3	1	3	2	3	2	3	2	3	3	2	3	3
CO6	K4	3	3	1	3	2	3	2	3	2	3	3	2	3	3
CO7	K4	3	3	1	3	2	3	2	3	2	3	3	2	3	3
Course	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge-level from cognitive domain; A, Affective domain; P, Psychomotor domain

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 Inorganic Chemistry

List of Courses where this course will be Prerequisite

Material Technology, Environment Science and Technology

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

To acquaint the students with synthesis, properties and applications of various industrial inorganic chemicals

Sr. No.	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 Peroxo 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 Text Books/ 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 of chemical principles applied to various industrial processes
CO2	Describe the fundamental processes underlying manufacture of important organic and inorganic chemicals
CO3	Review and assess the impact of the chemical factors on the efficiency of industries and feedstock manufacturing

CO4	Modify existing applications for improving the efficiencies in terms of yields, energy requirement and environmental impact

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K2	3	2	1	2	0	3	2	3	3	3	3	1	3	2
CO2	K3	3	3	2	2	2	3	3	1	3	3	2	2	3	3
CO3	K2	3	2	0	2	1	3	3	3	3	0	3	1	2	1
CO4	K2	3	2	1	2	1	2	3	3	3	3	1	1	3	2
Course	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

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

Analytical Chemistry

List of Courses where this course will be prerequisite

Pharmaceutical Formulation Technology –II, Pharmaceutical Technology, Medicinal Natural Products, Pharmaceutical Chemistry and Catalytic Process, Pharmaceutical Formulation Technology – III, Validation and Regulatory Requirements, institute Elective- II: Structural analysis by Spectroscopy; Process Technology of Drugs and Intermediates

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 (continuous wave (CW) versus pulsed FT instruments); 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, UV-Vis and FT-IR techniques	2
	Total	**30**

List of Textbooks/Reference Books

1	Practical Pharmaceutical Chemistry; 4th ed. - Part 2; Beckett, A. H., Stenlake, J. B., Eds.; The Athlone Press, London, UK (1988)
2	Pharmaceutical Analysis; Lee, D. C., Webb, M., Eds.; Blackwell Publishing Ltd., Oxford, UK (2003)
3	Analytical Chemistry; 6th ed.; Christian, G. D., Ed.; Wiley India (P.) Ltd., New Delhi, India (2008)
4	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)
5	Vogel's Textbook of Quantitative Chemical Analysis; 5th ed.; Jeffery, G. H., Basset, J., Mendham, J., Denney, R. C., Eds.; Dorling Kindersley (India) Pvt. Ltd. (Pearson Education Ltd.), New Delhi, India (2000)
6	Introduction to Spectroscopy; Pavia, D. L., Lampman, G. M., Kriz, G. S., Vyvyan, J. R., Eds.; Cengage Learning, Stamford, USA (2015)
7	Fundamentals of Analytical Chemistry; 9th ed.; Skoog, D. A., West, D. M., Holler, F. J., Crouch, S. R., Eds.; Cengage Learning, Boston, USA (2014)
8	William Kemp, Organic Spectroscopy; 3rd ed.; Macmillan Education, UK (1991)
9	Indian Pharmacopoeia 2018, Vol. I-IV; 8th ed.; The Indian Pharmacopoeia Commission, Gaziabad, India (2018)
10	USP 2019 – United States Pharmacopoeia 42 – National Formulary 37 (USP 42 – NF 37), Vol. 1-5; The United States Pharmacopeial Convention, USA (2019)
11	BP 2020 – British Pharmacopoeia 2020, Vol. 1-5; British Pharmacopoeia Convention, UK (2019)
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.(K2)

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

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K2	3	3	2	2	0	3	3	3	3	3	3	2	3	3
CO2	K3	3	2	2	0	3	3	3	0	2	3	2	0	3	2
CO3	K4	3	2	1	2	1	2	2	2	3	3	3	1	2	3
CO4	K2	3	1	2	2	2	3	1	3	2	1	3	2	3	2
Course	K4	3	3	3	2	3	3	3	3	2	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

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

Physics, Basic Mathematics

List of Courses where this course will be Prerequisite

Energy Engineering, Unit Operations, Mechanical design of chemical equipments

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

Students will be able to understand various equipments like steam turbine, gas turbine, pumps, compressors, and power transmission system.

Sr. No.	**Course Contents (Topics and subtopics)**	**Required Hours**
1	**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 Diagram, elastic constants and their relations volumetric, linear and shear strains.	6

2	**Introduction to Thermodynamics**: First Law of Thermodynamics, Steady-flow energy equation, Second Law of Thermodynamics	4
3	**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/Pumps Different Types of Compressors and their applications, Different Types of Pumps, and their applications	8
4	**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 (No numerical)	4
5	**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
6	**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 Text Books/ 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	Describe the working of steam boilers, mountings, and accessories. (K2)
CO3	Explain the working principles of power developing systems such as steam turbines, gas turbines and internal combustion engines. (K2)
CO4	Describe the working principle of vapour compression and vapour absorption refrigeration systems. (K2)
CO5	Discuss different types of power transmission systems and their typical applications. (K2)
CO6	Explain the working principles of power absorbing devices such as pumps and compressors. (K2)

Mapping of Course Outcomes (Cos) with Programme Outcomes (Pos)															
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO2	K2	3	1	0	2	1	3	1	3	3	3	3	1	3	2
CO3	K3	3	3	2	2	2	3	3	3	3	2	3	2	2	3
CO4	K2	3	2	1	2	0	3	3	2	3	3	3	1	3	2
CO5	K2	3	2	1	2	0	3	3	2	3	3	3	1	3	2
CO6	K2	3	2	1	2	0	3	3	2	3	3	3	1	3	2
Course	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

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

Standard XII Physics and Mathematics courses

List of Courses where this course will be prerequisite

Various Technology Courses and Professional Career

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

In this course, 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.

Sr. No.	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	5
4	**Single phase transformers**: Principle of working, Efficiency, regulation.	5
5	**Electrical drives**: Basic concepts of different types of Electrical motors as drives, Their suitability for various applications.	5
6	**Regulated power supplies**, Diodes as rectifiers, Half wave and Full wave rectifier, Filters and Regulators	5
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	**45**

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 circuits. Solve basic electrical circuit problems.(K3)
CO2	Understand the basic concepts of single phase and three phase AC supply and circuits.(K2)
CO3	Understand the basic concepts of transformers and motors used as various industrial drives.(K2)
CO4	Understand the basic concepts of electronic devices and their applications.(K2)

Mapping of Course Outcomes (Cos) with Programme Outcomes (Pos)															
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO2	K2	3	2	0	2	1	3	3	3	3	2	3	0	3	2
CO3	K2	3	2	1	2	0	3	3	2	3	3	3	1	3	2
CO4	K2	3	0	1	2	1	2	3	3	1	3	1	1	2	2
Course	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

ESC	**Course Code:** CEP1720	**Course Title:** Process Calculations	**Credits = 2**		
			L	**T**	**P**
	Semester:	**Total contact hours: 60**	**0**	**0**	**4**
List of Prerequisite Courses					
	XIIth Standard Mathematics, Chemistry, Physics				
List of Courses where this course will be prerequisite					
	This is a basic Course. This knowledge will be required in ALL subjects later.				
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					

Sr. No.	**Course Contents (Topics and subtopics)**	**Reqd. 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 Text Books/ 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 will be able to convert units of simple quantities from one set of units to another set of units
CO2	Students will be able to calculate quantities and /or compositions, energy usages, etc. in various processes and process equipment such as reactors, filters, dryers, etc.

Mapping of Course Outcomes (Cos) with Programme Outcomes (POs)															
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K2	3	2	0	2	1	3	3	3	3	3	3	1	3	2
CO2	K3	3	3	2	2	2	3	3	3	3	3	2	2	3	3
Course	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

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 XIIth Chemistry Laboratory courses

List of Courses where this course will be prerequisite

This is a basic Course. This knowledge will be required in Applied Chemistry subjects later.

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

Students will become familiar with laboratory experimental skills, plan and interpretation of experimental tasks, understand the relevance of principles of physical chemistry in chemical processes

Sr. No.	**Course Contents (Topics and Subtopics)**	**Required Hours**
1	(8 to 10 experiments will be conducted from following list) **1.** To determine the total hardness of given water sample **2.** To determine the dissociation constants of a polybasic acid using pH meter **3.** To determine pKa of the given weak acid by potentiometric titration **4.** To determine the critical micelle concentration (CMC) of the given surfactant by surface tension measurement using a stalagmometer **5.** To determine the normality and volume of weak acid and strong acid in the given mixture using conductometric titration **6.** To determine the rate constant of hydrolysis of an ester catalyzed by an acid **7.** To study the kinetics of the reaction between K2S2O8 and KI and hence, determine rate of the reaction **8.** To verify Beer – Lambert's Law **9.** To determine the equivalent conductance of strong electrolyte at infinite dilution and verify Ostwald's law of dilution, for dissociation of weak electrolyte **10.** To determine the molecular weight of the given polymer by viscosity measurements **11.** To determine the vitamin C concentration from the given tablet sample by titration **12.** Demo of Gas chromatography and FT-IR.	4h per practical
	Total	**60**

List of Text Books/ Reference Books

1	Practical physical Chemistry – B.Viswanthan and P.S. Raghavan
2	Practical physical Chemistry- Alexander Findlay
Course Outcomes (students will be able to…..)	
CO1	Identify reaction rate parameters
CO2	List simple methods of chemical analysis
CO3	Determination of physic chemical parameters using simple laboratory tools

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)														
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	2	2	3	3	3	2	3	3	2	3	3
CO2	K4	3	3	1	3	1	2	3	1	3	3	0	2	3	3
CO2	K4	3	3	1	3	1	2	3	1	3	3	0	2	3	3
Course	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

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 XIIth Organic Chemistry Laboratory

List of Courses where this course will be prerequisite

All the Applied Chemistry Practicals

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

The course is relevant for training the students for working with binary mixtures. The students are exposed to basics of organic separations and identification of organic compounds based on their physicochemical properties. 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	4 4
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	5X4 2X4 2X4 2X4 2X4
	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
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.(K3)
CO2	Separate binary organic mixtures by multiple techniques.(K4)
CO3	Understand basic principles for separation of binary organic mixtures qualitatively and quantitatively.(K3)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)														
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	2	2	3	3	3	3	3	3	0	3	3
CO2	K4	3	3	2	3	2	3	3	0	3	3	3	2	2	3
CO3	K3	3	1	2	1	2	2	3	3	3	3	1	2	3	1

Course	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

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

Standard XII Science

List of Courses where this course will be prerequisite

SPL5: Pharmaceutical Formulation Technology – II (PHT1082)

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 onequipment • Layout design and unit operations	3
6	**Biphasics - Suspensions** • Preformulation • Principles and Stabilization techniques • Formulation Development • Evaluation • Large scale manufacture and packaging with focus onequipment • 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 onequipment • 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 • Evaluation	5

	• Large scale manufacturing with focus onequipment • 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: Photostability 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)

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

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K2	3	3	2	2	2	3	3	3	3	1	3	2	3	3
CO2	K4	3	2	2	3	3	2	3	3	2	3	2	2	3	2
CO3	K4	3	1	0	2	1	3	2	2	3	3	3	1	2	3
CO4	K3	3	3	2	1	1	2	3	3	3	2	0	2	1	2
CO5	K2	3	2	2	3	2	3	3	2	2	3	3	2	3	3
Course	K3	3	3	3	2	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

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

Green Chemistry and Technology

List of Courses where this course will be prerequisite

Pharmaceutical Formulation Technology –II, Pharmaceutical Technology, Medicinal Natural Products, Pharmaceutical Chemistry and Catalytic Process, Pharmaceutical Formulation Technology – IIII, Validation and Regulatory Requirements; Process Technology of Drugs and Intermediates

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; Case studies.	20
2	**Introduction to Alternative Methods of Chemical Synthesis:** Photochemistry, Microwave-Assisted Organic Synthesis (MAOS), Solvent-free synthesis, Electrochemistry and Sonochemistry	10
	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 Oganic Synthesis. Green Chemistry Series 51; RSC, Cryodon, UK (2018)
5	Albini, A., Protti, S. Paradigms in Green Chemistry and Technology. SpringerBriefs 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	Appreciate and implement Green Chemistry Principles in Professional Life.(K3)
CO2	Understand the hazards, effluents and statistical methods of optimization in green technology

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

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K2	3	3	2	2	0	3	3	3	3	3	3	2	3	3
CO2	K3	3	2	2	0	3	3	3	0	2	3	2	0	3	2
Course	K4	3	3	3	2	3	3	3	3	2	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

EEM	Course Code: HUT1205	Course Title: Basic Economics and Finance	Credits = 2		
			L	T	P
	Semester: III	Total Contact Hours: 30	2	0	0

List of Prerequisite Courses

Engineering Mathamatics

List of Courses where this course will be prerequisite

PROJECT ECONOMICS, FUNDAMENTALS OF MARKETING MANAGEMENT AND MARKET RESEARCH

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 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
		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 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	

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

CO1	Students will be able to know and apply accounting and finance theory.
CO2	Students will be able to understand the mechanics of preparation of financial statements, their analysis and interpretation
CO3	Students will be able to explain basic economic terms, concepts, and theories
CO4	Students will be able to identify key macroeconomic indicators

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO2	K3	3	2	2	2	2	3	3	3	1	2	3	2	3	1
CO3	K3	3	3	2	2	1	1	3	3	3	3	3	2	2	3
CO4	K3	3	3	2	2	2	3	0	2	3	3	3	2	3	1
Course	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

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

Standard XII Science

List of Courses where this course will be prerequisite

Pr 3: Pharmaceutical Technology Laboratory (Chemistry and Formulation) (PHP1044)

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	Prepare, evaluate and label Pharmacopoeial and non-Pharmacopoeial monophasic liquid oral formulations.(K4)
CO2	Prepare, evaluate and label Pharmacopoeial and non-Pharmacopoeial biphasic formulations.(K4)
CO3	Prepare, evaluate and label Pharmacopoeial and non-Pharmacopoeial semisolid and suppository formulations (K4)
CO4	Propose unit operations in large scale manufacturing and type of container specific to product application.(K3)

Mapping of Course Outcomes (Cos) with Programme Outcomes (Pos)															
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2

		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K4	3	2	1	2	0	3	3	3	3	3	3	1	3	2
CO2	K4	3	2	1	3	1	3	3	2	2	1	3	0	3	3
CO3	K4	3	3	3	2	1	2	3	0	3	2	3	2	2	3
CO4	K3	3	2	1	2	0	3	3	3	3	3	2	1	3	2
Course	K4	3	3	2	2	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

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

Organic Chemistry Laboratory (CHP1132), Analytical Chemistry (CHT1401)

List of Courses where this course will be prerequisite

Medicinal Natural Products Laboratory, Biotechnology Laboratory

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
12	Calibration of Abbe's Refractometer, Estimation of Refractive Index of natural oils and laboratory solvents, determination of the percentage of glycerin in the unknown by calibration curve. Polarimetry** Instrument information, Optical rotation of dextrose solution, determination of specific optical rotation of ethambutol,	4
	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.(K3)
CO2	Apply chromatographical concepts for separation of complex mixture.(K3)
CO3	Evaluate the components of a complex mixtures using spectroscopic and spectrometric techniques (K4)
CO4	Apply various analytical techniques for qualitative and quantitative analyses.(K3)

Mapping of Course Outcomes (Cos) with Programme Outcomes (Pos)

		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**

		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K4	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO2	K4	3	2	0	3	1	3	3	1	2	3	2	1	3	3
CO3	K4	3	3	3	2	2	1	3	3	3	2	3	2	2	2
CO4	K3	3	2	1	2	1	3	3	3	3	0	2	1	3	2
Course	K4	3	3	2	2	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

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

XII[th] Standard Physics and Mathematics

List of Courses where this course will be prerequisite

This is a basic course required in special subjects that deal with flow offluids, 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 equipments are explained with the help of several problems.

Sr. No.	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 Fluidised 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 Text Books/ 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
CO2	Students will be able to calculate flow and power required for pumps
CO3	Students should be able to calculate heat transfer coefficients and do basicsizing of double pipe and shell and tube heat exchangers
CO4	Students should be able to calculate mass transfer coefficients and estimatemass transfer rates in simple situations

Mapping of Course Outcomes (Cos) with Programme Outcomes (Pos)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO2	K3	3	3	1	2	1	3	1	3	3	3	1	2	3	3
CO3	K3	3	1	2	2	2	2	3	2	3	3	3	2	2	3
CO4	K3	3	3	2	0	2	3	3	3	3	2	3	0	3	3

Course	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution;0, No Contribution

K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

PCC	Course Code: PHT 1421	Course Title: SPL5: Medicinal Chemistry	Credits = 3		
			L	T	P
	Semester: IV	Total Contact Hours: 45	3	1	0

List of Prerequisite Courses

Organic Chemistry, Physical Chemistry (CHT1341), Industrial Chemistry

List of Courses where this course will be prerequisite

Pharmaceutical Chemistry – I (PHT), SPL10: Pharmaceutical Chemistry-II (PHT1056)

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: Definitions and explanation of terms used in Medicinal Chemistry (hits, lead, lead development, molecular libraries, toxicity studies, high throughput screening ,ADME etc.), nomenclature of drugs	2
	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.	3
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	4
	Drug absorption: drug dosage form, gastric emptying, gastric permeability to drug, first pass effect	1
	Drug distribution: drug-plasma binding, blood brain barrier, drug accumulation in tissues	2
	Drug Elimination: a) drug excretion b) drug biotransformation c) Biotransformation reactions: functionalization, conjugation reactions, reactions leading to toxic metabolite	6
	Prodrugs: concept of prodrugs, examples and applications, carrier prodrugs, bioprecursor prodrugs	2
	Drug Toxicity	2
	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	4
	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
4	Introduction to Modern Drug Discovery. Small molecules as drugs (examples from current drugs to be used). Brief Introduction to molecular modeling's	2
5	**Lead Optimization:** lead likeness and drug likeness, determination of compound, drug biological, biochemical properties, homologs, concepts of bioisosterism, isosteric replacements, ring transformations.	2
6	Concept of SAR, effects of substituents and functional groups, introduction to QSAR	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)
Course Outcomes (Students will be able to…..)	
CO1	Apply basic knowledge on physicochemical properties of drugs for understanding design principles.(K4)
CO2	Extract SAR and MOA of drugs at the molecular level of understanding.(K3)
CO3	Apply principles of drug discovery from hit to lead to preclinical molecules.(K4)
CO4	Theoretically predict absorption, distribution, metabolism and excretion of drugs and related concept of prodrugs.(K4)

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

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K4	3	2	1	2	1	3	1	3	3	1	3	1	3	2
CO2	K3	3	3	2	2	2	1	3	3	3	3	2	2	3	3
CO3	K4	3	3	1	3	2	2	3	2	0	3	3	0	3	3
CO4	K4	3	0	3	3	3	3	2	3	3	2	3	3	2	3
Course	K6	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

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 Biology, Basics of Biology and Applications to Technology (BST1110)

List of Courses where this course will be prerequisite

Medicinal Chemistry, Pharmaceutical Chemistry – I, Pharmaceutical Chemistry – II, Pharmaceutical Formulation Technology – III, Validation and Regulatory Requirements

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	1
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
6	**Structure and Function of Kidney**, Drugs acting on Kidneys: Diuretics	3
7	**Respiratory System:** Anatomy and Physiology	1
8	**Central Nervous System (CNS):** Anatomy and Physiology, Neurotransmission	4
9	**Drugs acting on CNS:** Sedatives, Hypnotics, Psychopharmacological agents, Antiepileptics, Anaesthetics, Nootropics, CNS stimulants	5
10	**Autonomic Nervous System** (ANS: Anatomy and Physiology, Adrenergic (Sympathetic) and Cholinergic (Parasympathetic) Systems	2
11	**Drugs acting on ANS:** Cholinergic agents, Anticholinergic agents, Adrenergics, Adrenergic blockers, Neuromuscular blockers	5
12	**Drugs acting on Metabolic Disorders:** Antidiabetics, Antihypertensives	2
14	**Analgesics** (Narcotics/Non-narcotics)	2
15	**Miscellaneous:** Local anesthetics, Antihistaminic drugs	3
16	**Chemotherapeutic Agents:** Synthetic, Semisynthetic and Natural Antimicrobial agents, Antiparasitic Agents	5
17	**Anticancer Agents**	4
	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

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.(K2)
CO3	Analyze 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.(K2)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K2	3	3	2	1	2	3	3	3	3	3	3	2	1	3
CO2	K2	3	2	2	3	0	3	1	3	2	3	1	2	3	2
CO3	K3	3	1	0	2	1	2	2	2	3	3	3	0	3	3
CO4	K4	3	3	2	2	2	1	3	3	1	2	2	2	2	2
CO5	K2	3	2	1	3	2	3	3	3	2	3	3	2	3	3
Course	K3	3	3	3	2	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

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

List of Prerequisite Courses
Various Technology Courses in previous semesters

List of Courses where this course will be prerequisite
Various Technology Courses in the forthcoming semesters

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+	3
2	Environmental impact assessment, Life cycle assessment (LCA)	3
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	4
5	Wastewater treatment; Groundwater and surface water pollution, removal of specific water contaminants; Solid waste; Hazardous waste	4
6	Inherent safety; Major disasters (e.g. Flixborough, UK; Bhopal, India; Seveso, Italy; Pasadena, Texas; Texas City, Texas; Jacksonville, Florida; Port Wentworth, Georgia)	5
7	Toxicology; Industrial hygiene	2
8	Source models; Toxic release and dispersion models	5
9	Fires and explosions; Concepts to prevent fires and explosions	3
10	Chemical reactivity	2
11	Reliefs and reliefs sizing; Hazard identification; Risk assessment	4
12	Safety procedures and designs	4
13	Some case histories	4
	Total	**45**

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 neighbourhood 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)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4
CO1	K3	3	3	2	2	2	3	3	2	3	3	3	2	3	3
CO2	K3	3	3	2	2	0	3	3	3	3	3	3	1	3	3
CO3	K3	3	3	0	2	2	3	1	3	3	1	3	2	2	3
CO4	K3	3	1	2	2	2	3	3	3	3	3	0	2	3	3
CO5	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
Course	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

EEM	**Course Code: CET1805**	**Course Title: Chemical Process Economics**	**Credits=2**		
			L	**T**	**P**
	Semester: IV	**Total contact hours: 30**	**2**	**0**	**0**

List of Prerequisite Courses	
Material and Energy Balance Calculations, Equip Design and Drawing I, Energy Engineering, Ind Eng Chem.	
List of Courses where this course will be prerequisite	
Home Paper I and II	
Description of relevance of this course in the B Tech. Program	
This course is required for the future professional career	

Sr. No	**Course Contents (Topics and subtopics)**	**Reqd.**
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.	8
3	Project financing, debt: equity ratio, promoters, contributors, shareholders	
4	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
5	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
List of Text Books/ Reference Books		
1	Chemical Project Economics, MahajaniV.V.andMokashi 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…..)		
1	Calculate working capital requirement for a given project	
2	Calculate cost of equipment used in a plant total project cost	
3	Calculate cashflow from a given project	
4	Select a site for the project from given alternatives	
5	List out various mile stones related to project concept to commissioning	

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3

CO2	K3	3	3	2	2	2	3	3	3	3	3	2	2	2	3
CO3	K3	3	3	1	0	2	3	1	3	3	3	3	2	3	2
CO4	K4	3	3	2	3	2	2	3	3	3	3	3	2	3	3
CO5	K2	3	2	1	2	1	3	3	3	3	0	3	1	3	2
Course	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO2	K3	3	3	2	2	2	3	3	3	3	3	2	2	2	3
CO3	K3	3	3	1	0	2	3	1	3	3	3	3	2	3	2
CO4	K4	3	3	2	3	2	2	3	3	3	3	3	2	3	3
CO5	K2	3	2	1	2	1	3	3	3	3	0	3	1	3	2
Course	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

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

List of Prerequisite Courses

Organic Chemistry Laboratory, Organic Chemistry

List of Courses where this course will be prerequisite

All Pharmaceutical Chemistry and Medicinal Chemistry Courses

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**
-	Functional group transformation: Minimum one exercise to be given for each of the following types of transformations, if possible leading to synthesis of drugs or drug intermediates -	-
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.(K3)
CO2	Implement techniques for synthetic reactions.(K4)
CO3	Design and carry out experiments for simple organic transformations.(K5)
CO4	Understand and apply reaction mechanisms and their practical implications.(K3)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO2	K4	3	3	2	3	0	3	3	1	3	3	3	3	3	3
CO3	K5	3	3	3	1	3	3	3	3	3	2	0	1	3	3
CO4	K3	3	3	3	3	3	1	3	3	3	1	3	3	3	3
Course	K6	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

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 I and II, Transport Phenomena
List of Courses where this course will be prerequisite
Environmental Engineering and Process Safety, Chemical Project Economics
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 fibres, Foods, Dyes and intermediates, Oils, oleo chemicals, and surfactants, Minerals, clean sing agents, Polymers and textiles, Biochemicals and biotechnology, pharmaceuticals and drugs, Microelectronics, energy from conventional and non-conventional resources, Metals

	Course Contents (Topics and subtopics)	Reqd. 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	
1	Elements of Chemical Reaction Engineering – H.Scott Fogler	
	List of Additional Reading Material / Reference Books	
1	Heterogeneous Reactions, Vol.I and II –L.K. Doraiswamy, M.M.Sharma	
	Course Outcomes (students will be able to…..)	
CO1	Describe and discuss principles of various types of reactors	
CO2	Calculate rates of reactions based on given reaction scheme	
CO3	Design various components of reactors used in industrial practice	
CO4	Compare various reactors and select an appropriate reactor for a given situation	
CO5	Describe and discuss principles of various types of reactors	

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

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	2	1	3	3	3	3	3	3	2	3	3
CO2	K3	3	2	2	2	2	1	3	0	3	3	2	0	3	3
CO3	K3	3	3	2	1	2	3	3	3	3	3	3	2	3	3
CO4	K4	3	3	2	3	0	2	3	3	1	3	3	1	3	3
CO5	K3	3	3	2	1	2	3	3	3	3	3	3	2	3	3
Course	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

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, Transport Phenomena	
	List of Courses where this course will be prerequisite	
	This is a basic course. It is required in many other courses that involve physical processes	
	Description of relevance of this course in the B. Tech. Program	
This is a basic Chem Engg. course. The principles learnt in this course are required in almost all the courses and throughout the professional career of student		
	Course Contents (Topics and subtopics)	**Reqd. 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 Text Books/ 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…..)	
1	Do basic sizing of continuous and batch distillation columns	
2	Analyze filtration data and select systems based on requirements, estimate filtration area for given requirements, understand filter aids and their usage	
3	Describe few industrial crystallization, filtration and drying equipment	
4	Describe the need and importance of other separation processes like adsorption, ion exchange and membrane	
5	Gain a practical perspective of unit operation in chemical industries	

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

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	2	1	3	3	3	3	3	0	2	3	3
CO2	K4	3	3	2	3	2	3	2	3	3	2	3	2	3	3
CO3	K2	3	2	0	2	1	3	3	2	3	3	3	1	3	2
CO4	K2	3	2	1	2	0	3	3	3	3	1	3	1	2	2
CO5	K3	3	3	2	2	2	1	3	3	1	3	3	2	3	3
Course	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

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

SPL1: Pharmaceutical Formulation Technology – I (PHT1081)

List of Courses where this course will be prerequisite

SPL12: Validation and Regulatory Requirements (PHT1084)

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. • Preformulation considerations for tablet coating • Types of coating • Quality control of coated tablets • Large scale manufacture and packaging with focus onequipment • Layout design and Unit operations	5
8	**Capsules:** • Introduction to capsule dosage form: rationale, advantages etc. • Preformulation considerations for capsule dosage form • Hard gelatin capsules: formulation considerations, capsule manufacture equipments, quality control tests, packaging, Large-scale manufacture, layout design • Soft gelatin capsules: formulation considerations, capsule filling equipments, quality control tests, packaging, Large scale manufacture, layoutdesign • Large scale manufacture and packaging with focus onequipment • 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 • Preformulation • 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	5

	• Layout design and Unit operation	
	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)	
	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 preformulation, formulation, unit operation, large-scale manufacturing, layout design of tablets.(K2)	
CO2	Explain the coating polymers, technology and equipments used for coating of tablets and describe microencapsulation techniques.(K2)	
CO3	Apply principles of dosage form design and evaluation for various solid oral dosage forms.(K3)	
CO4	Design and evaluate the novel drug delivery systems.(K4)	

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

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K2	3	2	1	2	1	3	3	1	3	3	0	1	3	2
CO2	K2	3	3	2	2	0	2	3	3	3	2	3	2	2	3
CO3	K3	3	2	2	3	3	2	1	3	3	3	2	2	3	3
CO4	K4	3	3	1	3	2	3	0	3	2	3	3	3	2	3
Course	K4	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

PEC	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.

	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, organopalladium, 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 catalysis	4
14	Biocatalysis, biocatalytic systems, Enzyme catalyzed reactions, principles, details studies on Lipases and catalyzed reactions	4
15	Immobilized biocatalytic 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 biocatalytic 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 and Logical design of synthesis of drug and biological molecules.(K5)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4
CO1	K4	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO2	K3	3	2	2	2	2	0	3	2	2	3	3	1	3	3
CO3	K5	3	2	3	3	3	3	2	3	3	0	2	3	3	2
CO4	K4	3	3	2	1	2	3	3	2	1	3	1	2	2	3
CO5	K5	3	3	2	3	2	3	3	2	3	3	2	2	3	3
Course	K6	3	3	2	3	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

PCC	Course Code: PHT1426	Course Title: Honors Course-I: Reagents in API Process Industry	Credits = 4		
	Semester: V	Total Contact Hours: 60	L: 3	T: 1	P: 0

List of Prerequisite Courses
List of Courses where this course will be prerequisite
Description of relevance of this course in the B. Tech. Program

Sr. No	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	Knowledge of important reagents used in chemical/Pharmaceutical industries.
CO2	
CO3	
CO4	
CO5	

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO2	K3	3	2	2	2	2	3	3	3	1	2	3	2	3	1
CO3	K3	3	3	2	2	1	1	3	3	3	3	3	2	2	3
CO4	K3	3	3	2	2	2	3	0	2	3	3	3	2	3	1
CO5	K3	3	2	2	0	2	3	3	3	1	3	0	2	3	3
Course	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

PCC	Course Code:	Course Title:	Credits = 2

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

List of Prerequisite Courses

Organic Chemistry Laboratory, Organic Chemistry

List of Courses where this course will be prerequisite

All Pharmaceutical Chemistry and Medicinal Chemistry Courses

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.

Sr. No	Course Contents (Topics and Subtopics)	Required Hours
	Functional group transformation: Minimum one exercise to be given for each of the following types of transformations, if possible leading to synthesis of drugs or drug intermediates -	
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.(K3)
CO2	Implement techniques for synthetic reactions.(K4)
CO3	Design and carry out experiments for simple organic transformations.(K5)
CO4	Understand and apply reaction mechanisms and their practical implications.(K3)

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

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO2	K4	3	3	2	3	0	3	3	1	3	3	3	3	3	3
CO3	K5	3	3	3	1	3	3	3	3	3	2	0	1	3	3
CO4	K3	3	3	3	3	3	1	3	3	3	1	3	3	3	3
Course	K6	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

PCC	Course Code:	Course Title:	Credits = 2

	PHP1428	Pr 5: Pharmaceutical Formulation Technology Laboratory-II	L	T	P
	Semester: V	Total Contact Hours: 60	0	0	4

List of Prerequisite Courses

SPL1: Pharmaceutical Formulation Technology-I, Organic Chemistry Laboratory

List of Courses where this course will be prerequisite

Pharmaceutical Formulation Technology Laboratory – II, Process Technology Laboratory

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 an d Subtopics)	Required Hours
	Chemistry	
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 formu-lations) 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)
CO2	Develop a set of separation and purification and structural characterization skills.(K5)
CO3	Prepare, evaluate and label pharmacopoeial and non pharmacopoeial solid oral dosage forms.(K5)
CO4	Perform dissolution testing for conventional and non-conventional solid oral dosage forms.(K4)

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

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K4	3	2	1	2	1	3	1	1	3	3	3	1	3	2
CO2	K5	3	3	2	2	1	3	3	3	3	3	3	3	3	1
CO3	K5	3	3	2	0	2	3	3	2	3	3	3	2	2	3
CO4	K4	3	3	3	2	3	3	0	3	3	2	2	3	3	3
Course	K6	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

Semester-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					
Standard XIIth Biology					
List of Courses where this course will be prerequisite					
In-Plant Training (PHP1078) and other relevant courses					
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.

Sr, No	Course Contents (Topics and Subtopics)	Required Hours
1	**Introduction to Pharmaceutical Biotechnology** and its role in healthcare and diagnostics	6
2	**Fermentation Technology:** 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	12
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 academe 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.(K4)
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.(K4)
CO5	Explain how individual genetic variations affect responses to drug and formulations to be able to develop 'personalized' medicines.(K3)

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

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4
CO1	K3	3	3	2	2	3	3	3	3	3	3	3	1	3	3
CO2	K3	3	3	1	0	2	3	3	1	3	3	3	2	2	3
CO3	K3	3	3	2	3	2	3	2	3	3	3	2	2	3	2
CO4	K3	3	3	2	2	2	2	3	3	2	0	3	2	2	3
CO5	K4	3	2	2	3	2	3	3	3	3	3	2	2	3	3
Course	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

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 – II

List of Courses where this course will be prerequisite

Project – II, Process Technology of Drugs and Intermediates

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, Equipments 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 • Comparison of Indian and European guidelines w.r.t. USFDA guidelines	5
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.(K2)
CO2	comprehend product and process validation and documentation required for the same.(K3)
CO3	analyze the regulatory pathways for new drug application and generic product development for various products.(K3)
CO4	comprehend relevant regulations and laws governing the pharmaceutical manufacturing.(K4)

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

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4
CO1	K2	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO2	K3	3	2	3	3	0	3	3	2	2	3	0	3	2	3
CO3	K3	3	3	1	2	3	2	2	3	1	3	3	3	3	3
CO4	K4	3	2	3	3	2	1	3	3	3	2	3	0	3	3
Course	K3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

PEC	**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

Standard XIIth Biology and Chemistry

List of Courses where this course will be prerequisite

All Phytochemistry and Natural Product Chemistry courses

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

The course is designed to train the students with the basics of Medicinal Natural Products and Phytochemistry.

	Course Contents (Topics and Subtopics)	**Required Hours**
1	Scope of the subject, Source 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	Preparation of drug for commerce and quality control, application of spectroscopy and chromatography techniques for isolation, identification and analysis of phytoconstituents.	8
4	Phytochemistry: Chemical constituents in the production of plants (carbohydrates, protein enzymes, lipids, alkaloids, glycosides, steroids, tannins, terpenoids, flavonoids, plant pigments, etc.)	8
5	Biosynthesis approach: Building blocks and metabolic pathways for the formation of secondary metabolites	7
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
7	Wealth of India (11 volumes), Publications and Information Directorate
8	Jackson B. P., D. W. Snowdon, Atlas of Microscopy of Medicinal Plants, Culinary Herbs and Spices, 1990, CBS Publishers
9	The Merck Index, Merck Research Laboratories
10	Latest Edition of Indian Pharmacopoeia

Course Outcomes (Students will be able to…..)	
CO1	Understand and Undertake systematic identification of different plant/herbal material.(K3)
CO2	Understand and undertake steps involved in the preparation of herbal drugs for commerce. (K3)
CO3	Understand and undertake Extraction of plant materials and thereafter separation of phytoconstituents and also undertake separation of constituents by column chromatography.(K4)
CO4	Undertake evaluation of herbal raw material as well as formulations made from them.(K3)
CO5	Describe comprehensive requirement for setting up of extraction plant.(K3)

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

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO2	K3	3	3	2	2	2	2	3	1	3	3	1	2	2	3
CO3	K4	3	3	0	3	2	3	3	2	3	3	2	3	3	3
CO4	K3	3	3	3	1	3	2	3	3	3	0	3	3	2	3
CO5	K3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Course	K4	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

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

List of Courses where this course will be prerequisite

Medicinal Chemistry

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:* □-lactam antibiotics including Penicillins, Cephalosporins, Carbapenems, Monobactams Tetracyclincs and Glycylcyclins Marcolides and Ketolides Aminoglcosides Miscellaneous including Chloramphenicol, Vancomycin, Bacitracin and Newer Agents *Synthetic Antibacterials:* Sulfonamides and DHFR inhibitors, Quinolones, Oxazolidinediones and other miscellaneous agents	12
2	*Antiparasitic Agents:* Antiamoebics, Antimalarials, Anthelmintics Miscellaneous agents including drugs against Trypanosomiasis, Leishmaniasis, Scabies, Filariasis, Overview of DND*i*	4
3	*Antifungal Agents:* Azoles, Polyene antibiotics Miscellaneous agents including Allylamines, Tolnaftate, Griseofulvin, etc.	4
4	*Antimycobacterial Agents:* Antitubercular agents, Antileprotic agents, Drugs against *Mycobacterium avium complex* (MAC), Newer Antitubercular targets	4
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	6
6	*Antiviral Agents:* 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	6
	Part II	
7	*Introduction to Drugs Acting on Cholinergic Nervous System:* Cholinergic receptors, Acetylcholine, Cholinergic agonists, Cholinergic Antagonists and Cholinesterase Inhibitors Pharmacotherapy of Alzheimer's Disease	4
8	*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	4
9	*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
10	*Introduction to Centrally-Acting Analgesics:* Opioid or Narcotic analgesics: μ-Agonists, other analgesics Mixed agonist/antagonist analgesics	6

	μ-Antagonists Antidiarrheal agents Cough suppressants Antitussives	
	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)

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

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4
CO1	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO2	K2	3	3	2	3	2	0	3	2	3	1	3	3	2	3
CO3	K3	3	2	3	1	3	2	3	2	3	3	2	2	3	3
CO4	K4	3	3	2	2	2	3	3	3	3	3	3	0	2	3
Course	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

PCC	**Course Code:** PHT1433	**Course Title:** Honors Course-II(Chemistry and Technology of Fine Chemicals)	**Credits = 4** L	T	P
	Semester: VIII	**Total Contact Hours: 60**	**3**	**1**	**0**

List of Prerequisite Courses
Pharmaceutical Analysis, Green Chemistry and Physical Chemistry
List of Courses where this course will be prerequisite
Professional career
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	18

	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.	
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.(K4)	
CO4	demonstrate the process of preparation of solutions and adapt a method of the planning and implementation of organic and inorganic reactions.(K3)	

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

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K2	3	2	3	3	3	3	3	3	3	3	3	3	3	3
CO2	K3	3	3	2	1	2	3	3	2	3	2	0	2	2	3
CO3	K4	3	3	3	3	3	2	3	3	3	3	3	3	3	3
CO4	K3	3	3	0	2	3	3	3	3	3	1	2	3	3	2
Course	K3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

VSEC	**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, Transport Phenomena, Chemical Engineering Operations, Chemical Reaction Engineering				
List of Courses where this course will be prerequisite					
	Other B. Tech. courses				
Description of relevance of this course in the B. Tech. Program					
Chemical Engineering lab provides 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)	Reqd. 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 Text Books/ 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…..)	
1	Learn how to experimentally verify various theoretical principles	
2	Visualize practical implementation of chemical engineering equipment's	
3	Develop experimental skills	

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

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO2	K4	3	3	2	1	2	3	3	0	3	3	3	2	2	3
CO3	K4	3	3	2	3	2	2	3	3	3	3	2	2	3	2
Course	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

PCC	Course Code: PHP14134	Course Title: Pr 6: Biotechnology Laboratory	Credits = 2		
			L	T	P
	Semester: VI	Total Contact Hours: 60	0	0	4

List of Prerequisite Courses

Biochemistry (BST1102)

List of Courses where this course will be prerequisite

Project-I and Project –II

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 immobolization, 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	study kinetics of the diverse enzymes for their application in research.(K3)
CO2	perform microbial fermentation and recover and purify bioproducts.(K4)
CO3	apply nucleic acid isolation techniques for advanced studies in research and other areas.(K4)

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

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	1	2	3	3	3	3	3	3	1	3	3
CO2	K4	3	3	2	3	2	3	3	1	3	2	3	2	3	3
CO3	K4	3	3	3	3	3	0	2	3	3	3	2	3	3	3
Course	K4	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

PEC	**Course Code:** PHP1435	**Course Title:** Pr 7: Medicinal Natural Products Laboratory	**Credits = 2**		
			L	**T**	**P**
	Semester: VI	**Total Contact Hours: 60**	**0**	**0**	**4**

List of Prerequisite Courses
Analytical Chemistry, Pharmaceutical Analysis and Green Chemistry
List of Courses where this course will be prerequisite
SPL6:Medicinal Natural Products
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**
	Standardization of plant drugs using following methods -	
1	Morphology, microscopic quantitative microscopy, details microscopic study of drugs	15
2	Physical constants like specific gravity, swelling factor, ash values, extractive values, refractive index, optical rotation, etc.	15
3	Chemical methods identification tests for various classes of phytoconstituents, extraction and isolation of active principles such as alkalis, glycosides, tannins, carbohydrates 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	
Course Outcomes (Students will be able to…..)		
CO1	standardize the medicinal plants using morphological and microscopic analyses.(K3)	
CO2	characterize the medicinal plants using various analytical techniques.(K4)	
CO3	identify the phytoconstituents in medicinal plants using various chemical tests.(K4)	
CO4	isolate phytoconstituents from the natural materials using chromatographic analyses and further characterize using spectroscopic and spectrometric techniques.(K5)	

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4
CO1	K3	3	1	2	2	2	3	3	3	3	3	3	2	3	3
CO2	K4	3	3	2	3	2	2	1	2	3	0	3	2	3	3
CO3	K4	3	3	3	0	3	3	2	3	1	3	2	3	2	2
CO4	K5	3	3	2	2	2	3	3	2	2	3	3	1	3	3
Course	K5	3	3	2	3	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

Semester-VII

PCC	Course Code: PHT1436	Course Title: SPL13: Pharmaceutical Formulation Technology – III	Credits = 3		
			L	T	P
			2	1	0
	Semester: VII	Total Contact Hours: 45			

List of Prerequisite Courses

Pharmaceutical Formulation Technology-II

List of Courses where this course will be prerequisite

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 control tests, storage	3
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, equipments, advances, problems and solutions thereof • Quality control of ophthalmics • 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	Apply concepts related to preformulation, formulation, evaluation, packaging, large scale manufacturing and facility design of parenteral products.(K3)	
CO2	Apply the principles of dosage form design to various formulations of different dosage forms, their evaluation and packaging.(K4)	
CO3	Evaluate importance of facility requirements, stringent testing norms and extreme care during manufacturing to ensure safety and efficacy of the parenteral dosage forms.(K4)	

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

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4
CO1	K3	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO2	K4	3	2	3	3	1	3	3	2	3	3	3	1	3	3
CO3	K4	3	3	2	3	3	2	0	3	3	1	0	3	2	3
Course	K4	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

PCC	Course Code: PHT1437	Course Title: SPL14:Scale-up in Pharmaceutical Industry	Credits = 2		
			L	T	P
	Semester: VII	Total Contact Hours: 30	1	1	0

List of Prerequisite Courses

Basic knowledge of absorption spectroscopy, Mass spectrometry, Undergone courses in Instrumental Methods of Analysis.

List of Courses where this course will be Prerequisite

Nil

Description of relevance of this course in the B. Tech. (Pharm. Chem. Tech.) Programme

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	**Process Design for Scale-Up** Process development strategies Importance of engineering in PDs	2
2	**Scale-Up – An Overview** Role of the Pilot Plant Overview of scale-up issues Technology transfer issues	2
3	**Batch Reactors** Typical plant operations and equipment Characteristics of batch operations	3
4	**Raw Materials** Raw material and route selection Large-scale charging methods and issues	2
5	**Temperature Control** Large scale temperature control Heat transfer in batch reactors Controlling exothermic reactions	3
6	**Agitation and Mixing** Large scale mixing equipment Mixing limited reaction Mixing scale-up / scale-down	4
7	**Quench & Work-Up** Liquid-liquid extractions Phase continuity issues and emulsions	2
8	**Distillation & Stripping** Differential distillation Azeotropes and solvent exchange	2
9	**Crystallization and Precipitation** Basic principles / yield estimation Controlling supersaturation Scale-up issues	4
10	**Product Isolation and Drying** Large-scale solid-liquid separations Filtration and drying equipment Filtration and drying modelling	3
11	**Process Hazards and Safety Assessment** Common hazards in large-scale processing Process hazard assessments and evaluations	3
	Total	**30**

List of Text Books/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.

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)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4
CO1	K2	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO2	K4	3	3	2	0	3	3	3	3	3	3	3	1	3	3
CO3	K3	3	3	3	3	3	3	2	0	3	3	2	3	2	3
CO4	K2	3	3	1	3	2	2	3	3	2	1	3	3	3	2
CO5	K4	3	2	3	3	3	3	3	3	3	3	3	2	3	3
Course	K4	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

PEC	**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

Basic knowledge of absorption spectroscopy, Mass spectrometry, Undergone courses in Instrumental Methods of Analysis.

List of Courses where this course will be Prerequisite

Nil

Description of relevance of this course in the B. Tech. (Pharm. Chem. Tech.) Programme

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.

Sr. No.	**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 Text Books/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.
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)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4
CO1	K2	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO2	K4	3	3	2	0	3	3	3	3	3	3	3	1	3	3
CO3	K3	3	3	3	3	3	3	2	0	3	3	2	3	2	3
CO4	K2	3	3	1	3	2	2	3	3	2	1	3	3	3	2
CO5	K4	3	2	3	3	3	3	3	3	3	3	3	2	3	3
Course	K4	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

PEC	**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, Medicinal Chemistry and Pharmaceutical Chemistry

List of Courses where this course will be Prerequisite

Profession career to experience the various aspects in drug synthesis.

Description of relevance of this course in the B. Tech. (Pharm. Chem. Tech.) Programme

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.

Sr. No.	**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
	Synthesis of drug molecules by multiple approaches in the following classes of drugs (involving three or more steps):	
	a. Anti-infective (Two molecules)	2

	b. CNS drugs (Two molecules)	2
	c. CVS drugs (Two molecules)	2
	d. Anti-diabetic drugs (Two molecules)	2
	e. Anti-histaminics (Two molecules)	2
	f. Anticancer compounds (Two molecules)	2
	g. NSAIDs (Two molecules)	2
2	Asymmetric synthesis, resolution of enantiomers applicable to drug synthesis	2
3	Biocatalysis	2
4	Catalytic synthesis	2
5	Protecting groups in organic synthesis	2
	Total	**30**

List of Text Books/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.(K3)
CO2	Predict methods and routes for chiral synthesis/chiral separation.(K3)
CO3	Apply catalytic and biocatalytic techniques for the synthesis of drugs and intermediates.(K3)
CO4	Understand how to derivatize natural products.(K2)
CO5	Apply the use of protecting groups in synthesis.(K3)

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

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	1	3	3	3	3	3	3	3	3	3	3	3	3
CO2	K3	3	3	2	0	2	3	3	3	2	3	3	2	3	3
CO3	K3	3	3	3	3	3	2	2	3	3	1	3	2	0	3
CO4	K2	3	3	2	3	3	2	3	3	3	3	2	3	3	3
CO5	K3	3	3	3	3	1	3	3	3	0	3	3	3	2	3
Course	K3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

PEC	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
Nil

List of Courses where this course will be Prerequisite
Nil

Description of relevance of this course in the B. Tech. (Pharm. Chem. Tech.) Programme
To train the students with respect to basics of Intellectual Property Rights (IPR)

Sr. No.	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 Text Books/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.(K2)
CO3	Implement the desired practises 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)

PEC	Course Code: PHT	Course Title: Molecular Biology	Credits = 2		
			L	T	P
	Semester: VII	Total Contact Hours: 30	1	1	0

List of Prerequisite Courses
Molecular Biology and Biotechnology
List of Courses where this course will be Prerequisite
Nil
Description of relevance of this course in the B. Tech. (Pharm. Chem. Tech.) Programme
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

Sr. No.	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 Text Books/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.(K2)
CO2	design strategies to synthesize biological products using recombinant microbial host cells.(K4)
CO3	use the knowledge of microbial metabolic processes to carry out genetic engineering of microbes to degrade recalcitrant material.(K4)
CO4	apply different protocols available for genetic engineering of plants and animals.(K3)

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

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4
CO1	K2	3	3	2	3	3	3	3	3	3	3	3	2	2	3
CO2	K4	3	3	3	3	2	1	3	3	0	3	2	3	3	3
CO3	K4	3	2	2	3	2	3	3	2	3	3	3	1	3	2
CO4	K3	3	3	3	3	3	3	3	3	3	1	2	3	2	3
Course	K4	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

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

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4
CO1	K2	3	3	2	3	2	0	3	3	3	3	3	2	3	3

CO2	K2	3	3	3	1	3	3	3	2	3	3	0	3	3	3
CO3	K4	3	2	2	3	3	3	2	3	2	3	2	2	1	3
CO4	K4	3	3	3	3	2	3	3	3	3	3	3	3	3	3
Course	K4	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

PCC	**Course Code:** PHT 1441	**Course Title:** Honours-III: Chemistry of Natural Products	**Credits = 4**		
			L	**T**	**P**
	Semester: VII	**Total Contact Hours: 60**	**3**	**1**	**0**

List of Prerequisite Courses

Organic Chemistry, Medicinal Chemistry

List of Courses where this course will be prerequisite

Medicinal Natural Products, Medicinal Chemistry, Medicinal Natural Products Laboratory

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, artimisine, 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 flavanoinds, 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 Haemoglobin, 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, Americal Chemical Society (1989)
3	Biochemistry, D.E. Metzler, Academic Press (2001)
4	Organic Chemistry, G. M. Loudon, Oxford University Press (2002)
5	Introduction to Flavanoids, 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 .(K2)
CO3	know characteristic features and typical biological activity with respect to structural features and synthetic routes.(K3)
CO4	evaluate the potential of natural products for therapeutic applications.(K4)

Mapping of Course Outcomes (Cos) with Programme Outcomes (Pos)															
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	2	2	3	3	3	3	2	3	2	3	3
CO2	K2	3	2	0	2	1	3	3	3	2	3	3	1	2	2
CO3	K3	3	1	1	3	1	2	2	3	2	3	2	1	3	2
CO4	K4	3	2	1	2	0	3	3	2	3	3	3	0	3	2
Course	K4	3	3	2	2	2	3	3	3	2	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

RM-1	**Course Code: PHT1442**	**Course Title: Literature Review (Research Methodology-I)**	**Credits = 2**		
			L	**T**	**P**
	Semester: VII	**Total contact hours: 45**	**1**	**0**	**2**

Course Outcomes (students will be able to…..)		
List of Prerequisite Courses		
1	NA	
List of Courses where this course will be prerequisite		
	NA	

Description of relevance of this course in the B. Chem. 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)	**Reqd. hours**
1	Introduction of Course Academic Honesty Practices General philosophy of science & Arguing About Knowledge Case studies in science history	3
2	Motivation and Background Motivation/Demotivation for Research, Building Background for Research and How to read research papers	3
3	Time Management (Academic and Non-academic time), Effort Management, Plan execution, Energy Management Issue, Role and expectation of research supervisor and student	4
4	Finding and Solving Research Problems	4

	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	
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 (Gnatt 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	4
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	6
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.	6
10	Publishing and Reviewing Publication process, How to publish papers, where to submit, Review process and reacting to a review report Reviewing scientific papers	4
11	Scientific Norms and Conventions Authorship. Plagiarism. Simultaneous submissions. Reviewing norms. Referring to other papers. Use of data. Collaborative Research Work	3
	Total hours	**45**
List of Textbooks		
	Menzel, D.; Writing a Technical Paper; McGraw-Hill, United States (1961).	
	Best, J. W., Kahn, J. V., Jha, A. K.; Research in Education; 10th ed.; Pearson, New Delhi, India (2005)	
List of Additional Reading Material / Reference Books		

Course Outcomes (Students will be able to…..)	
CO1	Understand the basic concepts of research and the components therein, formally (K2)
CO2	Understand and appreciate the significance of statistics in Chemical Technology, Pharmacy and Chemical Engineering (K2)
CO3	Understand and apply importance of literature survey in research design (K3)
CO4	Understand an in-depth knowledge on the documentation in research(K2)

CO5	Evaluate importance of various parts of a research report/paper/thesis in presentation of research results(K4)
CO6	Prepare and Deliver a model research presentation (K5)
CO7	Understand the significance of various types of IPRs in research(K1)
CO8	Create a model research project(K6)

RM-2	**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					
	Applied Mathematics I				
List of Courses where this course will be prerequisite					
	This course is required for graduating engineers to function effectively in Industry, Academia and other professional spheres. This course is in Semester VIII				
Description of relevance of this course in the B.Tech. Program					
Modern day manufacturing activities and R&D activites need decisions taken with a scientific rigour 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 organisations, 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)		**Reqd. 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		
List of Text Books / 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 GebhardtOptimal 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…..)					
1	Students should be able to understand basic principles of design of experiments.				
2	Students should be able to perform statistical analysis of single experiments and do post hoc analysis.				

3	Students should be able to conduct experiment and analyse the data using statistical methods.	
4	Students should be able to choose an appropriate design given the research problem.	
5	Students should be able to perform statistical analysis of different designs using R and interpret the results.	

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO2	K3	3	2	2	2	2	3	3	3	1	2	3	2	3	1
CO3	K3	3	3	2	2	1	1	3	3	3	3	3	2	2	3
CO4	K3	3	3	2	2	2	3	0	2	3	3	3	2	3	1
CO5	K3	3	2	2	0	2	3	3	3	1	3	0	2	3	3
Course	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

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

Seminar (PHP1077)

List of Courses where this course will be prerequisite

Project – II (PHP1075)

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	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. Each student, based on his/her interest and merit, selects the research topic and is allotted a supervisor. The work involves detailed review of the literature, formulation of research project, hypothesis, objectives, methodology, possible expected outcomes, planning for experimentation, experimental trials, data generation and analysis. Finally, the student will compile the report as per the communicated format and then present in front of the Evaluators.	120
	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)
CO2	Formulate a scientific question and approach to solve it (K6)
CO3	Plan the experimental methodology for the project (K5)
CO4	Develop skills to communicate the research plan effectively (K6)
CO5	Develop skills for writing a scientific document on the research work (K6)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4
CO1	K5	3	3	3	3	3	3	3	3	3	3	3	3	3	3

CO2	K6	3	3	3	3	3	3	3	3	3	3	2	3	3	1
CO3	K5	3	2	3	3	3	3	3	1	3	3	3	3	3	3
CO4	K6	3	3	3	3	3	2	3	3	3	0	3	3	2	3
CO5	K6	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Course	K6	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

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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
Pr 3: Pharmaceutical Technology Laboratory (Chemistry and Formulation)(PHT1044), Pr 1: (Pharmaceutical Formulation Technology Laboratory – I (PHP1081)
List of Courses where this course will be prerequisite
Project – II (PHP1075)
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 and evaluation)	8
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)
Course Outcomes (Students will be able to…..)	
CO1	Formulate evaluate parenteral and ophthalmic products.(K4)
CO2	Evaluate primary packaging for sterile products.(K4)
CO3	Perform accelerated stability testing and calculate $t_{1/2}$.(K4)
CO4	Develop skills related to working in aseptic area.(K3)

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

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4
CO1	K4	3	0	3	3	3	3	3	3	3	3	3	3	3	3
CO2	K4	3	3	3	3	2	3	3	3	3	1	2	3	2	2
CO3	K4	3	3	3	1	3	3	2	3	0	3	3	0	3	3
CO4	K3	3	3	2	3	3	3	1	3	3	3	3	2	3	3
Course	K4	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

PCC	Course Code: PHT1446	Course Title: SPL15: Pharmaceutical Chemistry-II	Credits = 3		
			L	T	P
	Semester: VIII	Total Contact Hours: 45	5	1	0

List of Prerequisite Courses

Organic Chemistry, Medicinal Chemistry and Physiology and Pharmacology

List of Courses where this course will be Prerequisite

The course will be useful in their professional career

Description of relevance of this course in the B. Tech. (Pharm. Chem. Tech.) Programme

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:

Sr. No.	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	5
	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), Miscella-neous agents and Emerging approaches	3
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, Miscelleneous 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 management of Type 2 diabetes, e.g., Glucagon-like peptide (GLP-1) analogs and agonists	3
	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	**Miscelleneous Classes of Drugs** a) Drugs acting on calcium homeostatic, iron preparations b) Introduction and Recent Approaches involving Biologicals c) Nucleotide Therapeutics	5
	Total	**45**

List of Text Books/ 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.(K2)
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.(K3)
CO3	decipher the structure-activity relationship (SAR), metabolism, therapeutic indications, drug-drug interactions, adverse effects of drugs and/or biologics.(K3)
CO4	evaluate the logic behind the design of synthetic routes for small-molecule drugs and related compounds such as metabolites, impurities and prodrugs.(K4)

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

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2

		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K2	3	3	3	3	3	3	3	0	3	3	3	3	3	3
CO2	K3	3	3	2	3	3	1	3	3	3	2	3	2	3	2
CO3	K3	3	3	3	2	2	3	3	3	3	3	3	1	2	3
CO4	K4	3	3	3	2	3	3	3	3	3	2	2	3	3	2
Course	K3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

PCC	**Course Code:** PHT1447	**Course Title:** Honors-IV: Process Technology of Drugs and Intermediates	**Credits = 3**		
			L	**T**	**P**
	Semester: VIII	**Total Contact Hours: 45**	**5**	**1**	**0**

List of Prerequisite Courses

Concepts of organic and physical chemistry should be clear; Concepts of mass transfer and heat transfer should be clear; Elementary chemical reaction engineering and in-plant training should be completed; Concept of elementary drawing should be clear

List of Courses where this course will be prerequisite

Professional Career

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

To train the students with respect to process development, basic requirements for safe plane 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	**45**

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.(K2)
CO2	follow the impact of regulatory statutes on process development.(K3)
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.(K3)

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

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K2	3	3	3	3	3	3	3	3	3	3	1	3	3	3
CO2	K3	3	3	2	1	2	3	3	2	3	2	3	3	3	3
CO3	K4	3	1	3	3	3	3	3	2	3	3	3	2	2	3
CO4	K3	3	3	3	2	3	0	3	3	3	3	2	0	3	3
Course	K3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

	Course Code: PHT1448	**Course Title: Honors Course-V (Novel Drug Delivery System)**	**Credits = 3**		
			L	**T**	**P**
	Semester: VIII	**Total Contact Hours: 45**	**5**	**1**	**0**
List of Prerequisite Courses					
	Pharmaceutical Technology I,II and III				
List of Courses where this course will be prerequisite					
Description of relevance of this course in the M. Tech. Program					
To train the students on technological aspects of drug delivery systems					
Sr. No.	**Course Contents (Topics and subtopics)**		**Reqd. hours**		
Technological considerations in development of the following					
1	**Oral drug delivery systems** Oral controlled release drug delivery, Gastro-retentive drug delivery, Osmotic drug delivery, Ion exchange 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** Injectables: 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 Text Books/ Reference Books	
1	Handbook of Pharmaceutical Controlled Release Technology, edited by Donald Wise Marcel Dekker, 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-Feu Chang 1989.	
4	Transdermal Drug Delivery by Richard H. Guy (Editor), Jonathan Hadgraft (Editor), Michiko Elizabeth 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)	

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO2	K3	3	2	2	2	2	3	3	3	1	2	3	2	3	1
CO3	K3	3	3	2	2	1	1	3	3	3	3	3	2	2	3
CO4	K3	3	3	2	2	2	3	0	2	3	3	3	2	3	1

CO5	K3	3	2	2	0	2	3	3	3	1	3	0	2	3	3
Course	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

PCC	**Course Code:** **PHP1449**	**Course Title:** **Project – II (Experiments)**	**Credits = 3**		
			L	**T**	**P**
	Semester: VIII	**Total Contact Hours: 120**	**0**	**0**	**12**

List of Prerequisite Courses

Project – I

List of Courses where this course will be prerequisite

Relevant courses in previous courses (Sem. I to Sem. VII)

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

The course is designed to develop skills necessary for executing and solving a unique research problem in Pharmaceutical Sciences and Technology field. After the laboratory work, the findings of the research are presented in a coherent manner, which may result in a patent, publication and/or presentation.

	Course Contents (Topics and Subtopics)	**Required Hours**
1	The topic of the research with clearly defined Objectives and Hypotheses should be explored systematically, in a scientifically planned rational set of experiments. Students should have actual experimental data collected on the chosen research topic.	90
2	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. The outcome is submitted in the form of a report.	30
	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 (K5)
CO2	Apply different statistical tools for scientific data analysis (K4)
CO3	Evaluate critically the experimental data and draw meaningful inferences (K5)
CO4	Develop skills to communicate the research outcome effectively (K6)
CO5	Develop skills for writing a complete document on the project work (K6)

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

		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	K4	3	3	2	3	2	3	3	3	2	3	3	2	3	3
CO3	K5	3	3	3	3	3	0	3	3	3	3	3	3	3	3
CO4	K6	3	3	3	3	3	3	1	3	3	3	3	2	3	3
CO5	K6	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Course	K6	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

PEC	Course Code: PHP1450	Course Title: Pr 9: Process Technology Laboratory	Credits = 2		
			L	T	P
	Semester: VIII	Total Contact Hours: 60	0	0	6

List of Prerequisite Courses

General exposure to Chemistry Laboratory and experience in handling chemicals; Background of Analysis and Organic reactions; Background of process modification; Microbiology and Biotechnology

List of Courses where this course will be prerequisite

Professional career

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	hone in their process development skills (K3).
CO2	explore the innovation component in process development activities.(K4)
CO3	understand and follow bioconversions.(K2)

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

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	2	1	2	1	3	3	3	3	3	3	2	3	3
CO2	K4	3	2	0	2	1	3	3	3	1	3	3	1	3	3
CO3	K2	3	1	1	2	1	3	2	3	3	3	3	0	3	2
Course	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

OJT	Course Code: PHP14151	Course Title: Internship with Industry	Credits = 12		
			L	T	P
	Semester: VIII	Total Contact Weeks: 12-16	0	0	0

List of Prerequisite Courses

None

List of Courses where this course will be prerequisite

Project – I (PHP1074), Project – II (PHP1075)

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 Weeks
1	Each Student will be involved in R & D/manufacturing (QA/QC/Plant Engineering /Stores and Purchase)/marketing/finance/consultancy/Technical services/ Engineering/Projects, etc., as deemed necessary by the assigned/chosen industry. Oral presentation & written report of the in-plant training will be evaluated along with industry feedback.	12
	Total	**12**

Course Outcomes (Students will be able to…..)	
CO1	Apply the concept of project & production management in further planning (K3)
CO2	Develop critical thinking regarding the various operations involved in dyestuff technology and allied industry (K4)
CO3	Solve certain industrial challenges in dyestuff technology and allied field (K6)
CO4	Present and communicate an industrial problem effectively (K6)
CO5	Write a scientific report on the training (K6)

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

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4
CO1	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO2	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	2
CO3	K6	3	3	3	3	3	3	2	3	1	3	2	3	3	3
CO4	K6	3	3	2	3	3	3	3	0	3	3	3	3	2	3
CO5	K6	3	3	3	3	1	3	3	3	3	2	3	3	3	3
Course	K6	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain