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 2021. The 205 credit programmes each have around 6% humanities, 23% basic sciences, 8% engineering sciences, 12% chemical engineering plus 51% special subjects..

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.

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 modeling 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

Semester I									
Course Code	Subjects	Credits	Hrs/Week			Marks for various Exams			
			L	T	P	C.A.	M.S.	E.S.	Total
CHT1137	Organic Chemistry - I	3	2	1	0	10	15	25	50
CHT1341	Physical Chemistry - I	3	2	1	0	10	15	25	50
CHT1139	Industrial Inorganic Chemistry	3	2	1	0	10	15	25	50
MAT1101	Applied Mathematics - I	4	3	1	0	20	30	50	100
PYT1101	Applied Physics - I	4	3	1	0	20	30	50	100
GEP1113	Engineering Graphics and Elementary Autocad	4	2	0	4	50	-	50	100
CHP1343	Physical and Analytical Chemistry Laboratory	2	0	0	4	25	-	25	50
	TOTAL:	23	14	5	8				500
Semester I									
Subject Code	Subjects	Credits	Hrs/week			Marks for various Exams			
			L	T	P	C.A.	M.S.	E.S.	Total
CHT1401	Analytical Chemistry	3	2	1	0	10	15	25	50
CHT1342	Physical Chemistry - II	3	2	1	0	10	15	25	50
CHT1138	Organic Chemistry - II	3	2	1	0	10	15	25	50
PYT1103	Applied Physics - II	3	2	1	0	10	15	25	50
MAT1102	Applied Mathematics - II	4	3	1	0	20	30	50	100
CET1507	Process Calculations	4	3	1	0	20	30	50	100
PYP1101	Physics Laboratory	2	0	0	4	25	-	25	50
CHP1132	Organic Chemistry Laboratory	2	0	0	4	25	-	25	50
HUP1101	Communication Skills	2	0	0	4	50	-	-	50
	TOTAL:	26	14	6	12				550
Syllabus Structure B. Tech. Second Year									
Semester III									
Subject Code	Subjects	Credits	Hrs /week			Marks for various Exams			
			L	T	P	C.A.	M.S.	E.S.	Total
BST1110	Basics of Biology and Applications to Technology	3	2	1	0	10	15	25	50
GET1110	Basic Mechanical Engineering	3	2	1	0	10	15	25	50
PHT1081	SPL1: Pharmaceutical Formulation Technology - I	4	3	1	0	10	15	50	100
CET1704	Material Technology	3	2	1	0	10	15	25	50
BST1102	Biochemistry/Txt, Poly, Dyes	4	3	1	0	20	30	50	100
BST1109	Microbiology/Txt, Poly, Dyes	3	2	1	0	10	15	25	50
PHP1081	Pr 1: Pharmaceutical Formulation Technology Laboratory I	2	0	0	4	25		25	50
PHP1084	Pr 2: Pharmaceutical and Biochemistry Analysis	2	0	0	4	25		25	50
	TOTAL:	24	14	6	8				500
Semester IV									

Subject Code	Subjects	Credits	Hrs/week			Marks for various Exams			
			L	T	P	C. A.	M.S.	E. S.	Total
GET1117	Engineering Mechanics and Strength of Materials	3	2	1	0	10	15	25	50
CET1105	Transport Phenomena	4	3	1	0	20	30	50	100
GET1105	Electrical Engineering and Electronics	3	2	1	0	10	15	25	50
PHT1051	SPL2: Chemistry of Natural Products	4	3	1	0	20	30	50	100
PHT1050	SPL3: Physiology and Pharmacology	3	2	1	0	10	15	25	50
PHT1052	SPL4: Pharmaceutical Analysis and Green Chemistry	3	2	1	0	10	15	25	50
GEP1106	Electrical Engineering and Electronics Laboratory	2	0	0	4			25	50
MAP1201	Computer Applications Laboratory	2	0	0	4			25	50
	TOTAL:	24	14	6	8				500

Syllabus Structure B. Tech. Third Year

Semester V

Subject Code	Subjects	Credits	Hrs /week			Marks for various Exams			
			L	T	P	C. A.	M.S.	E. S.	Total
CET1401	Chemical Engineering Operations	3	2	1	0	10	15	25	50
CET1212	Chemical Reaction Engineering	3	2	1	0	10	15	25	50
PHT1082	SPL5: Pharmaceutical Formulation Technology -II	4	3	1	0	20	30	50	100
PHT1049	SPL6: Medicinal Natural Products	3	2	1	0	10	15	25	50
PHT1050	SPL7: Medicinal Chemistry I	3	2	1	0	10	15	25	50
MAT1106	Design and Analysis of Experiments	4	2	2	0	20	30	50	100
PHP1044	Pr 3: Pharmaceutical Chemistry and Formulation Technology Laboratory	4	0	0	8			50	100
PHP1056	Pr 4: Medicinal Natural Products Laboratory	2	0	0	4			25	50
	TOTAL:	26	13	7	12				550

Semester VI

Subject Code	Subjects	Credits	Hrs/week			Marks for various Exams			
			L	T	P	C.A.	M.S.	E. S.	Total
PHT1055	SPL8: Pharmaceutical Chemistry and Catalytic Process	4	3	1	0	20	30	50	100
PHT1063	SPL9: Pharmaceutical Biotechnology	4	3	1	0	20	30	50	100
PHT1056	SPL10: Medicinal Chemistry II	3	2	1	0	10	15	25	50
HUT1103	Industrial Psychology & Human Resource Management	3	2	1	0	10	15	25	50

HUT1106	Environmental Science and Technology	3	2	1	0	10	15	25	50
	Institute Elective – I (Annexure A)	3	2	1	0	10	15	25	50
PHP1077	Seminar	3	0	0	6				50
PHP1053	Pr 5: Pharmaceutical Chemistry Laboratory	2	0	0	4	25		25	50
PHP1055	Pr 6: Biotechnology Laboratory	2	0	0	4	25		25	50
	TOTAL:	27	14	6	14				550
	In-plant Training of 8 to 10 weeks after end of semester								

Internship

• After the end of the sixth semester examination and before the start of the seventh semester, every student will have to undergo an internship. The internship would be of 6 credits.

• The internship (preferably Industrial Internship) would be assigned to the student by the Departmental Internship Coordinator, with the approval of the Head of the Department.

• The total duration of the internship would be for a period equivalent to 12 Calendar weeks. This period typically start from 1st May and end before 30th July every year. This means the end semester examination of T. Y. Tech (Semester VI) should be completed by 25th April every year. The Semester VII (4th Year B.Tech.) should commence w.e.f. 1st Aug every year. The internship may be completed in one or more organizations as described below.

• The internship could be of the following forms:

(i) 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.

(ii) Research internship in reputed Institutes (within India or Abroad) like, ICT, IITs, NITs, IISC, NCL, IICT 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 Department.

• Students will be assigned a grade based on the written report and a presentation; evaluated by a committee of faculty members.

Syllabus Structure B. Tech. Final Year

Semester VII

Subject Code	Subjects	Credits	Hrs/week			Marks for various Exams			
			L	T	P	C. A.	M.S.	E.S.	Total
CET1703	Chemical Process Control	3	2	1	0	10	15	25	50
PHT1083	SPL11: Pharmaceutical Formulation Technology III	3	2	1	0	10	15	25	50
PHT1084	SPL12: Validation and Regulatory Requirements	3	2	1	0	10	15	25	50
	Institute Elective- II (Annexure B)	3	2	1	0	10	15	25	50
PHP1078	In-Plant Training	6	0	0	0	10	15	25	50
HUT1203	Industrial Management	4	3	1	0	20	30	50	100
CEP1714	Chemical Engineering Laboratory	2	0	0	4	25		25	50
PHP1054	Pr 7: Medicinal Chemistry Laboratory	2	0	0	4	25		25	50
PHP1074	Project I	2	0	0	4				50
	TOTAL:	28	11	6	12				500

Semester VIII									
Subject Code	**Subjects**	**Credits**	**Hrs /week**			**Marks for various Exams**			
			L	**T**	**P**	**C.A.**	**M.S.**	**E. S.**	**Total**
CET1504	Chemical Project Engineering and Economics	3	2	1	0	10	15	25	50
PHT1058	SPL13: Process Technology of Drugs and Intermediates	4	3	1	0	20	30	50	100
PHT1057	SPL14 : Medicinal Chemistry III	3	2	1	0	10	15	25	50
PHT1060	SPL15: Chemistry and Technology of Fine Chemicals	3	2	1	0	10	15	25	50
	Programme Elective (Annexure C)	3	2	1	0	10	15	25	50
	Pre-approved Open Electives from MOOOCs/NPTEL	3	2	1	0	10	15	25	50
PHP1075	Project II	4	0	0	8				100
PHP1055	Pr 8: Process Technology Laboratory	4	0	0	8	50		50	100
	Total	27	13	6	16				550

Semester I

	Course Code: CHT1137	Course Title: Organic Chemistry – I	Credits = 3		
			L	T	P
	Semester: I	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 – II (CHT1138), Biochemistry (BST1102) and several Special Subjects of Pharmaceutical Sciences and Technology Department

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	**a. IUPAC Nomenclature of Organic Compounds**	3
	b. Reactive intermediates Carbocations, Carbanions, Carbon radicals and Carbenes – Generation, Structure, Stability and Reactions	5
2	**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
3	**Haloalkanes** Aliphatic Nucleophilic Substitution Reactions: S_N1, S_N2 Elimination Reactions: E1, E2	7
4	**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
5	**Chemistry of Aromatic Compounds** Hückel rules, Aromatic, Non-aromatic and Anti-aromatic compounds, Benzenoid and non-benzenoid aromatic compounds	3
6	**Electrophilic Aromatic 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	10
	Total	**45**

List of Text Books/Reference Books

1	Clayden, J., Greeves, N., Warren, S.; Organic Chemsitry; 2nd ed.; Oxford University Press
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	appreciate the stereochemical implications of organic compounds and visualize and appreciate chirality concept.(K2)
CO3	understand organic chemistry reactions related to aliphatic as well as aromatic compounds as well as decipher the outcome of a given organic transformation.(K3)
CO4	interpret and analyse 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
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

	Course Code: CHT1341	Course Title: Physical Chemistry – I	Credits = 3		
			L	T	P
	Semester: I	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

Standard XII Chemistry

List of Courses where this course will be Prerequisite

Physical and Analytical Chemistry Laboratory (CHP1343), Physical Chemistry – II (CHT1342)

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	**Introduction -** Thermodynamic systems, Work, Heat and Energy, State and Path functions, Intensive and Extensive variables	3
2	**First Law of Thermodynamics -** Enthalpy and heat capacities, Application of First Law to gases, Standard states, Enthalpy changes of chemical and physical conversions, Thermochemistry – Hess's Law	6
3	**Second and Third Laws of Thermodynamics -** 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 Third Law of Thermodynamics, Absolute entropies, Verification of Third Law	6
4	**Spontaneous Process and Equilibrium -** Combined statement of First and Second Laws of thermodynamics, Helmholtz and Gibbs free energy, Spontaneity and Free energy, Maxwell's relations, Effect of T and P on free energy, Van't Hoff equation, Free energy and equilibrium constant, Ellingham diagrams	7
5	**Multicomponent Systems -** Free energy and entropy of mixing, Partial molar quantities and chemical potential, Gibbs Duhem equation	5
6	**Phase Equilibria -** Gibbs Phase rule, Clausius- Clapeyron equation, Stability of phases, First and second order phase transitions, Phase diagrams of one and two two-component systems, l-L systems - TC, PC phase diagrams, distillation and azeotropes, L/S systems, S/S – eutectics and deep eutectics, Phase diagram of three-component systems	3
7	**Equilibrium in Solutions –** Ideal and non-ideal solutions, Henry's law and Raoult's law, Colligative properties Solubility Equilibria – Solubility constant, Common ion effect, Effect of added salts on solubility, pH, Weak and strong acids and bases, Buffer solutions, Ionic solutions, Activity and activity coefficients, Thermodynamic properties of electrolytes in solutions	6
8	Chemical Equilibria - Equilibrium constants, Le Chaterlier's principle, Effect of temperature, pressure and composition on equilibrium	6
9	Electrochemistry – Thermodynamics of electrochemical systems - Types of electrochemical cells, Determination of electrode potentials, Activity and activity coefficients, Dissociation of electrolytes, Ionic equilibria	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	Atkins, Peter W.; Paula, Julio de. Elements of Physical Chemistry; 7th ed.; Oxford University Press (2017)
3	Levine, Ira. Physical Chemistry; 6th ed.; McGraw-Hill Education (2009)

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

CO1	comprehend the laws of thermodynamics and related concepts and to explain the molecular basis for the same. (K2)
CO2	apply the concepts of partial molar quantities to explain the behaviour of pure substances and solutions.(K3)

CO3	understand principles of phase equilibria in two- and three-component systems.(K3)
CO4	elucidate the effect of thermodynamic quantities on chemical equilibria and relate it to properties of chemical systems.(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	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

	Course Code: CHT1139	Course Title: Industrial Inorganic Chemistry	Credits = 3		
			L	T	P
	Semester: I	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 (PCB1302), Engineering Mechanics and Strength of Materials (GET117), Environment Science and Technology (HUT1106)

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	**Primary Inorganic Materials:** Water, Hydrogen, Hydrogen Peroxide and Inorganic Peroxo Compounds, Nitrogen, Ammonia, Nitric acid, and Nitrogen Compounds, Phosphorus, Phosphoric acid and its Compounds, Sulfur, Sulfuric acid and Sulfur Compounds, Halogens, Chloralkali and Halogen Compounds	12
2	**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, Metallurgy of Iron	10
3	**Organo-Silicon Compounds:** Industrially Important Organo-silicon Compounds, Industrially Important Silanes, Silicones, Industrial Silicone Products	7
4	**Inorganic Solids:** Silicate Products, Inorganic Fibers, Construction Materials, Enamel, Ceramics, Metallic Hard Materials, Carbon Modifications, Fillers, Inorganic Pigments, Cement, Glass	8
5	**Nuclear Cycle:** Economic Importance of Nuclear Energy, General Information about the Nuclear Fuel Cycle, Availability of Uranium, Nuclear Reactor Types, Nuclear Fuel Production Disposal of Waste from Nuclear Power Stations	8
	Total	**45**

List of Text Books/ Reference Books

1	Büchel, Karl Heinz; Moretto, Hans-Heinrich; Woditsch, Peter. Industrial Inorganic Chemistry,
2	Benvenuto, Mark Anthony. Industrial Inorganic Chemistry; de Gruyter (2015)
3	Swaddle, T. W. Inorganic Chemistry – An Industrial and Environmental Perspective; 1st ed.; Academic Press (1997)
4	House, James, E. Inorganic Chemistry; 3rd ed.; Academic Press, Inc. (2019)

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

CO1	understand various industrial chemicals of nitrogen, sulfur, hydrogen, phosphorus and halogens.(K2)
CO2	understand alkali and alkaline-earth metal based industrial chemicals, iron metallurgy.(K3)
CO3	understand inorganic solid materials like glass, silicone, cement, ceramics, etc.(K2)
CO4	understand nuclear fuel and power industry.(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	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	K 3	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

	Course Code: MAT1101	**Course Title: Applied Mathematics – I**	**Credits = 4**		
			L	**T**	**P**
	Semester: I	**Total Contact Hours: 60**	**3**	**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

Applied Mathematics is beyond crunching numbers. It is useful for solving real-life problems and make an impact in the world, technology being one of those fields. The knowledge gained is required for solving various mathematical equations in several Chemical Engineering courses such as MEBC, Momentum Transfer, Reaction Engineering, Separation Processes, Thermodynamics, and several others.

Sr. No.	**Course Contents (Topics and Subtopics)**	**Required Hours**
1	**Linear Algebra:** Vectors in IR^n, Notion of linear independence and dependence. Vector subspaces of IR^n, Basis of a vector subspace, Row space, Null space, and Column space, Rank of a matrix, Determinants and rank of matrices Abstract vector spaces, Linear transformations in IR^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 methods Diagonalization of matrices and its applications stochastic matrices, Solving initial value system of linear ordinary differential equations	15
2	**Differential Calculus:** Higher order differentiation and Leibnitz Rule for the derivative, Taylor's and Maclaurin's theorems, Maxima/Minima, Convexity of functions, Radius of Curvature. 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	15
3	**Integral Calculus:** Beta and Gamma functions, Differentiation under the integral sign, Multiple integrals, Line and surface integrals, Applications of Green's, Gauss-Divergence and Stokes theorems	15
4	**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	**60**

List of Textbooks/Reference Books

1	Stang, G. Linear Algebra and its Applications; 4th ed.; Thomson (2006)
2	Anton, Howard; Kaul, Anton. Elementary Linear Algebra; 12th ed.; Wiley (2019)
3	Friedberg, Stephen H.; Insel, Arnold J.; Spence, Lawrence E. Linear Algebra; 5th ed.; Pearson Education (2019).
4	Hughes-Hallett, Deborah; Gleason, Andrew M.; McCallum, William G. Calculus: Single and Multivariable; 6th ed.; John Wiley & Sons, Inc. (2012)
5	Kreyszig, E.; Advanced Engineering Mathematics; 10th ed.; Wiley Global Education (2010) (Officially Prescribed)
6	Iyengar, S. R. K.; Jain, R. K. Advanced Engineering Mathematics; 4th ed.; Alpha Science (2014)
7	Ross, Sheldon M. A First Course in Probability; 10th ed.; Pearson Education (2018)

8	Hines, William W.; Montgomery, Douglas C.; Goldsman, David M.; Borror, Connie M. Probability and Statistics in Engineering; 4th ed.; John Wiley & Sons, Inc. (2003)
9	Boes, Duane C.; Graybill, Franklin A.; Mood, Alexander McFarlane. Introduction To the Theory of Statistics; 3rd ed.; McGraw Hill Education (India) (2013)
Course Outcomes (Students will be able to…..)	
CO1	understand the notion of differentiability and be able to find maxima and minima of functions of one and several variables.(K3)
CO2	compute surface and volume integrals.(K3)
CO3	understand the notion of vectors and vector spaces.(K2)
CO4	solve systems of linear equations and eigenvalue problems analytically and numerically. (K3)
CO5	fit relationship between two data sets using linear, non-linear regression.(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	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

	Course Code: PYT1101	Course Title: Applied Physics – I	Credits = 4		
			L	T	P
	Semester: I	Total Contact Hours: 60	3	1	0

List of Prerequisite Courses

Standard XIIth Physics

List of Courses where this course will be prerequisite

Applied Physics – II (PYT1103), Physics Laboratory (PYP1101), Chemical Process Control (CET1703), Chemical Reaction Engineering (CET1212), Transport Phenomena (CET1105)

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

This is a basic physics course. This knowledge will be required in almost all subjects later on. This knowledge is also required for understanding various chemical engineering concepts that will be introduced in courses such as momentum transfer, reaction engineering, separation processes, thermodynamics, heat transfer, etc.

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	**Solid State Physics** Crystal Structure of Solids: unit cell, space lattices and Bravais lattice, Miller indices, directions and crystallographic planes, Cubic crystals: SSC, BCC, FCC, Hexagonal crystals: HCP, atomic radius, packing fraction, Bragg's law of x-ray diffraction, determination of crystal structure using Bragg spectrometer Semiconductor Physics: Formation of energy bands in solids, concept of Fermi level, classification of solids: conductor, semiconductor and insulator, intrinsic and extrinsic semiconductors, effect of doping, mobility of charge carriers, conductivity, Hall effect	15
2	**Fluid Mechanics** Basic concepts of density and pressure in a fluid, ideal and real fluids, Pascal's law, absolute pressure and pressure gauges, basic concepts of surface tension and buoyancy, fluid flow, equation of continuity, Bernoulli's equation, streamlined and turbulent flow, concept of viscosity, Newton's law of viscosity, brief introduction to non-Newtonian behaviour	15
3	**Optics and Fibre Optics** Diffraction: Introduction to interference and example; concept of diffraction, Fraunhofer and Fresnel diffraction, Fraunhofer diffraction at single slit, double slit, and multiple slits; diffraction grating, characteristics of diffraction grating and its applications Polarisation: Introduction, polarisation by reflection, polarisation by double refraction, scattering of light, circular and elliptical polarisation, optical activity Fibre Optics: Introduction, optical fibre as a dielectric wave guide: total internal reflection, numerical aperture and various fibre parameters, losses associated with optical fibres, step and graded index fibres, application of optical fibres	10
4	**Lasers** Introduction to interaction of radiation with matter, principles and working of laser: population inversion, pumping, various modes, threshold population inversion, types of laser: solid state, semiconductor, gas; application of lasers least squares and Simple linear regression, Nonlinear regression	10
5	**Ultrasound** Generation of ultrasound: mechanical, electromechanical transducers; propagation of ultrasound, attenuation, velocity of ultrasound and parameters affecting it, measurement of velocity, cavitation, applications of ultrasound	10
	Total	**60**

List of Textbooks/Reference Books

1	Physics: Vols. I and II – D. Halliday and R. Resnick, Wiley Eastern
2	Lectures on Physics: Vols. I, II and III – R. P. Feynman, R. B. Leighton and M. Sands, Narosa.
3	Concepts of Modern Physics – A. Beiser, McGraw-Hill.
4	Introduction to Modern Optics – G. R. Fowles ,Dover Publications
5	A Course of Experiments with LASERs – R. S. Sirohi, Wiley Eastern.
6	Optical Fibre Communication – G. Keiser, McGraw-Hill
7	Optoelectronics – J. Wilson and J. F. B. Hawkes, 2nd ed, Prentice-Hall India

8	Ultrasonics: Methods and Applications – J. Blitz, Butterworth
9	Applied Sonochemistry – T. J. Mason and J. P. Lorimer, Wiley VCH.
Course Outcomes (Students will be able to…..)	
CO1	apply acoustic cavitation of Chemical Engineering Processes. (K3)
CO2	apply Bernoulli equation in simple pipe flows. (K3)
CO3	introduced to the principles of lasers, types of lasers and applications. (K2)
CO4	calculate resolving power of instruments.(K3)
CO5	describe principles of optical fibre communication.(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	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
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

	Course Code: GEP1113	Course Title: Engineering Graphics and Elementary AUTOCAD	Credits = 4		
			L	T	P
	Semester: I	Total Contact Hours: 90	2	0	4

List of Prerequisite Courses

Basic Geometry

List of Courses where this course will be prerequisite

Basic Mechanical Engineering (GET1110), Engineering Mechanics and Strength of Materials (GET1117), Chemical Engineering Operations (CET1401), Chemical Process Control (CET1703)

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

A Chemical Engineering student is required to know various processes and equipments used in the processes. Some of the elementary processes such as filtration, size reduction, evaporation, condensation, crystallization etc., are very common to all the branches of Technology. These and several other processes require machines and equipments. One should be familiar with the design, manufacturing, working, and maintenance of such machines and equipments. The subject of 'Drawing' is a medium through which, one can learn all such matters, because the drawings are used to represent the objects and the processes on paper. With the help of the drawings, a lot of accurate information is conveyed, which otherwise will not be practicable through spoken words or written text. Drawing is a language used by Engineers and Technologists. This course is required in many subjects as well as later on in the professional career.

	Course Contents (Topics and Subtopics)	Required Hours
1	**Orthographic Projections:** Conversion of 3D object or pictorial view into front view, top view and side views using first angle method of projection Sectional views draw sectional front view, top view, and side view Problems with section plane cutting object exactly at centre or off centre Orthographic views of at least 15 machine parts using mini drafter and drawing board	20
2	**Isometric Projections and Isometric Views:** Isometric scale, draw pictorial view or 3D view using front and top view or front view and any one side view Machine parts with circle, semicircle in the orthographic views and slots on inclined planes At least 10 isometric drawings using mini drafter and drawing board	12
3	**Missing Views:** Draw top view when front and any one side view is given Draw any one side view or both the side views when front view and top view is given. Problems involving sectional views. At least 6 machine parts using mini drafter and drawing board.	12
4	**Assembly Drawing**: Draw front view and top view or side view of assembly after assembling all the details of machine parts Convert assembly into details Assembly drawing of Nut and bolt, footstep bearings, Plummer block, etc.	20
5	**Introduction to Computer-Aided Drawing:** Role of CAD in design and development of new products, Advantages of CAD. Creating two-dimensional drawing with dimensions using suitable software (Minimum 2 exercises mandatory) Introduction to Solid Modelling: Creating 3D models of various components using suitable modelling software (Minimum 2 exercises mandatory)	26
	Total	**90**

List of Textbooks/Reference Books

1	Bright, Steven. AutoCAD Fundamentals: A Comprehensive Guide on Engineering Drawing and Modeling (2020)
2	Rathnam, K. A First Course in Engineering Drawing; Springer (2017)
3	Agrawal, Basant. Engineering Drawing; McGraw-Hill Education (2015)
4	Bhatt, N. D. Engineering Drawing by N. D. Bhatt.; 11th ed.; C. Publishing House Pvt. Ltd. (2011)
5	Shah, M. B.; Rana, B. C. Engineering Drawing; 2nd ed.; Pearson Education (2014)
6	Giesecke, Frederick E.; Lockhart, Shawna; Goodman, Marla; Johnson, Cindy M. Technical Drawing with Engineering Graphics; 15th ed.; Pearson Prentice Hall (2016)
7	Dubey, N. H. Engineering Drawing; 15th ed.; Nandu (2015)

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

CO1	prepare multi view orthographic projections of objects by visualizing them in different positions. (K3)
CO2	draw sectional views and develop surfaces of a given object. (K3)

CO3	prepare pictorial drawings using the principles of isometric projections to visualize objects in three dimensions. (K3)
CO4	prepare assembly drawing. (K3)
CO5	obtain Multiview projections and solid models of objects using CAD tools (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	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

	Course Code: CHP1343	Course Title: Physical and Analytical Chemistry Laboratory	Credits = 2		
			L	T	P
	Semester: I	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	Experiments based on chemical reaction kinetics, phase equilibria and electrolyte systems, surface and interfacial phenomena such as surface tension and CMC measurements	4 hrs/session X 15 sessions
	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 and determine physicochemical parameters using simple tools.(K3)
CO2	interpretation of data and drawing scientific conclusions, dryers, etc.(K4)

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

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
		K3	K4	K6	K5	K6	K3	K3+ S	K3	K3+ A	K2+A	K3	K6+A+ P	K3	K4
CO1	K 3	3	3	2	2	2	3	3	3	2	3	3	2	3	3
CO2	K 4	3	3	1	3	1	2	3	1	3	3	0	2	3	3
Course	K 4	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 II

	Course Code: CHT1401	Course Title: Analytical Chemistry	Credits = 3		
			L	T	P
	Semester: II	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

Standard XII Chemistry

List of Courses where this course will be prerequisite

Physical and Analytical Chemistry Laboratory (CHP1343), SPL4: Pharmaceutical Analysis and Green Chemistry (PHT1052), 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 (GLP)	5
2	Sampling: Basics and procedures, preparation of laboratory samples 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 principles, instrumentation and applications of - UV-visible spectroscopy - Fluorescence spectroscopy	8
5	Electrochemical Methods: General principles, instrumentation and applications of – Conductometry, Potentiometry, Coulometry, Voltammetry	8
6	Chromatographic Methods: General principle, instrumentation and applications of - Gas chromatography (GC), High-performance liquid chromatography (HPLC), Ion-exchange chromatography, Size-exclusion chromatography	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	K	3	2	1	1	1	3	2	3	3	3	3	1	1	2

	2														
Course	K 3	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

	Course Code: CHT1342	**Course Title:** Physical Chemistry – II	**Credits = 3**		
			L	**T**	**P**
	Semester: II	**Total Contact Hours: 45**	**2**	**1**	**0**

List of Prerequisite Courses

Standard XII[th] Chemistry, Physical Chemistry - I (CHT1341)

List of Courses where this course will be prerequisite

Other Chemistry and Applied Chemistry courses

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

Students should learn to appreciate the relevance of kinetic studies and parameters affecting the same. The understanding of kinetic principles should be applied towards understanding complex reaction pathways and their mechanistic studies. The concept of interfaces and surfaces are instrumental in conveying the applications and importance of disperse systems.

Sr. No.	**Course Contents (Topics and Subtopics)**	**Required Hours**
1	**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
2	**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
3	**Homogenous Catalysis** – homogeneous acid / base catalysis (specific and general acid catalysis), enzyme catalysis (Michalis-Menten kinetics)	4
4	**Reactions at Interface** – Adsorption isotherms, kinetics of surface reactions- Hishelwood and Rideal models of surface reactions	4
5	**Theories of Reaction Rates** - Theory of unimolecular reactions, collision theory and transition state theory, Effect of temperature, Solvent effects on reaction rates	6
6	**Surface and Interfacial Chemistry** – introduction, surface tension and surface free energy, methods of determining surface and interfacial tensions	10
7	**Thermodynamics of Surfaces** – surface excess, Gibbs adsorption equation, curved surfaces- bubbles, droplets and foams, Kelvin, Young Laplace and Thomson equations, homogeneous nucleation	4
8	**Liquid-Liquid and Solid-Liquid Interfaces** – contact angle, wetting and spreading, adhesion and cohesion, contact angle measurements and hysteresis	4
9	**Surfactants** – Types, adsorption at surfaces and interfaces, surfactant aggregates, factors affecting aggregation phenomena, applications of surfactants and mixed surfactant systems	4
10	**Colloids** – Preparation, stability, characterization, surface charges and electrical double layer Emulsions: Thermodynamics and stability of emulsions, microemulsions and foams, HLB values	5
	Total	**45**

List of Textbooks/Reference Books

1	P. W. Atkins, J. de Paula and J. Keeler. Physical Chemistry; 11[th] ed.; Oxford University Press (2017)
2	Keith J. Laidler. Chemical Kinetics; 3[rd] ed.; Harper & Row, New York (1987)
3	Duncan Shaw. Introduction to Colloid and Surface Chemistry; 4[th] ed.; Butterworth-Heinemann (2013)
4	Drew Myers. Surfaces, Interfaces, and Colloids: Principles and Applications; 2[nd] ed.; John Wiley & Sons, Inc. (1999)

5	M. J. Rosen. Surfactants and Interfacial Phenomena; 4th ed.; John Wiley & Sons, Inc. (2012)
Course Outcomes (Students will be able to…..)	
CO1	comprehend fundamental knowledge in chemical kinetics with basics of order, molecularity and temperature effect.(K2)
CO2	examine kinetics for complex, fast as well as surface reactions and comprehend different theories in kinetics.(K4)
CO3	comprehend fundamental knowledge and thermodynamics in surface and interfacial chemistry.(K2)
CO4	evaluate the behavior of surface active agents and disperse systems based on the knowledge of interfacial phenomena.(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	0	3	3	3	3	3	3	0	3	2
CO2	K4	3	1	2	3	2	3	3	3	3	1	3	2	3	3
CO3	K3	3	3	0	2	2	3	3	2	2	3	3	1	3	2
CO4	K4	3	2	2	3	2	0	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

	Course Code: CHT1138	Course Title: Organic Chemistry – II	Credits = 3		
			L	T	P
	Semester: II	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

Organic Chemistry – I (CHT1137)

List of Courses where this course will be prerequisite

Other Chemistry and Applied Chemistry courses

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

To acquaint the students with concepts related to aromatic, heteroaromatic and pericyclic reactions so that they are perfectly aligned to apply the same for the future courses and in their professional career

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	**Nitro and Amino Arenes** Reactions, basicity of aminoarenes, diazotization reactions	5
2	**Aromatic Nucleophilic Substitution Reactions** Addition, elimination mechanism; elimination – addition mechanism (benzyne), Sandmeyer reaction	5
3	**Pericyclic Reactions** Symmetry of molecular orbitals, frontier orbitals of ethylene, 1,3-butadiene, 1,3,5-hexatriene and allyl system, classification of pericyclic reactions; Woodward-Hoffmann correlation diagrams, FMO and PMO approaches; electrocyclic reaction -conrotatory and disrotatory motions of 4n, 4n+2 and allyl systems; cycloaddition -antara facial and suprafacial addition, 4n and 4n+2 systems, 2+2 addition of ketenes, 1,3 dipolar cycloadditions and cheleotropic reactions; sigmatropic rearrangements - suprafacial and antarafacial shifts of hydrohen, sigmatropic shifts involving carbon moieties, 3,3- and 5,5- sigmatropic rearrangements, Claisen, Cope and Aza-Cope rearrangements, ene reaction.	13
4	**Heteroaromatic Compounds** IUPAC nomenclature, structures and common names, comparison with benzenoid compounds, reactivity and synthesis – pyrroles, furans, thiophenes and pyridines	10
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	12
	Total	**45**

List of Textbooks/Reference Books

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

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

CO1	be well versed with aromatic chemistry and interpret the outcome of general transformations.(K3)
CO2	appreciate and visualize the reactions involving radicals such as cyclizations, pericyclic reactions in synthesis.(K3)
CO3	understand the importance of heterocycles, learn the properties and synthetic routes, interpret 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)

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	0	3	3	2	3	3
CO2	K3	3	3	2	2	1	3	3	3	3	3	3	2	0	3
CO3	K3	3	3	2	1	2	2	1	3	2	3	3	2	3	3
CO4	K3	3	2	0	2	2	3	3	3	3	3	3	1	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

	Course Code: PYT1103	Course Title: Applied Physics – II	Credits = 3		
			L	T	P
	Semester: II	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

Standard XIIth Physics, Applied Physics – I (PYT1101)

List of Courses where this course will be prerequisite

This is a basic Physics course. This knowledge will be required in almost all subjects later on.

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

The knowledge gained from this course is required for understanding various chemical engineering concepts that will be introduced in courses such as momentum transfer, reaction engineering, separation processes, thermodynamics, heat transfer, etc.

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	**Quantum Mechanics** Introduction to quantum physics, black body radiation, explanation using the photon concept, photoelectric effect, Compton effect, de Broglie hypothesis, wave-particle duality, Born's interpretation of the wave function, verification of matter waves, uncertainty principle, Schrodinger wave equation, particle in box, quantum harmonic oscillator, hydrogen atom (no detailed derivation)	25
2	**Dielectric and Magnetic Properties of Materials** Introduction to the 'del' operator and vector calculus, revision of the laws of electrostatics, electric current and the continuity equation, revision of the laws of magnetism. Polarisation, permeability and dielectric constant, polar and non-polar dielectrics, internal fields in a solid, Clausius-Mossotti equation, applications of dielectrics. Magnetisation, permeability and susceptibility, classification of magnetic materials, ferromagnetism, magnetic domains and hysteresis, applications.	20
	Total	**45**

List of Textbooks/Reference Books

1	Physics: Vols. I and II – D. Halliday and R. Resnick, Wiley Eastern
2	Lectures on Physics: Vols. I, II and III – R. P. Feynman, R. B. Leighton and M. Sands, Narosa.
3	Concepts of Modern Physics – A. Beiser, McGraw-Hill.
4	Solid State Physics – A. J. Dekker, 1957, MacMillan India.
5	Perspectives of Modern Physics – A. Beiser, McGraw-Hill (1969)

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

CO1	do simple quantum mechanics calculations.
CO2	define various terms related to properties of materials such as, permeability, polarization, etc.
CO3	state some of the basic laws related to quantum mechanics as well as magnetic and dielectric properties of materials.

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	1	2	1	3	2	3	3	3	3	0	3	2
CO3	K2	3	2	1	2	0	3	3	3	0	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

	Course Code: MAT1102	Course Title: Applied Mathematics – II	Credits = 4		
			L	T	P
	Semester: II	Total Contact Hours: 60	3	1	0

List of Prerequisite Courses

HSC Standard Mathematics, Applied Mathematics – I (MAT1101)

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

Applied Mathematics is beyond crunching numbers. It is useful for solving real-life problems and make an impact in the world, technology being one of those fields. The knowledge gained is required for solving various mathematical equations in several Chemical Engineering courses such as MEBC, Momentum Transfer, Reaction Engineering, Separation Processes, Thermodynamics, and several others.

	Course Contents (Topics and Subtopics)	Required Hours
1	**Numerical Methods I:** Solutions of system of linear equations (Gauss-elimination, LU-decomposition, and others) Numerical methods for solving non-linear algebraic/transcendental, Newton's method, Secant, Regula Falsi methods Numerical solution set of linear algebraic equations: Jacobi, Gauss Siedel, and under /over relaxation methods	15
2	**Numerical Methods II:** Interpolation and extrapolation for equal and non-equal spaced data (Newtons Forward, Newtons backward and Lagrange) Numerical integration (trapezoidal rule, Simpson's Rule) Numerical methods for solution of initial values problems using RK method, Euler's method and Taylor series method	15
3	**Differential Equations I:** Differential Equations: Solution of Higher order ODE with constant and variable coefficients and its applications to boundary and initial value problems, Series solution of differential equations, Bessel functions, Legendre Polynomials, Error function	15
4	**Differential Equations II:** Fourier series, Laplace Transforms and their application in differential equation (both ODEs PDEs) Partial Differential Equations, Classification of higher order PDEs, Solution of parabolic equation using separation of variables	15
	Total	**60**

List of Textbooks/ Reference books

1	Kreyszig, E.; Advanced Engineering Mathematics; 10th ed.; Wiley Global Education (2010) (Officially Prescribed)
2	Iyengar, S. R. K.; Jain, R. K. Advanced Engineering Mathematics; 4th ed.; Alpha Science (2014)
3	Jain, M. K.; Iyengar, S. R. K.; Jain, R. K. Numerical Methods for Scientific and Engineering Computation; 4th Ed.; New Age International (P) Ltd. (2004)
4	Boyce, W. E.; DiPrima R. C. Elementary Differential Equations; 10th ed.; John Wiley & Sons (2012)
5	Brown, J. W.; Churchill, R. V. Fourier Series and Boundary Value Problems; 8th ed.; McGraw-Hill Higher Education (2011)

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

CO1	solve system of linear algebraic equations.(K3)
CO2	do numerical integrations of functions.(K3)
CO3	solve higher order ODE by analytical methods.(K4)
CO4	solve initial value problems using numerical methods.(K3)
CO5	apply Fourier series and Laplace transform techniques to solve ODE and PDE.(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	2	3	3
CO2	K3	3	3	2	3	2	3	3	3	0	3	1	2	3	2
CO3	K4	3	2	1	2	0	3	3	1	3	3	3	1	3	3
CO4	K3	3	3	3	2	2	2	2	3	3	3	2	2	3	2
CO5	K3	3	2	2	1	2	3	3	3	2	3	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

	Course Code: CET1507	Course Title: Process Calculations	Credits = 4		
			L	T	P
	Semester: II	Total Contact Hours: 60	3	1	0

List of Prerequisite Courses

Standard XII[th] 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

The course introduces various concepts used in Chemical Engineering to the students. The knowledge of this course is required for in ALL B. Tech. courses in the subsequent semesters including the project work. It can be applied in various situations such as process selection, economics, sustainability, environmental impacts and others.

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	Introduction to chemical process calculations, Overview of single- 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	convert units of simple quantities from one set of units to another set of units.(K2)
CO2	calculate quantities and /or compositions, energy usages, etc. in various processes and process equipment such as reactors, filters, dryers, etc.(K3)
CO3	apply material balances in multiphase systems.(K3)
CO4	apply energy balance to various systems.(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	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
CO3	K3	3	1	2	2	1	3	3	3	2	3	3	1	3	3
CO4	K3	3	3	2	0	2	3	3	3	3	3	3	2	2	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

	Course Code: PYP1101	**Course Title:** Physics Laboratory	**Credits = 2**		
			L	**T**	**P**
	Semester: II	**Total Contact Hours: 60**	**0**	**0**	**4**

List of Prerequisite Courses

Applied Physics – I (PYT1101)

List of Courses where this course will be prerequisite

This is a basic Physics Laboratory course. This knowledge will be required in almost all subjects later on.

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

Students will be able to learn various concepts by doing experiments on different topics. This knowledge will be required in almost all subjects later on. This knowledge is also required for understanding various chemical engineering concepts that will be introduced in courses such as momentum transfer, reaction engineering, separation processes, thermodynamics, heat transfer, etc.

Sr. No.	**Course Contents (Topics and Subtopics)**	**Required Hours**
1	Viscosity	5
2	Thermistor	6
3	Thermal conductivity	5
4	Ultrasonic interferometer	6
5	Photoelectric effect	5
6	Hall effect	6
7	Newton's rings	5
8	Dispersive power of prism	8
9	Laser diffraction	8
10	Resolving power of grating	6
	Total	**60**

List of Text Books/ Reference Books

1	Physics : Vols. I and II – D. Halliday and R. Resnick, Wiley Eastern
2	Lectures on Physics: Vols. I, II and III – R. P. Feynman, R. B. Leighton and M. Sands, Narosa
3	Concepts of Modern Physics – A. Beiser, McGraw-Hill.
4	Introduction to Modern Optics – G. R. Fowles ,Dover Publications.
5	Optical Fibre Communication – G. Keiser, McGraw-Hill.
6	A Course of Experiments with LASERs – R. S. Sirohi, Wiley Eastern
7	Optoelectronics – J. Wilson and J. F. B. Hawkes, 2nd ed, Prentice-Hall India.
8	Ultrasonics: Methods and Applications – J. Blitz, Butterworth
9	Applied Sonochemistry – T. J. Mason and J. P. Lorimer, Wiley VCH.

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
Cours	K	3	3	2	3	2	3	3	3	3	3	3	2	3	3

e	4														

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: CHP1132	**Course Title: Organic Chemistry Laboratory**	**Credits = 2**		
			L	**T**	**P**
	Semester: I	**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

	Course Code: HUP1101	Course Title: Communication Skills	Credits = 2		
			L	T	P
	Semester: II	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 III

	Course Code: BST1110	Course Title: Basics of Biology and Applications to Technology	Credits = 3		
			L	T	P
	Semester: III	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

Standard XII[th] Biology

List of Courses where this course will be prerequisite

Safety studies pertaining to Chemicals, Pharmaceuticals, Polymers, cosmetics, Lubricants, Textiles, etc.

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

This interdisciplinary course will help a student understand basics of Human biology along with certain terminologies to enable them to read contemporary research pertaining to important technological developments. The course will help a student to understand the safety evaluation of materials as per regulatory guidelines

	Course Contents (Topics and Subtopics)	Required Hours
1	**Overview of Basics of Human Anatomy and Physiology**, the terminologies used etc. Definitions of Anatomy, Physiology, Histology, Biochemistry, Homoeostasis, Health, Disease, Toxicity, Safety, Genotoxicity, etc. Systems that make the human body, the rationale behind introducing the subject to the technology students of Pharma, foods, Polymers, Surface coatings, Oils, Textiles, Dyes	9
2	**Overview of the Cell Functioning** as a whole unit and its organelles with their functions and its applications to technology. An overview of normal cell division, cell death by apoptosis, necrosis , Cancerous growth, metabolites/ energy production , cellular secretions, different types of cells, cell repair, biomarkers, etc.	9
3	**Overview of Biomaterials:** Biodegradable, Biocompatible and their technological applications	6
4	**Practical Applications:** Design some simple experiments to evaluate toxicity using cellular experiments, organisms, animals etc. OECD guidelines. Concept of Safety studies and industrial relevance. (oral, dermal, inhalation)	6
5	**Toxicity Evaluation** in terms of mortality, Genotoxicity, hypersensitivity (allergy), biocompatibility as per various international guidelines namely, ICH, OECD, ISO to name a few.	10
6	Irritation potential evaluation of lubricants, surfactants, excipients, etc.	5
	Total	**45**

List of Textbooks/Reference Books

1	R. K. Goyal. Human Anatomy and Physiology, Ahmedabad, India.
2	H. P. Rang, M. M. Dale, J. M. Ritter, Pharmacology
3	Ross and Wilson's Anatomy and Physiology in Health and Illness Anne Waugh and All
4	Online guidelines of OECD, ISO, ICH

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

CO1	understand basic concepts and terminologies of Biology.(K2)
CO2	appreciate interdisciplinary nature of biology and will be able to design and execute simple experiments.(K3)
CO3	understand about the concept of toxicity/safety and its relevance to technology and its applications in everyday life.(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	0	3	3	3	3	3	3	1	3	2
CO2	K3	3	3	2	2	2	3	1	3	3	2	1	2	2	3
CO3	K2	3	1	0	2	1	3	3	3	0	3	3	1	3	2
Cours	K	3	3	2	2	2	3	3	3	3	3	3	2	3	3

e	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: GET1110	**Course Title:** Basic Mechanical Engineering	**Credits = 3**		
			L	**T**	**P**
	Semester: III	**Total Contact Hours: 45**	**2**	**1**	**0**

List of Prerequisite Courses

None

List of Courses where this course will be Prerequisite

Material Technology (PCB1302), Engineering Mechanics and Strength of Materials (GET1117), Environmental Science and Technology (HUT1106)

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 Thermodynamics:** First Law of Thermodynamics, Steady-flow energy equation, Second Law of Thermodynamics	3
2	**Properties of Steam and Boilers:** Steam formation, Types of steam, Steam Properties – Enthalpy, Simple numerical for finding enthalpy and dryness fraction Steam Boilers: Classification, Working principle of Cochran, Babcock & Wilcox, etc. boilers	6
3	**I. C. Engines:** Classification, Working of 2-stroke, 4-stroke C.I. and S.I. Engines with P-V diagrams, Definitions and simple numerical for determining indicated power, Brake power, Mechanical efficiency, Indicated thermal efficiency, and Brake thermal efficiency	6
4	**Prime Movers:** Classification of Prime movers, Working principle of steam, gas and water turbines, Concept of impulse and reaction steam turbines	4
5	**Compressors:** Classification of compressors, Reciprocating compressors, Single-stage and multistage compressors, P-V diagram, Rotary compressors, Fan, Blower & Compressors, Centrifugal and axial compressors, Application of compressors	4
6	**Pumps:** Classification of pumps, Reciprocating pumps, Centrifugal pumps, Axial pumps, Gear pumps, Maintenance of pumps	4
7	**Refrigeration:** COP of refrigerator and heat pumps, Classification of refrigerants, Nomenclature, Properties desired by refrigerants, Vapour compression refrigeration cycle, Methods of increasing COP of VCRS, Vapour absorption refrigeration systems	5
8	**Renewable Energy:** Role and importance of nonconventional and alternate energy sources such as solar, wind, ocean, bio-mass and geothermal	4
9	**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 numericals)	5
10	**Properties and Applications of Engineering Materials:** Metals –ferrous, cast-iron, tool steels and stainless steels and non-ferrous aluminium, brass, bronze Polymers – Thermoplastic and thermosetting polymers Ceramics – Glass, optical fibre, glass, cermets Composites – fibre-reinforced composites, metal-matrix composites	4
	Total	**45**

List of Text Books/ Reference Books

1	Nag, P. K. Engineering Thermodynamics; 5th ed.; McGraw Hill Education (2013)
2	Morse, Frederick T. Power Plant Engineering; 3rd ed.; Van Nostrand Reinhold Inc. (1953)
3	Ballaney, P. L. Thermal Engineering: Engineering Thermodynamics & Energy Conversion Techniques; 5th ed.; Khanna Publishers (1966)
4	Lal, J. Hydraulic Machines Including Fluidics; 6th ed.; Metropolitan Book Co. Pvt. Ltd. (2016)
5	Twidell, John; Weir, Tony. Renewable Energy Resources; 3rd ed.; Routledge (2015)

6	Rai, G. D. Non-conventional Energy Sources; Khanna (1988)
7	Arora, C. P. Refrigeration and Air Conditioning; 4th ed.; McGraw Hill (2021)
8	Rattan, S. S. Theory of Machines; 5th ed.; McGraw Hill (2019)

Course Outcomes (Students will be able to…..)	
CO1	discuss the steam formation process and its properties. (K2)
CO2	understand basics of heat transfer, refrigeration and I. C. Engines. (K2)
CO3	understand mechanism of power transfer through belt, rope and gear drives and understand the properties of common engineering materials and their applications in engineering industry. (K3)
CO4	explain the working principles of power-absorbing devices such as pumps and compressors and explain need and importance of various renewable energy sources. (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	K 2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO2	K 2	3	1	0	2	1	3	1	3	3	3	3	1	3	2
CO3	K 3	3	3	2	2	2	3	3	3	3	2	3	2	2	3
CO4	K 2	3	2	1	2	0	3	3	2	3	3	3	1	3	2
Course	K 3	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

	Course Code: PHT1081	Course Title: SPL1: 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 • Large scale manufacturing with focus onequipment	5

	• 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

	Course Code: CET1704	Course Title: Material Technology	Credits = 3		
			L	T	P
	Semester: III	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

Applied Physics – I (PYT1101), Applied Physics – I (PYT1103)

List of Courses where this course will be prerequisite

Equipment design, Final Year Project, Process Development and Engineering, Project Engineering and Economics

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

Selection of Material of Construction for a given application, Maintenance and corrective measures for various Engineering materials, Troubleshooting

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	**Engineering Materials:** Classification, Fundamentals of Engineering properties of materials, Phase diagrams, Study of ferrous and nonferrous materials	12
2	**Composite and Smart Materials**	3
3	**Structure-Property Relationship:** Subatomic to macroscopic level, Modification and control of material properties	10
4	**Theory of Failure of Materials:** Fracture, creep and fatigue	8
5	**Corrosion Engineering:** Electrochemical principles, different types of corrosion, Polarization, Mechanisms of corrosion control and prevention, Preventive coatings. Corrosion behavior of industrial materials	8
6.	**Criteria for Selection of Materials** in Chemical Process industry	4
	Total	**45**

List of Textbooks

1	The Essence of Materials for Engineers, Robert W. Messler, Jr.
2	Materials Science and Engineering, Raghavan V.
3	Materials Science and Engineering, Van Vlack L.H.
4	Engineering Materials and Applications, Flin R.A., Trojan P.K.

List of Additional Reading Material/Reference Books

1	Material Science and Engg, Callister
2	Mechanical Metallurgy, Dieter

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

CO1	resolve the issues related to mechanical failure.(K3)
CO2	troubleshoot corrosion-related industrial problems.(K2)
CO3	learn from incidences (LF!).(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	1	3	2	3	3
CO2	K3	3	3	2	0	2	3	3	2	3	3	0	2	2	3
CO3	K2	3	2	1	2	1	2	3	3	3	2	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

	Course Code: BST1102	Course Title: Biochemistry	Credits = 4		
			L	T	P
	Semester: III	Total Contact Hours: 60	3	1	0

List of Prerequisite Courses

Standard XII Biology and Chemistry

List of Courses where this course will be prerequisite

Pharmaceutical and Biochemical Analysis Laboratory, Pharmaceutical Biotechnology, Process Technology and Biotechnology Laboratory or other relevant courses

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

To train the students with respect to the core chemistry principles involved in functioning of biological systems, structural and chemical biology of macromolecules, including proteins, carbohydrates, lipids, nucleic acid and vitamins , structure, function and kinetic properties of enzymes and their role in metabolism of living cells, major catabolic as well as anabolic pathways involved in cell metabolism and quantitative aspects of biochemical analysis of macromolecules

	Course Contents (Topics and Subtopics)	Required Hours
1	**Carbohydrates:** Fundamentals of chemistry of carbohydrates, concept of ring structures and straight chain structure of common carbohydrates glucose, fructose, galactose, lactose, maltose, sucrose, polysaccharides, starch, glycogen, cellulose	5
	Qualitative tests / colour reaction: phenyl hydrazine, alkali – oxidation reduction with practical significance	2
	Metabolic pathways and energy yield for breakdown of carbohydrates: glycolysis, gluconeogenesis, citric acid cycle, pentose phosphate pathway, electron transport chain and coupled oxidative phosphorylation	5
2	**Lipids:** Fatly aids, waxes, phospholipids, sphingolipids, terpenoids. With are representative structure and significance	4
	Functions & comparative distribution of lipids, lipoproteins	4
	B-oxidation of fatly acids, functions of cholesterol & significance	
	Rancidity, sap value, iodine value & hydrogenating	4
3	**Proteins and Amino Acids:** Structures, pK – isoelectric point, essential & non-essential amino acids, Colour reaction of amino acids	5
	Structure of protein: globular, fibrous	4
	Structural organization of protein: primary, secondary, tertiary, quaternary	5
	Elementary idea about chromatography & electrophoresis	2
4	**Nucleic acids and their Components:** DNA& RNA bases, nucleosides, nucleotides, chemistry of nucleic acids, Structure and functions of RNA & DNA	5
	Types of RNA: mRNA, tRNA&rRNA	5
	Salient factures of protein biosynthesis & idea of genetic code	
5	**Enzymes**: Definition, function, nomenclature, classification, mechanism of enzyme action, specificity of enzymes,enzyme kinetics, enzyme inhibition and regulation	5
6	**Vitamins and Co-enzymes:** Structures& function of Nicotinamide, nicotinic acid, riboflavin, lipoic acid, biotin, thiamine, B6, folic acid, B12, pantothenic acid, ascorbic acid, vitamins A, D, K, and E	5
	Total	**60**

List of Textbooks/Reference Books

1	Principles of Biochemistry, Lehninger AL, Nelson DL and Cox MM, 5th ed.; MacMillan (2008)
2	Biochemistry, Stryer L, Berg JM and Tymoczko JL, 5th ed.; Freeman & Co. (2002)
3	Fundamentals of Biochemistry – Voet D. J. and Voet J. G.; Upgrade edition; John Wiley & Sons (2002)

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

CO1	apply of fundamental knowledge of chemistry to biological systems and understand and elucidate structural as well as metabolic role of different macromolecules in the cell.(K3)
CO2	apply analytical tests involved in detection of macromolecules in/derived from biological samples.(K3)
CO3	understand the role of enzymes in cellular environment and their use in industrial applications for their practical applications and evaluate and elucidate impact of different catalytic reactions involved in metabolic pathway.(K2)
CO4	evaluate and explain influence and interactions of different metabolic pathway on each other.(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	2	1	2	1	3	3	3	3	3	3	1	3	2
CO2	K3	3	2	0	2	1	3	3	2	2	3	0	1	3	2
CO3	K2	3	3	2	1	2	3	2	3	3	2	3	2	2	3
CO4	K4	3	2	1	2	0	3	3	3	3	1	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

	Course Code: BST1109	Course Title: Microbiology	Credits = 3		
			L	T	P
	Semester: III	Total Contact Hours: 60	2	1	0

List of Prerequisite Courses

Standard XII Science (Any combination of Physics, Chemistry, Mathematics and Biology)

List of Courses where this course will be prerequisite

Various Technology Courses such as Medicinal Chemistry – II (PHT1056), Environmental Science and Technology (HUT1106)

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

To familiarize students with diverse microorganisms in different industries like food, dairy, bio-based fermentation, oil, pharmaceutical industry and bioenergy, with diversity of microorganisms, microbial cell structure and function, microbial growth and metabolism, environmental factors affecting their growth and cultivate/control growth of microbes using physical and chemical technologies; with basics of microbial replication, transcription, translation and mutagenesis and involvement of microorganisms in diseases and role of immune system in defending invading pathogens

	Course Contents (Topics and Subtopics)	Required Hours
1	**Introduction to Microbiology** and its significance (beneficial and harmful) in Foods (Dairy including pre and probiotics, cheese, vitamins, beverages etc.), Pharmaceuticals (Antibiotics, vaccine production, pathogenic organisms etc), Oils (bioremediation, bio-diesel from microorganism etc.), and environment (waste water, nitrification, methanation, green chemicals and biofuels, etc.)	5
2	**Prokaryotes and Eukaryotes** - Morphology, structure and function of microbial cells and their components	5
3	**Major Groups of Microorganisms** - Bacteria, Virus, Yeasts and Molds, Rickettsia, Chlamydia and Algae	5
4	**Gram Character** and staining techniques, Isolation, preservation and maintenance of pure cultures	5
5	**Nutrient Requirements** of microorganism, Composition, preparation and sterilization of microbiological media; Classification of media, Methods of sterilization, disinfection, sanitation, asepsis	5
6	**Growth Studies** (lag phase, log phase, stationary phase, death phase); concept of generation time; Physical and chemical factors affecting growth of microbes	5
7	**Extremophiles and their Applications** - Acidophiles, Basophiles, Thermophiles, Hyperthermophiles, Psychrophiles, Osmophiles	5
8	**Microscopy** (dark, Fluorscence, atomic force, scanning tunnel, confocal etc.); Enumeration of microorganisms (TPC, Yeast and molds count, MPN, turbidometry, rapid methods like flow cytometry, etc.)	5
9	**Principles of Immunology**	5
	Total	**45**

List of Textbooks/Reference Books

1	Microbiology by Prescott, Harley & Klein's 7th Edition, 2008, McGraw-Hill
2	Microbiology by Pelczar, 5th edition, 1993, Mcgraw-Hill

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

CO1	know the application of diverse microorganisms in different industries like food, dairy, oil, pharmaceutical, bio-based fermentation and bio-energy.(K2)
CO2	know the cultivation/control methods for diversity of microorganisms, their physiology and metabolism.(K2)
CO3	understand the flow of genetic information from DNA to protein and the mechanisms involved therein.(K2)
CO4	understand the significance of microorganisms in diseases and basic immune system against invading pathogens.(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	1	3	1	3	2
CO2	K3	3	2	1	2	0	1	3	2	3	3	3	1	3	2
CO3	K2	3	3	2	2	2	3	2	3	1	2	3	2	2	3
CO4	K4	3	2	0	2	1	3	3	3	3	3	3	1	0	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

	Course Code: PHP1081	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	K 4	3	2	1	2	0	3	3	3	3	3	3	1	3	2
CO2	K 4	3	2	1	3	1	3	3	2	2	1	3	0	3	3
CO3	K 4	3	3	3	2	1	2	3	0	3	2	3	2	2	3
CO4	K 3	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

	Course Code: PHP1084	**Course Title:** Pr 2: Pharmaceutical and 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

Pr 4: Medicinal Natural Products Laboratory (PHP1056), Pr 6: Biotechnology Laboratory (PHP1055)

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

	Course Code: GET1117	Course Title: Engineering Mechanics and Strength of Materials	Credits = 3		
			L	T	P
	Semester: IV	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

Standard XII Physics and Mathematics, Applied Mathematics - I and - II, Applied Physics - I

List of Courses where this course will be Prerequisite

Material Technology, Strength of Materials, Environment Science and Technology

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

This subject will help students to understand use of basics of Applied Mechanics and Strength of Materials. As a practicing Engineer and Technologist, the students will relate different types of forces to be considered along with their quantification during design of equipments. It will also help in understanding the conditions of equilibrium and their application for analysing the problems, importance of centre of gravity and moment of inertia in Engineering Design, study of different types of stresses and strains occurring in various components of the structure including in thin cylindrical shells., advantages and disadvantages of various geometric sections available for Engineering design. In addition, the students will be acquainted with different advance fibre polymer composite materials used in industry for various applications and several performance- enhancing construction chemicals. In summary, this is a foundation course for a proficient Design Engineer and Technologist.

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	**Concepts of Forces**, their types, Resolution of forces, Composition of forces, Steps in Engineering Design, Different types supports and free body diagram	4
2	**Equilibrium of Rigid Bodies** - Conditions of equilibrium Determinant and indeterminate structures Equilibrium of beams, trusses and frames Problems on analysis of beams and truss.	6
3	**Concept of Centroid and Moment of Inertia** (Second moment of area) its use Parallel axis theorem Problems of finding centroid and moment of Inertia of single figures, composite figures Perpendicular axis theorem, Polar M.I., Radius of gyration.	5
4	**Shear Force and Bending Moment** - Basic concept, S.F. and B.M. diagram for cantilever, simply supported beams (with or without overhang) Problems with concentrated and U.D. loads.	4
5	**Stresses and Strains** - Tensile and compressive stresses, Strains, Modulus of elasticity, Modulus of rigidity, Bulk modulus Thermal stresses and strains Problems based on stresses and strains Basics of Engineering Design - Steps in the engineering design, Importance of analysis, 1-D, 2-D and 3-D analysis and interpretation of results. Design philosophies	6
6	**Theory of Bending** - Assumptions in derivation of basic equation, Basic equation, Section modulus, Bending stress distribution	3
7	**Problems on Shear Stress** - Concept, Derivation of basic formula Shear stress distribution for standard shapes Problems of Shear stress distribution	3
8	**Slope and Deflection of Beams** - Basic concept, Slope and Deflection of cantilever and simply supported beams under standard loading Macaulay's method	4
9	**Thick and Thin Cylinders** - Concept of radial, longitudinal stresses, behaviour of thin cylinders Problems on thin cylindrical and spherical shells Behaviour of thick cylinders (Theory only)	4
10	**Natural Materials**, Manmade Materials Composite Materials – Types of composite materials and their uses in various industrial applications Different types of performance enhancing and special purpose construction chemicals; Plasticizers and super-plasticizers; Recycling of waste – value addition; Testing of Materials and its relevance	6
	Total	**45**

List of Text Books/ Reference Books	
1	Thadani, B. N. Engineering Mechanics; Asia Publishing House (1966)
2	Popov, Egor P. Introduction to Mechanics of Solids; Macdonald (1968)
3	Beer. Mechanics of Materials; 7th ed.; Mc Graw-Hill India (2016)
4	Dadhe, V. G.; Jamdar, M. G.; Walavlkar, Y. N. Fundamentals of Applied Mechanics; Sarita Prakashan (1989)
5	Timoshenko, S.; Young, D. H.; Rao, J. V.; Pati, Sukumar. Engineering Mechanics; 5th ed.; McGraw Hill Education (2017)
6	Singer, Ferdinand L.; Pytel, Andrew. Strength of Materials; 4th ed.; Harper Colins Publishers (2012)
7	Kaw, Autar K. Mechanics of Composite Materials; 2nd ed.; CRC Press (2006)
8	Shetty, M. S.; Concrete Technology: Theory and Practice; S. Chand & Co. Ltd. (2005)
Course Outcomes (Students will be able to…..)	
CO1	quantify the actions and able to find reactions by applying conditions of equilibrium, find out the Centroid and Moment of Inertia for various cross sections used in engineering structures and for plane areas and be able to draw the Shear Force and Bending Moment diagram for different types of beams under simple and complex loading.(K3)
CO2	calculate the forces, reactions, stresses, strains in components of the bodies of a complex engineering structure.(K3)
CO3	find out the Bending Stresses at different positions and Shear Stress distribution across the cross section at various points and calculate the Slope and Deflection at different points under simple and complex loading.(K3)
CO4	know various materials used in various applications in engineering. cement composite – Concrete, Chemicals used to alter the properties of concrete.(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	1	3	2	3	3
CO2	K3	3	3	1	2	1	3	3	2	3	3	3	2	1	3
CO3	K3	3	2	2	2	2	3	2	3	3	3	0	2	3	3
CO4	K2	3	2	0	2	1	3	3	3	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

	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

XIIth 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 of fluids, heat and mass transfer, etc.

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

This basic course introduces concepts of momentum, heat and mass transfer to students. Various other concepts such as pressure, momentum, energy are introduced as well. Laws related to conservation of momentum, energy, mass are taught. Applications of these laws to various engineering and technological situations and process 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, Fluid moving machinery such as pumps	10
3	**Particle Dynamics**, Flow through fixed and fluidized Beds	4
4	**Equations of Continuity and Motion** in laminar flows and its applications for simple Couette flow and Poiseuille flow applications	6
5	**Heat Conduction**, Convective heat transfer and concept of heat transfer coefficient	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 of mass 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	calculate friction factor, pressure drop, power.(K3)
CO2	calculate flow and power required for pumps.(K3)
CO3	calculate heat transfer coefficients and do basic sizing of double pipe and shell and tube heat exchangers.(K3)
CO4	calculate mass transfer coefficients and estimate mass transfer rates in simple situations. (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	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

	Course Code: GET1105	**Course Title:** Electrical Engineering and Electronics	**Credits = 3**		
			L	**T**	**P**
	Semester: IV	**Total Contact Hours: 45**	**2**	**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 basics of electricity alongside basic knowledge about Transformer and selection of different types of drives for a given application process. They will get basic knowledge of electronic devices and their applications in Power supplies, amplifiers and other circuits.

Sr. No.	**Course Contents (Topics and Subtopics)**	**Required Hours**
1	**Basic Laws:** Kirchoff's current and voltage law, Simple series and parallel connections, star and delta transformation, Mesh and nodal analysis, Basic elements R, L and C. Concept of self and mutual inductance	6
2	**Network Theorems:** super position, Thevenin's theorems	3
3	**A.C. Fundamentals:** Equations of alternating voltages and currents, cycle, frequency. Time period, amplitude, peak value average value, R.M.S. value, A.C. through resistance, inductance and capacitance, simple RL, RC and RLC circuits. Resonance in series RLC circuits, Power, power factor, series and parallel circuits	5
4	**Three-Phase Systems:** Star and delta connections, relationship between line and phase voltages and currents, Power in three phase circuits	5
5	**Transformer:** Introduction, principle of operation, e.m.f. equation, phasor diagrams. Ideal transformer, transformer on no load, Transformer under load, Transformer losses, efficiency, regulation	5
6	Introduction to dc and ac drives	5
7	**Diodes and Rectifiers:** P-N junction diode characteristics, Zener diode, Half wave and full wave rectifiers, their waveforms, brief introduction to filters	4
8	**Bi-polar Junction Transistor:** Current components. Modes of operation, Input and output characteristics, Regions of operation, Transistor as an amplifier, classification of amplifiers	6
9	**Introduction to Uni junction transistor**, Characteristics, UJT relaxation oscillator	3
10	**Silicon-controlled Rectifier:** Controlled rectification, characteristics, methods of turning-on. Applications	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 Machines by P.S. Bhimbra
5	Electrical Technology by B. L. Theraja, A. K.Therajavol I, II, IV
6	Thyristors and their applications by M. Ramamurthy
7	Power Electronics by P.S. Bhimbra

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

	Course Code: PHT1051	Course Title: SPL2: Chemistry of Natural Products	Credits = 4		
			L	T	P
	Semester: IV	Total Contact Hours: 60	3	1	0

List of Prerequisite Courses

Organic Chemistry – I (CHT1137), Organic Chemistry – II (CHT1138)

List of Courses where this course will be prerequisite

SPL6: Medicinal Natural Products (PHT1049), SPL7: Medicinal Chemistry – I (PHT1050), Pr 4: Medicinal Natural Products Laboratory (PHP1056)

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

	Course Code: PHT1050	Course Title: SPL3: 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

SPL7: Medicinal Chemistry – I (PHT1050), SPL10: Medicinal Chemistry – II (PHT1056), SPL14 : Medicinal Chemistry – III (PHT1057), SPL11: Pharmaceutical Formulation Technology – III (PHT1083), SPL12: Validation and Regulatory Requirements (PHT1084)

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

	Course Code: PHT1052	Course Title: SPL4: Pharmaceutical Analysis and Green Chemistry	Credits = 3		
			L	T	P
	Semester: IV	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

Analytical Chemistry

List of Courses where this course will be prerequisite

SPL5: Pharmaceutical Formulation Technology –II (PHT1082); Pr 3: Pharmaceutical Technology (PHP1044); Pr 4: Medicinal Natural Products (PHP1056); SPL8: Pharmaceutical Chemistry and Catalytic Process (PHT1055); SPL11: Pharmaceutical Formulation Technology – III (PHT1083); SPL12: Validation and Regulatory Requirements (PHT1084); Institute Elective- II: Structural Elucidation by Spectroscopy (PHT1093); SPL13: Process Technology of Drugs and Intermediates (PHT1058)

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. In addition, the students are exposed to 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 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	4
4	**Refractometry and 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)	6
6	**Atomic Absorption (AAS) and Atomic Emissions Spectroscopy (AES)**: Theory and Instrumentation, Sample introduction, Inductively-Coupled Plasma (ICP) AES Applications in Material and Life Sciences	3
7	**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
8	**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	6
9	**Hyphenated Techniques:** GC-MS, LC-MS, LC-MS/MS, interfaces, advantages and limitations	3
10	**Examples** encompassing structural elucidation of simple organic compounds using ^{1}H-NMR, Mass, UV-Vis and FT-IR techniques	2
11	**Introduction to Green Chemistry:** Green Chemistry Principles, minimization of waste generation and waste prevention; Case studies	5
12	**Introduction to Alternative Methods of Chemical Synthesis:** Photochemistry, Microwave-Assisted Organic Synthesis (MAOS), Solvent-free synthesis, Electrochemistry and Sonochemistry	3
	Total	**45**

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)
12	Handbook of Green Chemistry, Vol. 11: Green Metrics; Anastas, P. T., Constable, D. J. C., Jimenez-Gonzalez, C., Eds.; Wiley-VCH, (2018)
13	ACS Green Chemistry Institute. https://www.acs.org/content/acs/en/greenchemistry/about.html
14	Green Chemistry in Industry: Green Chemical Processing.; Benvenuto, M. A., Plaumann, H., Eds.; de Gruyter, Berlin, GmbH (2018)
15	Brahmachari, G. Catalyst-free Oganic Synthesis. Green Chemistry Series 51; RSC, Cryodon, UK (2018)
16	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)
17	Green Chemistry Strategies in Drug Discovery. RSC Drug Discovery Series 46; Peterson, E. A., Manley, J. B. Eds.; RSC, Cambridge, UK (2015)
18	Worldwide Trends in Green Chemistry Education; Zuin, V. G., Mammino, L., Eds.; RSC, Cambridge, UK (2015)
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 to moderately complex organic molecules in stepwise manner.(K2)
CO5	appreciate and implement Green Chemistry Principles in Professional Life.(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	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
CO5	K3	3	2	1	3	2	3	3	3	2	3	3	2	1	3
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

	Course Code: GEP1106	Course Title: Electrical Engineering and Electronics Laboratory	Credits = 2		
			L	T	P
	Semester: IV	Total Contact Hours: 60	0	0	4

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 basics of electricity alongside basic knowledge about Transformer and selection of different types of drives for a given application process. They will get basic knowledge of electronic devices and their applications in Power supplies, amplifiers and other circuits.

	Course Contents (Topics and Subtopics)	Required Hours
	Suitable no of experiments out of the following will be conducted -	
1	Superposition Theorem	5
2	Thevenin's Theorem	5
3	Series RL circuit	4
4	Resonance in Series RLC circuit	5
5	H.W. and F.W. Rectifiers	4
6	Cathode Ray Oscilloscope	5
7	Input and output characteristic of npn transistor in CE mode	4
8	Load Test on Transformer	4
9	Three phase star connection	4
10	Three phase delta connection	4
11	Study of UJT relaxation oscillator	4
12	Design of UJT relaxation oscillator	4
13	Load Test on 3 phase induction motor	4
14	Study of Thermocouple	4
	Total	**60**

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 Machines by P.S. Bhimbra
5	Electrical Technology by B. L. Theraja, A. K. Therajavol I, II, IV
6	Thyristors and their applications by M. Ramamurthy
7	Power Electronics by P.S. Bhimbra

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

CO1	understand concepts of basic working of D.C circuits.(K2)
CO2	understand the basic applications of single phase and three phase AC supply and circuits. (K2)
CO3	understand the working and utility of transformers and motors used as various industrial drives.(K2)
CO4	understand the basic working and applications of electronic devices and circuits.(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	1	2	0	3	3	3	3	3	3	1	3	2
CO2	K2	3	2	1	1	1	3	3	3	3	3	3	0	2	2
CO3	K2	3	2	0	2	1	3	3	3	2	2	3	1	3	2
CO4	K3	3	3	2	2	2	3	3	2	3	3	3	2	3	3
Cours	K	3	3	2	2	2	3	3	3	3	3	3	2	3	3

e	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: MAP1201	Course Title: Computer Applications Laboratory	Credits = 2		
			L	T	P
	Semester: IV	Total Contact Hours: 60	0	0	4

List of Prerequisite Courses

HSC Standard Mathematics, Applied Mathematics – I (MAT1101)

List of Courses where this course will be prerequisite

This is a basic Mathematics course. This practical knowledge will be required in several subjects later.

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

Students will understand the basics of Python programming and get exposure to the use of spreadsheet programme and Excel for numerical computations and statistical analysis for engineering applications. The students will also explore R-programming for Regression Analysis, Testing of Hypothesis using of standard statistical inference. B. Tech programme requires students to analyze data and develop computer programmes to solve various problems in Engineering and Technology fields.

	Course Contents (Topics and subtopics)	Hours
1	Introduction to Spreadsheet Programmes, Use of formulae and Plotting Graphs of Function and Data Plotting in Excel	4
2	Exploring Basic Statistics and Hypothesis Testing with Spreadsheet	4
3	Numerical Solution of Linear and Non-Linear Equations in Excel	4
4	Basic Introduction to R and R Studio, Data Management in R	4
5	Plotting Graphs in R, Exploring Probability Distribution Function in R	3
6	Hypothesis Testing in R	4
7	Basic Regression Analysis in R	4
8	Introduction to Python, Installation of Python and jupyter notebook through Anaconda. Variables in Python, Exploring math and cmath modules	3
9	List, Tuples and Dictionaries in Python, if else and elif statements, Creating functions (using def and lambda functions)	4
10	For loops and while loops in Python. Use of break and continue statements with loops, Developing Python programmes using loops	4
11	Writing Python Programme to solve problems in basic numerical analysis such root finding, Numerical solutions of linear equations, Numerical integration, etc.	4
12	Use of Numpy and Scipy to deal with vectors, matrices and their operations	4
13	Use of Numpy and SciPy continued	3
14	Plotting graphs using matplotlib	4
15	Use of Pandas for data processing and analysis	4
16	Linear and multilinear regression using Python	3
	Total	**60**

List of Textbooks/ Reference Books

1	Carlberg, Conrad George. Statistical analysis: Microsoft Excel 2016; Que (2018).
2	Langtangen, Hans Petter. A Primer on Scientific Programming with Python; 5th ed.; Springer-Verlag Berlin Heidelberg (2016)
3	Thareja, Reema; Python Programming - Using Problem Solving Approach; Oxford University Press (2017)
4	Beazley, David; Jones, Brian K. Python Cookbook: Recipes for Mastering Python 3; O'Reilly Media (2013)
5	VanderPlas, Jack; Python Data Science Handbook: Essential Tools for Working with Data; 1st ed.; O'Reilly Media (2016)
6	Dalgaard, Peter; Introductory Statistics with R; 2nd ed.; Springer (2008)
7	Navarro, Daniel; Learning Statistics with R (2013)
8	Dennis, Brian; The R Student Companion; CRC Press (2012)
9	Verzani, John; Using R for Introductory Statistics; 2nd ed.; CRC Press (2014)

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

CO1	perform descriptive statistical analysis using Excel.(K3)
CO2	perform basic statistical tests using R.(K3)
CO3	perform linear regression using R.(K3)
CO4	write Python programs to implement basic numerical methods.(K4)
CO5	perform data processing and regression analysis using Python.(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	0	3	3	3	3	3	3	2	3	3
CO2	K3	3	3	2	1	2	3	3	3	3	3	1	2	0	3
CO3	K3	3	1	2	2	2	2	3	0	3	2	3	2	3	3
CO4	K4	3	3	0	3	2	3	3	3	3	3	3	0	3	3
CO5	K4	3	3	2	3	2	3	3	2	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

Semester V

	Course Code: CET1401	Course Title: Chemical Engineering Operations	Credits = 3		
			L	T	P
	Semester: V	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

Process Calculations (CET1507), Transport Phenomena (CET1105)

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. Programme

This is a basic Chemical Engineering course. The principles learnt in this course are required in almost all the forthcoming courses and throughout the professional career of students.

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	**Distillation:** Fundamentals of flash-, batch- and continuous distillation, Distillation columns internals, Steam and azeotropic distillation	12 – 15
2	**Liquid-Liquid Extraction:** Solvent selection, Construction of ternary diagrams, Staged calculations, Types of extraction equipment	6
3	**Crystallization:** Phase diagram (temp/solubility relationship), Evapo-rative 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, ypes of dryers	5
6	**Introduction to Other Aspects of Unit Operations:** Content will be aimed towards understanding practical and safety aspects of unit operations and/or introducing other separation processes like: adsorption/ion exchange, membrane processes and gas absorption, etc.	9 – 6
7	**Industrial Case Studies:** Interactive discussion with experienced professionals from industry or equipment vendors with emphasis on applicability, importance and challenges of different unit operations	3
	Total	**45**

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	perform basic sizing of continuous and batch distillation columns.(K3)
2	analyze filtration data and select systems based on requirements, estimate filtration area for given requirements, understand filter aids and their usage.(K4)
3	describe few industrial crystallization, filtration and drying equipment.(K2)
4	describe the need and importance of other separation processes like adsorption, ion exchange and membrane.(K2)
5	gain a practical perspective of unit operation in chemical industries.(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	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

	Course Code: CET1212	Course Title: Chemical Reaction Engineering	Credits = 3		
			L	T	P
	Semester: V	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

Physical Chemistry – I (CHT1341), Physical Chemistry – II (CHT1342), Transport Phenomena (CET1105)

List of Courses where this course will be prerequisite

Environmental Science and Technology (HUT1106), Chemical Project Engineering and Economics (CET1504)

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

The course 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

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	Kinetics of homogeneous reactions, Interpretation of batch reactor data, Single ideal reactors including design aspects	10
2	Multiple reactions, Temperature and pressure effects	5
3	Introduction to Non-ideal flow, RTD measurements, Models to predict conversions	5
4	Homogeneous and Heterogeneous Catalysis, Kinetics of Solid Catalyzed Reactions. Design of gas – solid catalytic reactors	15
5	Introduction to multiphase reactors	5
6	Mass Transfer with Chemical Reactions: Regimes of operation and Model contactors	5
	Total	**45**

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 apply the principles of various types of reactors (K3)
CO2	calculate rates of reactions based on given reaction scheme (K3)
CO3	design various components of reactors used in industrial practice (K3)
CO4	compare various reactors and select an appropriate reactor for a given situation (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	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
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

	Course Code: PHT1082	Course Title: SPL5: 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	5

	• Large scale manufacture and packaging with focus on equipment • 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

	Course Code: PHT1049	Course Title: SPL6: Medicinal Natural Products	Credits = 3		
			L	T	P
	Semester: V	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

Standard XII[th] 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	4
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	4
6	Extraction and isolation of plant drugs: conventional and modern techniques used in extraction and separation of phytoconstituents	4
7	Detailed study of one representative from each of the above mentioned chemical class (10 drugs)	8
8	Recent advances in phytopharmaceuticals (topic of current interest)	1
	Total	**45**

List of Textbooks/Reference Books

1	Dewick P.M., Medicinal Natural Products- A Biosynthetic Approach, 2[nd] 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

	Course Code: PHT1050	Course Title: SPL7: Medicinal Chemistry – I	Credits = 3		
			L	T	P
	Semester: V	Total Contact Hours: 45	3	1	0

List of Prerequisite Courses

Organic Chemistry – I (CHT1137), Organic Chemistry – II (CHT1138), Physical Chemistry – I (CHT1341), Physical Chemistry – II (CHT1342)

List of Courses where this course will be prerequisite

SPL6: Medicinal Chemistry – I (PHT1050), SPL10: Medicinal Chemistry – II (PHT1056), SPL14: Medicinal Chemistry – III (PHT1057)

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	1
	Historical perspective, significance of medicinal chemistry - Last 150 years serendipity, natural products in drug discovery	1
	Introduction to Modern Drug Discovery- Rational design, Molecular modeling, Genetics and DNA technology	2
	Classification of Drugs: Classification of drugs based on: Therapeutic classes, Drug targets, Mechanism of action, Chemistry, etc.	2
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	3
	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	1
	Drug Elimination: a) drug excretion b) drug biotransformation c) Biotransformation reactions: functionalization, conjugation reactions, reactions leading to toxic metabolite	5
	Prodrugs: concept of prodrugs, examples and applications, carrier prodrugs, bioprecursor prodrugs	2
	Drug Toxicity	1
	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 druggable targets	3
	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	3
	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	3
4	Small molecules as drugs (examples from current drugs to be used)	
	Strategies for hit identification: Strategies for identification of hits: natural product based, serendipity, design of analogs , systematic and random screening, development of new leads from old drugs, introduction to concept of chemical space	5

5	**Drug Design:** Introduction to molecular mechanics, Ligand based (pharmacophore modeling) and receptor based drug design(protein crystallography, molecular docking), drug repurposing, fragment based drug discovery	5
6	**Lead Optimization:** lead likeness and drug likeness, determination of compound, drug biological, biochemical properties, metabolic information using internet, homologs, concepts of bioisosterism, isosteric replacements, ring transformations, conformational restrictions, homo/ heterodimer ligands and chemical hybridization	3
7	SAR, QSAR: 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

	Course Code: MAT1106	Course Title: Design and Analysis of Experiments	Credits = 4		
			L	T	P
	Semester: V	Total Contact Hours: 60	2	2	0

List of Prerequisite Courses

HSC Standard Mathematics, Applied Mathematics – I (MAT1101), Computer Applications Laboratory (MAP1201)

List of Courses where this course will be prerequisite

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

This course is required for graduating technocrats to function effectively and efficiently in Industry, Academia and other Professional Spheres.

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
	Module I (Statistical Theory of Design of Experiments)	
1	**Fundamental Principles of Classical Design of Experiments:** Strategy of Experimentation, Typical applications of experimental design, Basic principles, Guidelines for designing experiments	2
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	4
3	**Experiments with a Single Factor: 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	8
4	**Factorial Designs:** Definition, Estimating model parameters, Fitting response curves and surfaces	4
	Module II (Data Analysis using Software (R/Python))	
5	The 2^k Factorial design, Blocking and confounding in the 2^k Factorial design, Focus of 2^2 and 2^3 designs, Blocking and confounding in the 2k Factorial Design	8
6	Plackett Burman methods, Central Composite Design (CCD)	4
7	Descriptive Statistics, Probability Distribution and Testing of Hypothesis using R	6
8	Regression techniques, Diagnostic checks, ANOVA using R and implementation of contrasts	6
9	Construction of Balanced Incomplete Block Designs and data analysis using R	6
10	Analysis of factorial designs using R, Understanding output and interpretation	6
11	Factorial designs, Data analysis and interpretation.	6
	Total	**60**

List of Textbooks/ Reference Books

1	Montgomery, Douglas C. Design and Analysis of Experiments; 9th Ed.; John Wiley & Sons, Inc. (2017)
2	Box, G. E.; Hunter, J. S.; Hunter, W. G. Statistics for Experimenters: Design, Innovation, and Discovery; 2nd Ed.; Wiley (2005)
3	Lawson, John. Design and Analysis of Experiments with R; 1st Ed.; CRC Press (2015)
4	Rasch, D.; Pilz, J.; Verdooren, R.; Gebhardt, A. Optimal Experimental Design with R; 1st Ed.; CRC Press (2011)
5	Unpingco, J. Python for Probability, Statistics, and Machine Learning; 2nd Ed.; Springer (2019)
6	Anderson-Cook, Christine M.; Montgomery, Douglas C.; Myers, Raymond H. Response Surface Methodology: Process and Product Optimization using Designed Experiments; 4th Ed.; Wiley (2016)
7	Montgomery, Douglas C. Introduction to Statistical Quality Control; 7th Ed.; Wiley (2009)
8	Lazić, Živorad R. Design of Experiments in Chemical Engineering: A Practical Guide; 1st Ed.; Wiley-VCH (2005)

Course Outcomes (Students will be able to…..)	
CO1	understand basic principles of design of experiments.(K2)
CO2	perform statistical analysis of single experiments and do post hoc analysis.(K3)
CO3	conduct experiment and analyse the data using statistical methods.(K4)
CO4	choose an appropriate design given the research problem.(K5)
CO5	perform statistical analysis of different designs using R and interpret the results.(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	K2	3	2	1	2	0	3	3	3	3	3	1	1	3	2
CO2	K3	3	3	2	2	2	3	3	3	0	3	3	2	3	3
CO3	K4	3	2	2	3	2	3	1	3	3	2	3	2	2	3
CO4	K5	3	3	3	3	3	3	3	3	3	3	0	3	3	3
CO5	K5	3	1	3	3	3	3	3	2	3	3	3	3	0	3
Course	K5	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: PHP1044	Course Title: Pr 3: Pharmaceutical Chemistry and Formulation Technology Laboratory	Credits = 4		
			L	T	P
	Semester: V	Total Contact Hours: 120	0	0	8

List of Prerequisite Courses

SPL1: Pharmaceutical Formulation Technology – I (PHT1081); Organic Chemistry Laboratory (CHP1132)

List of Courses where this course will be prerequisite

Pr 7: Pharmaceutical Formulation Technology Laboratory – II (PHT1082); Pr 8: Process Technology Laboratory (PHP1055)

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 practise 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 (10 X 4 Hrs)	40
2	Few examples of synthesis using green approaches	10
3	Application of synthetic methods reported in recent literature	10
	Formulation	
5	Representative examples of granules ready for compression (Preparation, packaging and evaluation)	8
6	Representative examples of tablets (Preparation, packaging and evaluation)	20
7	Representative examples and demonstration of tablet coating (Preparation, packaging and evaluation)	8
8	Representative examples of capsules (Preparation, packaging and evaluation)	8
9	Dissolution testing: Conventional marketed formulations (including Sustained-release formulations) representing- soluble drug, poorly soluble drug (selection of medium)	8
10	Representative examples of microencapsulation (Preparation, packaging and evaluation)	8
	Total	**120**

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

	Course Code: PHP1056	Course Title: Pr 4: Medicinal Natural Products Laboratory	Credits = 2		
			L	T	P
	Semester: V	Total Contact Hours: 60	0	0	4

List of Prerequisite Courses

Analytical Chemistry (CHT1401), SPL4: Pharmaceutical Analysis and Green Chemistry (PHT1052)

List of Courses where this course will be prerequisite

SPL6: Medicinal Natural Products (PHT1049)

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 VI

	Course Code: PHT1055	Course Title: SPL8: Pharmaceutical Chemistry and Catalytic Process	Credits = 4		
			L	T	P
	Semester: VI	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

	Course Code: PHT1063	Course Title: SPL9: Pharmaceutical Biotechnology	Credits = 4		
			L	T	P
	Semester: VI	Total Contact Hours: 60	3	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.

	Course Contents (Topics and Subtopics)	Required Hours
1	**Introduction to Pharmaceutical Biotechnology** and its role in healthcare and diagnostics	8
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	6 6 6
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	6 5 5 4
5	**Plant and Animal Tissue Culture** Techniques and applications	4 4
6	**Pharmacogenomics**	3
	Total	**60**

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+	K3	K3+	K2+A	K3	K6+A+	K3	K4

								S		A			S		
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

	Course Code: PHT1056	Course Title: SPL10: Medicinal Chemistry – II	Credits = 3		
			L	T	P
	Semester: VI	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

Organic Chemistry – I (CHT1137), Organic Chemistry – II (CHT1138), SPL7: Medicinal Chemistry – I (PHT1060), Physiology and Pharmacology (PHT1050)

List of Courses where this course will be prerequisite

SPL14: Medicinal Chemistry – III (PHT1057)

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:* β-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	9
2	*Antiparasitic Agents:* Antiamoebics, Antimalarials, Anthelmintics Miscellaneous agents including drugs against Trypanosomiasis, Leishmaniasis, Scabies, Filariasis. Overview of DND*i*	3
3	*Antifungal Agents:* Azoles, Polyene antibiotics Miscellaneous agents including Allylamines, Tolnaftate, Griseofulvin, etc.	3
4	*Antimycobacterial Agents:* Antitubercular agents, Antileprotic agents, Drugs against *Mycobacterium avium complex* (MAC), Newer Antitubercular targets	3
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	5
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	5
	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	3
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	3

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	7
10	*Introduction to Centrally-Acting Analgesics:* Opioid or Narcotic analgesics: μ-Agonists, other analgesics Mixed agonist/antagonist analgesics μ-Antagonists Antidiarrheal agents Cough suppressants Antitussives	4
	Total	**45**

List of Textbooks/Reference Books	
1	Lemke, T. L., Zito, S. W., Roche, V. F., Williams, D. A. Essentials of Foye's Principles of Medicinal Chemistry; Wolters Kluwer (2017)
2	Lemke, T. L., Williams, D. A., Roche, V. F., Zito, S. W. Foye's Principles of Medicinal Chemistry; 7th ed.; Wolters Kluwer (2013)
3	Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry; Beale, J. M., Jr., Block, J. H., Eds.; 12th ed.; Wolters Kluwer (2011)
4	Burger's Medicinal Chemistry & Drug Discovery, Vol. 1- 6; Abraham, D. J., Ed.; 6th ed.; John Wiley & Sons - New Jersey (2003)
5	Kleeman, A., Engel, J., Kutscher, B., Reichert, D. Pharmaceutical Substances: Syntheses, Patents and Applications of the Most Relevant APIs; 5th ed.; Thieme Medical Publishers Inc. (2009)
6	Lednicer, D. The Organic Chemistry of Drug Synthesis; Vol. 1 - 7); John Wiley & Sons, INC. (2008)
7	Silverman, R. B., Holladay, M. W. The Organic Chemistry of Drug Design and Drug Action; 3rd ed.; Elsevier (2014)
8	Warren, S., Wyatt, P. Organic Synthesis: The Disconnection Approach; 2nd ed.; Wiley; (2008)

Course Outcomes (Students will be able to…..)	
CO1	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

	Course Code: HUT1103	Course Title: Industrial Psychology and Human Resource Management	Credits = 3		
			L	T	P
	Semester: VI	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses
None

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

Description of relevance of this course in the B. Tech. Program
This course equips students with human resource management skills to be able to function effectively in their professional careers.

	Course Contents (Topics and Subtopics)	Required Hours
1	Introduction and Overview	2
2	Management Theories Taylor, Fayol, Weber, Hawthorne; Basic types of structures; Span of Control, Delegation, Authority, Responsibility	4
3	Recruitment Philosophies, Different methods of attracting candidates	3
4	Selection Application blanks, Interviews, Induction	2
5	Performance Management Goal setting process, Performance appraisal methods, Appraisal interviews, Rating errors	3
6	Training & Development Identifying training needs, Training methods (on the job and off the job techniques), Evaluation of training	3
7	Change Management Types of change, Theories of change management, Hurdles to change, Olmosk change strategies	3
8	Knowledge Management Innovation, Importance and benefits of Knowledge Management, Framework	3
9	Motivation Theories Classification of motives, Various theories (Maslow, Herzberg, ERG, Vroom, Equity and Nohria's 4 drive model)	4
10	Leadership Theories Blake Mouton model, Hersey Blanchard Model, Michigan Model	3
11	Organizational Culture Types of cultures, Understanding and influencing cultures	3
12	Conflict Management Stages of conflict, Types of conflict and sources of conflicts, Conflict resolution	3
13	Power &Politics Bases of power, Politicking strategies	3
14	Personality Theories of personality, Behaviour and personality styles	3
15	Perception Persception versus sensation, Perceptual process, Perceptual errors	3
	Total	**45**

List of Textbooks/Reference Books	
1	Innovation and Entrepreneurship, Peter Drucker
2	Essentials of organizational Behaviour, Srephen Robbins
3	Organizational Behaviour, Luthans
4	Select HBR cases and articles for review
5	Innovation and Entrepreneurship, Peter Drucker

Course Outcomes (Students will be able to…..)	
CO1	explain the fundamental concepts of industrial psychology and human resource

	management.(K2)
CO2	analyze practical solutions.(K4)
CO3	provide applicable solutions.(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	1	2	0	3	3	3	3	3	3	1	3	2
CO2	K4	3	3	1	3	2	3	2	3	3	3	1	2	3	3
CO3	K3	3	3	2	2	2	3	3	3	2	3	3	2	1	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

	Course Code: HUT1106	Course Title: Environmental Science and Technology	Credits = 3		
			L	T	P
	Semester: VI	Total Contact Hours: 45	2	1	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

	Course Code: PHP1077	Course Title: Seminar	Credits = 3		
			L	T	P
	Semester: VI	Total Contact Hours: 90	0	0	6

List of Prerequisite Courses
All the previous Pharmaceutical Sciences and Technology courses

List of Courses where this course will be prerequisite
All the B. Tech. (Pharm. Chem. Tech.) courses in this semester and the subsequent semesters.

Description of relevance of this course in the B. Tech. Program
The course is intended to develop student's ability to read, understand any given topic related to dyestuff technology, collect literature, write a scientific report on that topic based on the provided guidelines and present the scientific merits and demerits of the matter. Students shall prepare critical reviews of selected topics in Chemical Technology and allied subjects and submit in the form of standard typed reports. Students shall also make oral presentations of the reviews.

	Course Contents (Topics and Subtopics)	Required Hours
1	Any topic related to Pharmaceutical Sciences and Technology as well as Allied Sciences	90
	Total	**90**

List of Textbooks/Reference Books	
1	All relevant research papers, review articles, patents, conference proceedings, etc. related to the topic

Course Outcomes (Students will be able to…..)	
CO1	develop a protocol for literature survey about a certain topic (K4)
CO2	evaluate the literatures and interpret the scientific content (K5)
CO3	apply the concept of dyestuff technology on a selected topic (K3)
CO4	develop skills for presenting a scientific topic in dyestuff technology (K6)
CO5	develop skills for writing a scientific document (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	K4	3	3	1	3	2	3	3	3	3	3	3	2	3	3
CO2	K5	3	2	3	3	3	0	3	3	3	3	2	3	3	3
CO3	K3	3	3	2	2	2	3	3	2	3	3	3	1	3	3
CO4	K6	3	1	3	3	0	3	3	3	1	3	0	3	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

	Course Code: PHP1056	Course Title: Pr 5: Pharmaceutical Chemistry Laboratory	Credits = 2		
			L	T	P
	Semester: VI	Total Contact Hours: 60	0	0	4

List of Prerequisite Courses

Organic Chemistry Laboratory (CHP1132), Organic Chemistry – I (CHT1137), Organic Chemistry – II (CHT1138)

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

	Course Code: PHP1055	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 (PHP1074) and Project – II (PHP1075)

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

Semester VII

	Course Code: CET1703	Course Title: Chemical Process Control	Credits = 3		
			L	T	P
	Semester: VII	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

Material and Energy Balance Calculations, Applied Mathematics, Chemical Engineering Operations, Chemical Reaction Engineering

List of Courses where this course will be prerequisite

Chemical Engineering Laboratory, Projects

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

Process control plays a very critical role in the context of actual operation of a process plant. Most of the core chemical engineering courses focus on the steady state operation. In the real life environment, process is continuously subjected to various disturbances which deviates the operation from the designed steady state. This course specifically prepares students to assess the impact of such disturbances and equip them with the tools available to tackle these situations.

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	**Instrumentation:** Principles of measurement; Pressure, Temperature, Level, Flow and composition measuring devices; Introduction to controllers (PLC, digital control, DCS), Introduction to control valves, Types of control valves, Control valve characteristics	9
2	**Introduction to System Dynamics**, Concept of dynamic response, Linear systems, First, second and higher order system, Systems with dead-time, Definition of terms such as transfer function, Time constant, Gain of the process with practical examples Response of processes to standard inputs	9
3	**Introduction to Process Control:** Set point, disturbance, closed loop and open loop control, Feedback and feed-forward configurations, Poles and zeros of the transfer functions Basic control actions (ON/OFF, P, I and D), Effects of controller action on process response: Offset, closed-loop gain, controller gain effect of controller parameters	6
4	**Stability Analysis** of feedback systems, Notion of stability, Criteria for stability	6
5	**Control System Design:** Introduction to controller design Identification of controlled, manipulated and disturbance variables, Pairing of inputs and outputs Controller selection for pressure, flow, temperature, level and composition	9
6	**Multiple Loop and Traditional Advanced Control Systems:** Cascade control, Ratio control, Feed-forward control, Selective control, Split-range control, Inferential control	6
	Total	**45**

List of Text Books/ Reference Books

1	Chemical Process Control: An Introduction to Theory and Practice, Stephanopolous G.
2	Process Modeling, Simulation, and Control for Chemical Engineers, Luyben W.L.
3	Process Dynamics and Control, Seborg, D. E. and Mellichamp, D. A. and Edgar, T. F. and Doyle, F. J.
4	Process Control: Modeling, Design, and Simulation, Bequette, B. W.
5	Process Control Instrumentation Technology, Johnson, C. D.

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

1	specify the required instrumentation and control elements for a particular process (K3)
2	develop input-output transfer function models for dynamics of processes (K4)
3	characterize the dynamics and stability of processes based on mathematical analysis (K5)
4	design and tune process controllers (K6)
5	specify the required instrumentation and control elements for a particular process (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	0	3	3	3	2	3	3
CO2	K4	3	3	2	0	2	3	3	3	3	3	0	2	3	2
CO3	K5	3	2	3	3	1	3	1	3	3	1	3	3	3	3
CO4	K6	3	3	1	3	3	2	3	3	2	3	3	1	2	3
CO5	K3	3	1	2	2	2	3	3	3	3	3	3	2	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

	Course Code: PHT1083	Course Title: SPL11: 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 (PHT1082)

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 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

	Course Code: PHT1084	Course Title: SPL12: Validation and Regulatory Requirements	Credits = 3		
			L	T	P
	Semester: VII	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

Pharmaceutical Formulation Technology – II (PHT1082)

List of Courses where this course will be prerequisite

Project – II (PHP1075); SPL13: Process Technology of Drugs and Intermediates (PHT1058)

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

	Course Code: PHP1078	Course Title: In-Plant Training	Credits = 6		
			L	T	P
	Semester: VII	Total Contact Hours: 45	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

	Course Code: HUT1203	Course Title: Industrial Management	Credits = 4		
			L	T	P
	Semester: VII	Total Contact Hours: 60	3	1	0

List of Prerequisite Courses

None

List of Courses where this course will be prerequisite

None

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

This course is required for effective and holistic functioning of students in their professional career.

	Course Contents (Topics and Subtopics)	Required Hours
1	Greiner's Model of Organization Life Cycle Organic and mechanistic structures	3
2	Marketing Management Introduction, Porter's value chain, Porter's five forces, Porter's generic strategies	7
3	Introduction to the 4Ps of Marketing Product, Price, Place, Promotion	11
4	Production and Operations Management Concept of productivity, World class manufacturing, Business process reengineering, Kanban, JIT, Poka Yoke system, Maintenance practices	10
5	Quality Management The concept of quality, Quality control ,acceptance sampling and SQC Deing's 14 points, TQM, Insights into ISO-9000, ISO -14000,ISO-50000	6
6	Financial Management Accounting system, Balance-sheet evaluation, Fund-flow analysis, Financial ratios an insight, Costing	15
7	Materials Management Value analysis, Purchasing and vendor development, Warehousing and inventory control methods	4
8	Maintenance Management Classifications, Equipment and plant reliability and availability, Management of shut downs and turnarounds	4
	Total	**60**

List of Textbooks/Reference Books

1	Industrial Management, Jhamb L. C. and Jhamb S.
2	Industrial Management, Spriegel U.S.
3	Operations Management for Competitive Advantage, Richard B. Chase, F. Robert Jacobs, Nicholas Acquilano
4	World Class Manufacturing - A strategic Perspective, B.S. Sahay, K.B.C. Saxena, Ashish Kumar
5	Management Finance, Varanasay Murthy
6	Essentials of Management,Koontz
7	Principles of Marketing, Kotler
8	Quality Planning and Analysis, Juran
9	Financial Management, Prasanna Chandra
10	Financial Management, R. M. Srivastava
11	Select HBR cases and articles for review

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

CO1	explain the fundamental concepts of Marketing management and the various aspects therein.(K2)
CO2	understand the fundamental concepts of Finance and analyse the balance sheet.(K4)
CO3	understand various productivity techniques that when combined with engineering knowledge can be applied successfully in the industry.(K2)
CO4	study real life practical problems , constraints and will be able to think in terms of various alternative solutions.(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	1	2	1	3	3	3	3	3	3	1	3	2
CO2	K4	3	3	2	3	2	1	3	3	3	3	3	2	3	3
CO3	K2	3	2	0	2	1	3	3	2	3	3	0	1	3	2
CO4	K3	3	3	2	0	2	3	3	3	3	3	3	2	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

	Course Code: CEP1714	Course Title: Chemical Engineering Laboratory	Credits = 2		
			L	T	P
	Semester: VII	Total Contact Hours: 60	0	0	4

List of Prerequisite Courses

Process Calculations (CET1507), Transport Phenomena (CET1105), Chemical Engineering Operations (CET1401), Chemical Reaction Engineering (CET1212)

List of Courses where this course will be prerequisite

Other B. Tech. courses in this and the last semester

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

This course provides students the first-hand experience of verifying various theoretical concepts learnt in theory courses. It also exposes them to practical versions of typical chemical engineering equipments and servers as a bridge between theory and practice. This particular lab focuses on fluid dynamics, distillation, filtration, drying and sedimentation.

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	4 - 6 Experiments on fluid dynamics and heat transfer	24
2	3 - 5 Experiments on Chemical Engineering Operations	16
3	2 – 4 Experiments on Reaction Engineering	12
4	1 – 3 Experiments on process dynamics and control	8
	Total	**60**

List of 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…..)

CO1	learn how to experimentally verify various theoretical principles.(K3)
CO2	visualize practical implementation of chemical engineering equipments.(K4)
CO3	develop experimental skills.(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	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

	Course Code: PHP1054	Course Title: Pr 7: Medicinal Chemistry Laboratory	Credits = 2		
			L	T	P
	Semester: VII	Total contact hours: 60	0	0	4
List of Prerequisite Courses					
	Pharmaceutical Analysis, Organic chemistry				
List of Courses where this course will be prerequisite					
	Process Technology				

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

To train the students in basic medicinal chemistry laboratory practices and structure activity relationships including the use of molecular modelling software

Sr. No.	Course Contents (Topics and subtopics)	Reqd. hours
1	Multistep synthesis of APIs (3 examples)	5*4
2	Synthesis of analogs eg. carboxylic acid derivatives	2*4
3	Experimental determination of pKa and comparison with software generated data	2*4
4	Experimental determination of log P values and comparison with software generated data	2*4
5	Experimental determination of simple in-vitro activity of series of structurally relatedcompounnds	4
6	Structure property relationship from experimental data	4
7	Demonstration of pharmacophore development and QSAR	4
8	Demonstration of structure based drug design	4
	Total	60

List of Text Books/ Reference Books	
1	Furniss, Brian S. Vogel's textbook of practical organic chemistry, Pearson Education India,
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…..)	
CO 1	Work safely in the organic chemistry laboratory and synthesize drugs using multiple steps (K4)
CO 2	Compare physicochemical properties using experiments and software(K4)
CO 3	Predict SARs (K4)
CO 4	Understand basic drug design software and its applications (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	K	3	3	3	3	2	3	3	3	3	1	2	3	2	2

	4														
CO3	K 4	3	3	3	1	3	3	2	3	0	3	3	0	3	3
CO4	K 3	3	3	2	3	3	3	1	3	3	3	3	2	3	3
Course	K 4	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: PHP1074	**Course Title: Project – I**	**Credits = 2**		
			L	**T**	**P**
	Semester: VII	**Total Contact Hours: 60**	**0**	**0**	**4**

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.	60
	Total	**60**

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	K 5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	K 6	3	3	3	3	3	3	3	3	3	3	2	3	3	1
CO3	K 5	3	2	3	3	3	3	3	1	3	3	3	3	3	3
CO4	K 6	3	3	3	3	3	2	3	3	3	0	3	3	2	3
CO5	K 6	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

Semester VIII

	Course Code: CET1504	Course Title: Chemical Project Engineering and Economics	Credits = 3		
			L	T	P
	Semester: VIII	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

All Chemical and General Engineering Courses in previous semesters.

List of Courses where this course will be prerequisite

Project – II (PHP1075) and Professional career

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)	Required Hours
1	**Introduction to the Green Field Projects** and global nature of the projects Impact of currency fluctuations on Project justification and cash flows Concepts of 'Quality by Design' including typical design deliverables Understanding constructability, operability and maintainability during all stages of project execution Meaning of Project Engineering, various stages of project implementation	6
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 Introduction to concept of inflation, location index and their use in estimating plant and machinery cost Various cost indices	8
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	7
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	7
6	Process Selection, Site Selection, Feasibility Report	4
7	**Project Conception to Commissioning:** milestones, Project execution as conglomeration of technical and nontechnical activities, contractual details. Contract: Meaning, contents, Types of contract. Lump- sum Turnkey (LSTK),Eng, Procurement and Construction(EPC),Eng, Procurement and Construction Management (EPCM).Mergers and Acquisitions	6
8	Reading of balance sheets and evaluation of techno-commercial project reports	3
9	PERT, CPM, Bar-charts and network diagrams	4
	Total	**45**

List of Text Books/ Reference Books

1	Chemical Project Economics,MahajaniV.V.andMokashi SM.
2	Plant Designand Economics for Chemical Engineers,Peters M.S.,TimmerhausK.D.
3	Process Plant and Equipment Cost Estimation, Kharbanda O.P.

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

CO1	calculate working capital requirement for a given project.(K3)
CO2	calculate cost of equipment used in a plant total project cost.(K3)
CO3	calculate cash-flow from a given project.(K3)
CO4	select a site for the project from given alternatives.(K4)
CO5	list out various milestones related to project concept to commissioning.(K2)

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

	Course Code: PHT1058	Course Title: SPL13: Process Technology of Drugs and Intermediates	Credits = 4		
			L	T	P
	Semester: VII	Total Contact Hours: 60	3	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	7
2	**Concept of All-purpose and Multipurpose Plants** Plant Design, Effluent treatment, Solvent recovery for fine chemicals and Bulk Drugs	6
3	**Introduction, Chemical Process Life-cycle** Legislative requirements for safe process development and scale-up	6
4	**Development Techniques for Safe Process Design** Unit operations posing particular hazards during development	7
5	**Strategies for Chemical Hazards Assessment**, Hazards of gas and vapor generation, Identification of highly-energetic materials, Small-scale screening tests Case Studies	7
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	7
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	7
8	**Designing a Robust Process** and preventing scale-up problems, Solvent effects, Work-up and product isolation, Selecting the parameters to vary, Planning for scale-up	7
9	**Design of Environment-friendly Processes**, Effluent minimization and control, Statistical methods of optimizations	6
	Total	**60**

List of Textbooks/Reference Books

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

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

CO1	understand the principles of process design along with presentation and selection of different routes.(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: PHT1057	Course Title: SPL14: Medicinal Chemistry - III	Credits = 3		
			L	T	P
	Semester: VIII	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

Organic Chemistry (CHT1132), SPL5: Medicinal Chemistry – I (PHT1054), SPL6: Medicinal Chemistry – II (PHT1056), Physiology and Pharmacology (PHT1023)

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:**	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**	6
	b) Diuretics: Osmotic diuretics, Carbonic anhydrase inhibitors, Thiazideand and thiazide-like	3
	c) Antihypertensive Agents: Angiotensin-Converting Enzyme (ACE) Inhibitors, Angiotensin II Receptor Type	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*	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	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**	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
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

	Course Code: PHT1060	Course Title: SPL15: Chemistry and Technology of Fine Chemicals	Credits = 3		
			L	T	P
	Semester: VIII	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

SPL4: Pharmaceutical Analysis and Green Chemistry (PHT1052), Physical Chemistry – II (CHT1342)

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	1
2	**Production of Fine Chemicals** Introduction, Role of Catalysis, Atom Economy, Alternative Reagents and Catalysts, Novel Reaction Routes, Selectivity, Solvents, Conventional Solvents, Alternative Solvent, Production Plants, Multiproduct and Multipurpose Plants (MMPs) , Dedicated Continuous Plants, Batch Reactor Selection, Reactors for Liquid and Gas–Liquid Systems, Reactors for Gas–Liquid–Solid Systems, Batch Reactor Scale-up Effects, Temperature Control, Summary of the Scale-up of Batch Reactors, Safety Aspects of Fine Chemicals, Thermal Risks, Safety and Process Development.	14
3	**Understanding Fine Chemicals:** Selected Fine Chemical Technologies with examples: Alkylation, Halogenation, Oxidation, Reduction, Esterification, Nitration, and Hydrogenation	21
4	**Process Intensification and Process Development:** Introduction and important aspects of it	9
	Total	**45**

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

	Course Code:	Course Title: Pre-approved Open Electives from MOOCs / NPTEL	Credits = 3		
			L	T	P
	Semester: VIII	Total Contact Hours: 45	2	1	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					
-					

	Course Contents (Topics and Subtopics)	Required Hours
1	-	-
2	-	-
3	-	-
4	-	-
5	-	-
	Total	45

List of Textbooks/Reference Books	
1	As prescribed by the Course Instructor(s)
Course Outcomes (Students will be able to…..)	
CO1	As prescribed by the Course Instructor(s)
CO2	As prescribed by the Course Instructor(s)
CO3	As prescribed by the Course Instructor(s)
CO4	As prescribed by the Course Instructor(s)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)													
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PO13
CO1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	-	-	-	-	-	-	-

	Course Code: PHP1075	Course Title: Project – II	Credits = 4		
			L	T	P
	Semester: VIII	Total Contact Hours: 120	0	0	8

List of Prerequisite Courses

Project – I (PHP1074)

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.	80
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.	40
	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

	Course Code: PHP1055	Course Title: Pr 8: Process Technology Laboratory	Credits = 4		
			L	T	P
	Semester: VIII	Total Contact Hours: 120	0	0	8

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	70
2	Any innovative modifications in the process of drug synthesized (Two Examples); No repetition of the same from previous years	20
3	Scale-up and Green Chemistry route for synthesis (Two examples)	20
4	Bioconversions	10
	Total	**120**

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

Annexure A

Institute Electives Offered by DPST

Semester VI (PHT1095 or PHT1097)

	Course Code: PHT1095	Course Title: Intellectual Property Rights	Credits = 3		
			L	T	P
	Semester: VI	Total Contact Hours: 45	2	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	6
4	**Type of Intellectual Property: Copyright** Introduction, Process of filing, rights achieved	4
5	**Type of Intellectual Property: Trademarks** Introduction, Process of filing, rights achieved	4
6	**Type of Intellectual Property: Geographical Indications** Introduction, Process of filing, rights achieved	3
7	**Type of Intellectual Property: Industrial Design** Introduction, Process of filing, rights achieved	3
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	6
10	Patentability w.r.t. regional requirements	2
11	Patent filing under Paris Convention Treaty (PCT)	5
12	Role of IPR in Pharmaceuticals	5
	Total	**45**

List of Text Books/Reference Books	
1	All documentation from World Intellectual Property Organization
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)

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

	Course Code: PHT1097	Course Title: Applied Molecular Biology	Credits = 3		
			L	T	P
	Semester: VI	Total Contact Hours: 45	2	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	**45**

List of Text Books/Reference Books

1	Molecular Biotechnology: Principles and Applications of Recombinant DNA, by Glick and
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

Annexure B

Institute Electives Offered by DPST

Semester VII (PHT1092 or PHT1093)

	Course Code: PHT1092	Course Title: Pharmaceutical Packaging Technology	Credits = 3		
			L	T	P
	Semester: VII	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

Pharmaceutical Formulation Technology - II

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 packaging technology.

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	Introduction to Packaging, Classification of Packaging, Essential Requirements, Functions of Packaging, Importance / significance of Pharma Packaging, Properties of Ideal Package, Packaging formats in Pharma Industry, Packaging recycling symbols, FDA Definitions, Introduction to Packaging materials, Classification of Packaging materials, Approach to package design, New Trends in the pharmaceutical packaging, Packaging Regulations And Legal Requirements	5
2	Introduction to plastics and polymers, Raw Materials of Plastics, Types of Plastics, Resin identification code, Plastics and Packaging, testing of plastic containers	4
3	Introduction to glass, Selection of glass as packaging materials for the pharmaceutical products, Advantages and disadvantages of glass containers, Properties of glass, Production of glass, Types of glass, Manufacturing of Glass containers, Testing of glass containers	4
4	Introduction to metals, Aluminium and Aluminium foil, Collapsible Tubes, Tin, Stainless steel	4
5	Introduction to blister package, Blister design parameters, Materials, Formation, Types of Blisters, Advantages and disadvantages of Blister Packaging, Types of Problems/ Defects, Blister Packing Machine, Other packages, Strip Packs- High Barrier Laminates, Strip Packaging Process, Properties of Materials, Child-resistant strip package, Strip Sealing Machine, Strip Packing Machinery, Multi-Dose Strip Packaging	4
6	Introduction to Ancillary Materials used in Packaging, Adhesives, Paper, Paperboard, Wood, fibreboard , Packaging inserts , leaflets	4
7	Introduction to natural and synthetic rubber, Types of closures, Classification of contemporary closures by their utility, Special-purpose Closure, Closure Functions, Closure Materials, Types of Plastic Closures, Sealing Systems, Liners, Closure Liner Functions, Classification of Liners, Selection of Lining Material, Options for Closure Liners, Innerseals, Linerless Closures, Types of tapes, Strapping Materials, Evaluating Closure Liners, Standard Liners, Tacseal, Solutions, Liner Description	4
8	Introduction, Components of Corrugated fibre board, Types of Corrugated Board, Advantages & Disadvantages, Manufacturing, Box Structure, Box Dimensions, Types of Box, Applications of C.F.B., New developments in CFB	4
9	**Sterilization of Packaging Materials** Introduction, Pharmaceutical Importance of Sterilization, Physical and Chemical Factors that affect sterilization, Terms commonly used, Classification of Sterilization Methods, Sterilization of Packaging Materials, Tests for Sterility, Incubation and examination of sterility tests, Interpretation of the test results, Evaluation of Sterilization Method, Process of Microbial Destruction, Evaluation and In Process Monitoring of Sterilization Procedures	4

10	**Packaging of Parenterals, Ophthalmics, And Aerosols** Introduction, Packaging of Sterile Pharmaceuticals, Packaging Components, Inspection of Filled Injectable Products, Storage and Labelling, Packaging of Ophthalmics, Selection of Packaging Materials, Packaging of Aerosols	4
11	Testing of packaging material • Defects in Packages: Introduction, Defects in Packaging Material • Package Testing and Testing of Containers & Closures: Introduction, Testing of containers and closures • Stability of Packages: Introduction, Legislation, Regulation, Pharmaceutical Stability Testing in Climatic Cabinets, Pharmaceutical Stability Testing Conditions, Photo-Stability Testing, Review of Pharmaceutical Product Stability, Packaging and the ICH Guidelines	4
	Total	**45**

List of Text Books/Reference Books	
1	D. A. Dean, Roy Evans, Ian Hall. Pharmaceutical packaging technology. Tylor and Francis.
2	Edward J. Bauer, Pharmaceutical Packaging Handbook. Bausch And Lomb, Rochester, New York, USA
3	Wilmer A. Jenkins, Kenton R. Osborn. Packaging Drugs And Pharmaceuticals.
4	Salvatore J. Turco, Sterile dosage forms: their preparation and Clinical application
5	Remington: The Science and Practice of Pharmacy
6	Michael E. Aulton, Kevin Tylor (Ed.). Aulton's Pharmaceutics: The design and Manufacture of Medicine
7	Gilbert Banker and Christopher Rhodes. Modern Pharmaceutics
8	Leon Lachman; Lieberman Herbert A.; Kanig, Joseph L. The theory And Practice of Industrial Pharmacy.

Course Outcomes (Students will be able to…..)	
CO1	classify packaging materials and describe FDA regulations, properties of packaging materials. (K3)
CO2	apply concepts related to primary packaging materials, containers and closures and their testing.(K3)
CO3	explain secondary packaging materials and their testing.(K3)
CO4	describe ancillary materials, unit dose and multi dose packing, Packaging of Parenterals, Ophthalmics, and Aerosols.(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	2	3	3	3	3	3	3	2	3	3
CO2	K3	3	3	1	3	3	2	3	3	2	0	3	2	2	1
CO3	K3	3	3	3	3	3	1	3	2	3	3	2	3	0	3
CO4	K3	3	2	3	3	0	3	3	3	3	3	3	3	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; − No Contribution
K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

	Course Code: PHT1093	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,
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
Cours	K	3	3	3	3	3	3	3	3	3	3	3	3	3	3

e	4														

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

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

Annexure C

Programme Electives for DPST

Semester VIII (PHT1099 or PHT1061)

	Course Code: PHT1099	Course Title: Drug Synthesis Approaches	Credits = 3		
			L	T	P
	Semester: VIII	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

Organic Chemistry – I (CHT1137), Organic Chemistry – II (CHT1138)

List of Courses where this course will be Prerequisite

Profession career

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

To train the students with respect to organic, catalytic and bio catalytic 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	3
	Building blocks in drug synthesis	2
	Cabon-heteroatom bond disconnections, with examples	3
	Carbon-carbon bond disconnections, with examples	4
	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
	h. Miscellaneous Drugs (Two molecules)	2
2	Asymmetric synthesis, resolution of enantiomers applicable to drug synthesis	4
3	Derivatization of natural products	4
4	Biocatalysis	2
5	Catalytic synthesis	3
6	Protecting groups in organic synthesis	4
	Total	**45**

List of Text Books/Reference Books

1	Warren S. and Wyatt P., Organic Synthesis- The Disconnection Approach, 2nd edition; John
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

	Course Code: PHT1061	Course Title: Basics of Machine Learning	Credits = 3		
			L	T	P
	Semester: VIII	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

All Mathematics and Computer Applications courses

List of Courses where this course will be Prerequisite

Profession career

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

The course is designed to introduce the students with machine learning and its application in varies fields including medical, pharmaceutical, analytical, engineering, genetics, etc. The students can then further develop the skills sets required to be a high-end machine learning professional with technical domain expertise.

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	Introduction to Machine Learning Supervised and Unsupervised learning Choosing the right algorithm Practical applications of machine learning in various fields	8
2	Getting Started with Machine Learning Machine learning workflow using a Case Study (Healthcare) - Accessing and loading data - Data pre-processing - Feature derivation - Model building - Model validation - Model deployment	12
3	Applying Unsupervised Learning - Hard and soft clustering algorithms - Common dimensionality reduction algorithms for improving model performance - Case Studies	10
4	Applying Supervised Learning - Classification and Regression algorithms - Model improvement using feature selection, feature transformation, and hyperparameter tuning	10
5	Machine learning using MATLAB	5
	Total	**45**

List of Text Books/Reference Books

1	Dumont, R. Machine Learning: The Ultimate Beginners Guide: To Understanding Machine
2	Turner, R. Python Machine Learning: The Ultimate Beginner's Guide to Learn Python Machine Learning Step by Step; 2019.
3	Lee, A. Programming for Beginners: 3 Manuscripts: The Complete Guide to Learning Python Crash Course, Python Machine Learning and Python Data Science in a Week; 2021.
4	Giussani, A. Applied Machine Learning with Python; Bocconi University Press; 2020.
5	Fenner, M. E. Machine Learning With Python For Everyone: Addison Wesley Data & Analytics Series; 1st ed.; Addison-Wesley Professional/Pearson Education; 2020.

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

CO1	grasp the overall process of machine learning and its real-world applications.(K2)
CO2	understand difference between supervised and unsupervised machine learning algorithms for given data set.(K3)
CO3	apply machine leaning techniques to further refine their newly-acquired skills.(K3)
CO4	explore the machine learning applications using MATLAB.(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	3	3	3	3	3	3	3
CO2	K3	3	3	2	3	2	1	3	3	3	3	2	2	3	2
CO3	K3	3	2	3	3	3	3	3	0	3	1	3	3	2	3
CO4	K4	3	3	3	2	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