Syllabus for Bachelor of Technology

(B.Tech. in Polymer Engineering and Technology)

(Under the New Education Policy-NEP 2020)

in

(2023-2024)

INSTITUTE OF CHEMICAL TECHNOLOGY

(University Under Section-3 of UGC Act, 1956)

Elite Status and Center for Excellence

Government of Maharashtra

Nathalal Parekh Marg, Matunga, Mumbai 400 019 (INDIA)

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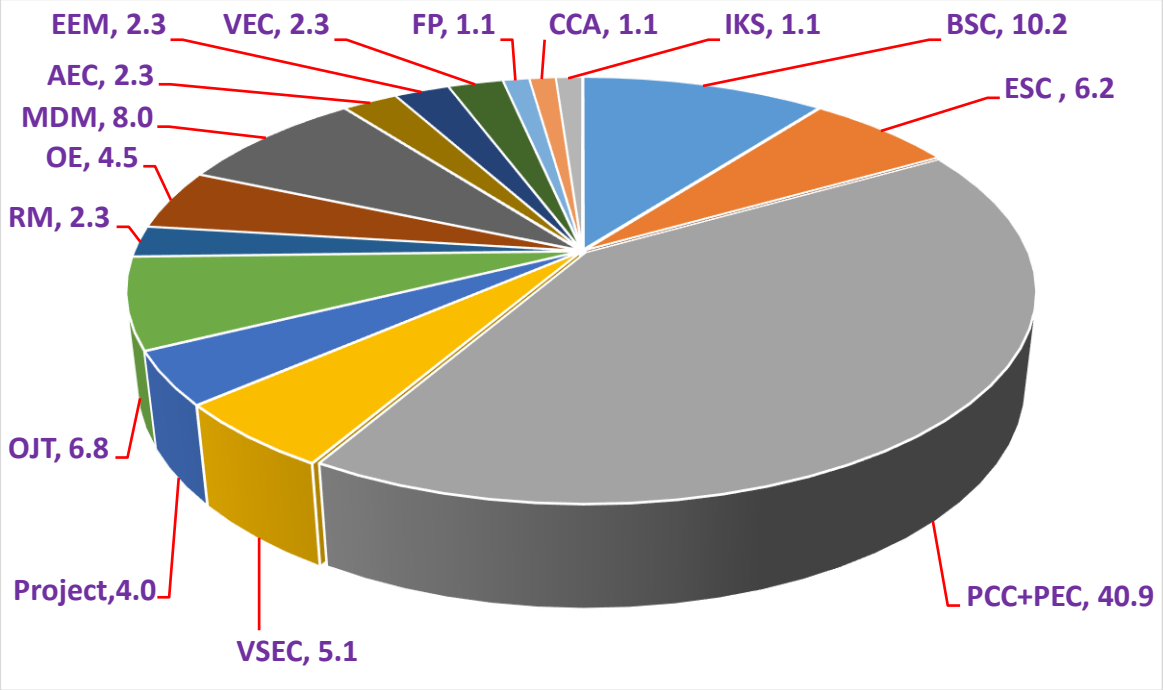
Department of Polymer Engineering and Technology

Preamble:

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



This does not include Honors courses of 18 credits.

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

B. Tech. (Polymer Engineering and Technology)

PROGRAMME EDUCATIONAL OBJECTIVES for B. Tech. (Polymer Eng. & Tech.)

PEO-1: Graduate with in-depth knowledge in the field of polymer engineering science and technology applicable for successful career in Polymer and Surface coating Technology.

PEO-2: Graduates with integrity, strong ethical values who are members and contribute to professional society.

PEO-3: Graduates who engage in lifelong learning or continuous education opportunities.

PEO-4: To prepare Graduates who contribute towards research and professional Development and who are entrepreneurial engineers

Programme Outcomes (POs) for B. Tech. (Polymer Eng. & Tech.)

PO1	Polymer technology knowledge: Apply the knowledge of mathematics, science, engineering and technology fundamentals, and Polymer technology specialization to the solution of complex problems in Polymer 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 Polymer 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 Polymer 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 Polymer technology
PO7	Environment and sustainability: Understand the impact of the professional Polymer 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 Polymer 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 Polymer technology activities with the Polymer 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 Polymer 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)	
PSO1	Higher studies: Able to have knowledge for higher studies related to Polymer Engineering and Technology disciplines.
PSO14	Pertinent with Polymer industry: Able to develop skills about Polymer Processing and testing and examine its lifecycle with inculcating the thought of sustainable development
PO15	Evolve as technocrats who could influence major policy decisions related to pharmaceutical and allied industries

Graduate Attributes

1. Problem analysis and solving skills
2. Familiar with usage of modern tools, techniques
3. Communication Skills
4. Capacity to analyze new concepts
5. Capacity to analyze and interpret experimental data Capacity to analyze business trends
6. Capacity to design, optimize and operate equipment and plants safely, economically and effectively
7. Design and Development of solutions to industrial and societal needs
8. Skills related to Project Management and Economics
9. Skills to analyze scientific literature including patents
10. Ethics

Syllabus Structure for B. Tech Course

SEMESTER- I										
Course Code	**Subjects**	**Course Type**	**Credits**	**Hrs/Week**			**Marks for various Exams**			
				L	**T**	**P**	**C.A.**	**M.S.**	**E.S.**	**Total**
CHT1405	Physical Chemistry	BSC	3	2	1	0				
CHT1406	Analytical Chemistry	BSC	3	2	1	0				
MAT1205	Engineering Mathematics	ESC	3	2	1	0				
PYT1205	Applied Physics	BSC	2	1	1	0				
GET1305	Engineering Graphics and Computer Aided Drawing	VSEC	3	1	0	4				
PST 1101	**SPL-1:** Polymer science and technology I(Common)	ESC	2	1	1	0				
PYP1101	Physics Laboratory	BSC	2	0	0	4				
HUT1110B	Communication Skills(English)	AEC	2	0	0	4				
	OPEN Activity - Sports/ Fine arts/Yoga/ Music/NSS**	CCA	2	0	0	4				
	TOTAL:		**22**	**9**	**5**	**16**				

SEMESTER- II										
Subject Code	**Subjects**	**Course Type**	**Credits**	**Hrs/week**			**Marks for various Exams**			
				L	**T**	**P**	**C.A.**	**M.S.**	**E.S.**	**Total**
CHT1407	Organic Chemistry	BSC	3	2	1	0				
CHT1408	Industrial Chemistry	BSC	3	2	1	0				
PET1201	**SPL-2**: Introduction to polymer engineering and technology	PCC	2	1	1	0				
GET1306	Basic Mechanical Engineering	ESC	2	1	1	0				
GET1125	Electrical Engineering and Electronics	ESC	2	1	1	0				
CEP1720	Process Calculations	ESC	2	0	0	4				
CHP1343	Physical and Analytical Chemistry Laboratory	BSC	2	0	0	4				
CHP1132	Organic Chemistry Laboratory	VSEC	2	0	0	4				
	OPEN Activity- Sports/ Fine Arts/Yoga/ Music/NSS**	CCA	2	0	0	4				

	MOOC- Indian Knowledge System (NPTEL - Introduction to Ancient Indian Technology)	IKS	2	0	0	4				
	TOTAL:		**22**	**7**	**5**	**20**				

Note: Universal Human Values (UHV) an audit course to be taken in inter-semester break after Semester-II to be taken as MOOC course.

** Students will undertake these co-curricular activities such as sports / Fine Arts / Yoga / Music / Literature etc administered through various clubs under Technological Association approved by Dean, Students Affairs.

	SEMESTER- III									
Subject Code	**Subjects**	**Course Type**	**Credits**	**Hrs /week**			**Marks for various Exams**			
				L	**T**	**P**	**C.A.**	**M.S.**	**E.S.**	**Total**
PST1303	**SPL-3:** Polymer chemistry and technology (Common)	PCC	4	3	1	0				
PST 1304	**SPL-4:** Polymer science and Technology II (Common)	PCC	2	1	1	0				
OE	From Basic Sciences (Chemistry/ Physics/Biology / Maths / Humanities)	OE	4	3	1	0				
	Communication Skills – (Marathi / Hindi or Any other language will be chosen using MOOCS)	AEC	2	1	1	0				
HUT1205	Basic Economics and Finance	EEM	2	1	1	0				
	Digital Computation in Emerging Areas **(NPTEL course: Introduction To Industry 4.0 And Industrial Internet Of Things)**	VEC	2	0	0	4				
	MDM-I: From Sciences and/or any other Engineering / Humanities Discipline	MDM	2	1	1	0				
PSP1301	**Pr 1**: Lab-1: Raw Material Analysis for Resins and Polymers (Common)	PCC	2	0	0	4				
PSP1302	**Pr 2**: Lab 2: Synthesis and Characterization of Resins and Polymers Lab I (Common)	PCC	2	0	0	4				
	TOTAL:		**22**	**11**	**7**	**8**				

	SEMESTER- IV									
Subject Code	**Subjects**	**Course Type**	**Credits**	**Hrs/week**			**Marks for various Exams**			
				L	**T**	**P**	**C. A.**	**M.S.**	**E. S.**	**Total**
CET1105	Transport Phenomena	PCC	4	3	1	0				
PST1401	**SPL-5:** Technology of Thermoplastic Polymers (common)	PCC	3	2	1	0				
PST1505	**SPL-6**: Technology of Thermoset polymers (common)	PCC	3	2	1	0				
OE	From Basic Sciences (Chemistry/ Physics/ Biology / Maths) or Humanities Discipline	OE	2	1	1	0				

CET1805	Chemical Process Economics	EEM	2	1	1	0				
HUT1206	Environmental Sciences and Technology	VEC	2	1	1	0				
	MDM II: From Sciences and/or any other Engineering /Humanities	MDM	2	1	1	0				
	Community Projects#	CEP/FP	2	0	0	4				
PSP1401	**Pr 3**: Lab-3: Synthesis and Characterization of Resins and Polymers Lab II (Common)	VSEC	2	0	0	4				
	TOTAL:		**22**	**11**	**7**	**8**				

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

SEMESTER- V

Subject Code	Subjects	Course Type	Credits	Hrs /week			Marks for various Exams			
				L	T	P	C. A.	M.S.	E. S.	Total
CET1806	Chemical Reaction Engineering	PCC	2	1	1	0				
CET1807	Chemical Engineering Operations	PCC	2	1	1	0				
PET1501	**SPL-7**: Recycling and reprocessing of polymers	PCC	4	3	1	0				
	Offered by the department/MOOCs (one of the electives can be PST 1609) **SPL-8** : Structure property Relationship (Common)	PEC	4	3	1	0				
OE	From Basic Sciences (Chemistry/ Physics/ Biology / Maths) or Humanities Discipline	OE	2	1	1	0				
PST1501	Honors Course-I (High polymer chemistry)	PCC	4	3	1	0				
	MDM III: From Sciences and/or any other Engineering / Humanities Discipline	MDM	4	2	0	4				
PEP1607	**Pr 4**: Lab 4: Processing of polymers lab	PCC	2	0	0	4				
PSP1504	**Pr 5**: Lab 5: Analysis and Characterization of Resins and Polymers Lab (Common)	PCC	2	0	0	4				
	TOTAL:		**26**	**14**	**6**	**12**				

SEMESTER- VI

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

PET1502	**SPL-9**: Additives and compounding of polymers	PCC	3	2	1	0				
PST1609	**SPL-10**: Polymer Processing	PCC	3	2	1	0				
	Offered by the department/MOOCs (one of the electives can be PST1712) **SPL-11**: Environmental health and Safety of Polymers and Coatings (Common)	PEC	4	3	1	0				
PET1815	**SPL-12**: Composites and Post Polymer Processing	PCC	4	3	1	0				
PST1610	Honors Course-II (Biopolymers)	PCC	4	3	1	0				
	MDM IV: From Sciences and/or any other Engineering / Humanities Discipline	MDM	2	1	1	0				
CEP1714	Chemical Engineering Laboratory	VSEC	2	0	0	4				
PEP1606	**Pr 6**: Lab-6 Identification of Resins and Polymers Lab	PCC	2	0	0	4				
PEP1608	**Pr 7**: Lab -7 : Recycling and reprocessing of polymers	PEC	2	0	0	4				
	TOTAL:		**26**	**14**	**6**	**12**				

SEMESTER- VII

Subject Code	**Subjects**	**Course Type**	**Credits**	**Hrs/week**			**Marks for various Exams**			
				L	**T**	**P**	**C. A.**	**M.S.**	**E.S.**	**Total**
PST1711	**SPL-13**: Evaluation and Testing of polymers and coatings (Common)	PCC	3	2	1	0				
PET1701	**SPL-14**: Technology of Plastic Packaging	PCC	2	1	1	0				
	Offered by the department/MOOCs (one of the electives can be PET1816 Speciality polymers	PEC	3	2	1	0				
	Offered by the department/MOOCs (one of the electives can be Smart Polymer	PEC	2	2	0	0				
PST1714	Honors-III **(**Nanomaterials and nanocomposites**)**	PCC	4	3	1	0				
	MDM V: From Sciences and/or any other Engineering / Humanities Discipline	MDM	2	1	1	0				
PHP1442	Literature Review (Research Methodology - I)	RM-1	2	1	0	2				
PHT1443	Design and Analysis of Experiments (Research Methodology - II)	RM-2	2	1	0	2				
	Project -I (Literature search + Expt)	Project	4	0	0	8				
PEP1701	**Pr 8**: Lab-8: Processing and characterization of polymers and polymer composites	PCC	2	0	0	4				
	TOTAL:		**26**	**13**	**5**	**16**				

SEMESTER- VIII

Semester-VIII (10 weeks)

Subject Code	Subjects	Course Type	Credits	Hrs /week			Marks for various Exams			
				L	T	P	C.A.	M.S.	E. S.	Total
PST1801	**SPL-15**: Adhesion and adhesives	PCC	3	5	1	0				
PET1813	Honors Course-IV **(Technology of Elastomers)**	PCC	3	5	1	0				
PST1713	Honors Course-V (**Sustainability of polymers**)	PCC	3	5	1	0				
	MDM VI: From Sciences and/or any other Engineering / Humanities Discipline	MDM	2	2	1	0				
	Project-II (Experiments)	PCC	3	0	0	12				
PEP1801	**Pr 9**: Lab-9: Advanced characterization of Polymers and Composites Lab	PEC	2	0	0	6				
Semester-VIII (12-16 weeks)										
PHP1451	Internship with Industry	OJT	12	0	0	0				
	Total		**28**	**17**	**4**	**18**				

Internship

- In the Eighth semester, every student will have to undergo an internship and/or On Job Training. The Internship would be of 12 credits.
- The internship would be assigned to the student by the Departmental Internship Coordinator, with the approval of Head, Chemical Engineering Department.
- The total duration of the internship would be for a period equivalent to 12 Calendar weeks. The internship may be completed in one or more organizations as described below.
- The internship could be of the following forms:
- Industrial internship in a company (within India or Abroad) involved in R&D / design / manufacturing (QA/QC/Plant Engineering/Stores and Purchase) / marketing / finance / consultancy / Technical services / Engineering / Projects, etc.
- At the end of the internship, each student will submit a written report based on the work carried out during the Internship. The report will be countersigned by the Supervisor from Industry / Institute as the case may be.
- Performance of the student will be assessed based on the written report and a presentation to a committee consisting of two faculty members from the Chemical Engineering Department.
- Students will be assigned a grade based on the written report and a presentation; evaluated by a committee of faculty members.
- Feedback will be taken from Industry mentors and this will used while assigning the grades.

BSC: Basic Science Course,
ESC: Engineering Science Course
PCC: Program Core Course, PEC: Program Elective Course
MDM: Multi-disciplinary Minor: Different discipline of engineering or different faculty altogether
OE: Open Elective: To be chosen Compulsorily from faculty other than major discipline
VSEC: Vocational and Skill Enhancement Course: Hands on training corresponding to major/minor
AEC: Ability Enhancement Course: English 2 credit, Modern Indian Language 2 credit
IKS: Indian Knowledge System: Indian Architecture/Maths/Medicine
VEC: Value Education Course: e.g. Understanding India, Environmental Science / Education / Digital and Tech solutions
RM: Research Methodology

CCA: Co-curricular activities: Health and wellness / Yoga / Sports / Cultural activities / NSS/NCC/Applied visual performing arts

EXIT Policy

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

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

Semester-I

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

List of Prerequisite Courses

Standard XII Chemistry

List of Courses where this course will be Prerequisite

Physical and Analytical Chemistry laboratory , other multidisciplinary courses on Chemistry / Chemical Engineering.

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

The course will enable the students to understand and apply the principles of thermodynamics to real-world systems. The students would be able to apply the insights to understand the stability of solutions, spontaneity of physical/chemical processes, effect of thermodynamics parameters on phase and chemical equilibria, etc.

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

List of Text Books/Reference Books

1	Atkins, Peter W.; Paula, Julio de; Keeler, James. Atkin's Physical Chemistry; 11th ed.; Oxford University Press (2018)
2	Elements of Physical Chemistry (7th edition) by P. W. Atkins and J. de Paula, Oxford University Press, 2016.

3	Chemical Kinetics (3rd edition) by Keith J. Laidler, New York : Harper & Row, 1987.
Course Outcomes (Students will be able to…..)	
CO1	*Elements of Physical Chemistry* (7th edition) by P. W. Atkins and J. de Paula, Oxford University Press, 2016.
CO2	*Physical Chemistry* (6th edition) by Ira Levine, McGraw-Hill Education, 2009
CO3	Elucidate the effect of thermodynamic quantities on chemical equilibria and relate it to properties of chemical systems
CO4	Comprehend fundamental knowledge in chemical kinetics with basics of order, molecularity and temperature effect
CO5	Examine kinetics for complex, fast as well as surface reactions and comprehend different theories in kinetics

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

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

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

BSC	Course Code: CHT1406	Course Title: Analytical Chemistry	Credits = 3		
			L	T	P
	Semester: I	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses
Standard XII Chemistry
List of Courses where this course will be prerequisite
Physical and Analytical Chemistry Laboratory , other Chemistry Courses
Description of relevance of this course in the B. Tech. Program
The course introduces the students to key concepts of chemical analysis – sampling, selection of analytical method and data analysis. It presents basic techniques like spectroscopy and chromatography. The students should be able to select an appropriate analytical technique and apply it in accordance with its strengths and limitations.

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	Introduction to chemical analysis, terminology (technique / method / procedure / protocol), broad classification of analytical techniques, good laboratory practices	5
2	Criteria for selecting analytical methods – accuracy, precision, sensitivity, selectivity, and detection limit Calibration and validation	8
3	**Data analysis**: errors – systematic and random errors, statistical treatment of experimental results (F, Q and t tests, rejection of data, and confidence intervals), least square method, correlation coefficients	6
4	**Spectroscopic methods**: General principle, instrumentation and applications of - UV-visible spectroscopy - Infrared spectroscopy - fluorescence spectroscopy	8
5	**Electrochemical methods:** General principle, instrumentation and applications of - Conductometry - Potentiometry	8
6	**Chromatographic methods:** General principle, instrumentation and applications of - Gas chromatography (GC) - HPLC	10
	Total	**45**

List of Textbooks/Reference Books	
1	David Harvey. Modern Analytical Chemistry; McGraw-Hill (1999)
2	R. A. Day and A. L. Underwood. Quantitative Analysis, Prentice Hall of India (2001)
3	H. H. Willard, L. L. Merritt, J. A. Dean and F. A. Settle. Instrumental Methods of Analysis, 7th ed.; Wadsworth Publishing, USA (2004)
4	D. A. Skoog, D. M. West, F. James Holler and S. R. Crouch. Fundamentals of Analytical Chemistry; 9th ed.; Cengage Learning (2013)
5	D. A. Skoog, F. James Holler and S. R. Crouch. Principles of Instrumental Analysis; 6th ed.; Cengage Learning (2016)

Course Outcomes (Students will be able to…..)	
CO1	apply the knowledge of sampling, data analysis and select proper analytical method. (K3)
CO2	explain the principles of UV Visible and Fluorescence spectroscopic methods. (K2)
CO3	explain the principles of electrochemical methods. (K2)
CO4	Understand the principles of chromatographic separations. (K2)

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

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

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

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

List of Prerequisite Courses	
HSC Standard Mathematics	

List of Courses where this course will be prerequisite

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

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

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

	Course Contents (Topics and subtopics)	Required Hours
1	**Linear Algebra:** Vectors in $\mathbb{R}^n$, notion of linear independence and dependence. $\mathbb{R}^n$ as a vector space, vector subspaces of $\mathbb{R}^n$, basis of a vector subspace, row space, null space, and column space, rank of a matrix. Determinants and rank of matrices. Linear transformations in $\mathbb{R}^n$, Matrix of a linear transformation, change of basis and similarity, rank-nullity theorem, and its applications. Inner product spaces, orthonormal bases, Gram-Schmidt orthogonalization process, Eigenvalues and eigenvectors, characteristic polynomials, eigenvalues of special Orthogonal projection and its application to least square methods, Diagonalization of matrices and its applications to stochastic matrices	15
2	**Differential Calculus:** Higher order differentiation and Leibnitz Rule for the derivative, Taylor's and Maclaurin's theorems, Maxima/Minima, convexity of functions and applications. Functions of two or more variables, Limit and continuity, Partial differentiation, Total derivatives, Taylor's theorem for multivariable functions and its application to error calculations, Maxima/Minima, Method of Lagrange Multipliers, Introduction to double and triple integrals.	15
3	**Probability & Statistics:** Random variables and cumulative distribution function; probability mass function and probability density function; Some common univariate distributions: Binomial, Poisson, Uniform, exponential, Normal; Expectation and Moments; Moment generating function, Multiple random variables, and Joint distribution; marginal distributions, Covariance and Correlation. Concept of parameter estimation: maximum likelihood estimation; method of least squares and simple linear regression; nonlinear regression	15
	Total	**45**

List of Textbooks/ Reference Books	
1	G. Strang, Linear Algebra and its Applications (4th Edition), Thomson (2006).
2	Howard Anton, Elementary Linear Algebra, John Wiley & Sons (2016)
3	Stewart, James, Single Variable Calculus, 6th Edition, Cenage learning (2016)
4	Hughes-Hallett et al., Calculus - Single and Multivariable (3rd Edition), John-Wiley and Sons (2003).
5	E. Kreyszig, Advanced Engineering Mathematics (8th Edition), John Wiley (1999). (Officially prescribed)
6	S. R. K. Iyengar, R. K. Jain, Advanced Engineering Mathematics Narosa, (2020)
7	A First Course in Probability, Sheldon Ross, Pearson Prentice Hall, 9th Edition (2018)
8	W.W. Hines, D. C. Montgomery, D.M. Goldsman, John-Wiely, Probability and Statistics in Engineering, John Wiley & Sons (2008)
9	Alexander M. Mood, Duane C. Boes, and Franklin A. Graybill, Introduction to the Theory of Statistics, Mc GrawHill, (1973)

Course Outcomes (students will be able to….)	
CO1	Understand the notion of differentiability and be able to find maxima and minima of functions of one and several variables(K2, K3)
CO2	Understand the computational and geometrical concepts related to linear transformations, eigenvalues and eigenvectors and apply them to solve computational problems(K1, K2, K3)
CO3	Demonstrate understanding of different concepts in linear algebra in solving computational problems related to vectors and matrices and apply them to solve problems arising the Engineering especially in AI and ML.(K2, K3, K5)
CO4	Understand the concepts of various probability distributions and apply them to analyze various engineering problems and make inference about the system (K2, K3, K4)

CO5	Understand the method of linear and nonlinear least squares method and apply it to choose appropriate mathematical functions for modelling real data sets, arising from engineering disciplines (K3, K4, K5)

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

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

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

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

	Course Outcomes (students will be able to…)
1	Assign Miller indices to various crystallographic planes and directions in a crystal lattice, thereby understand periodicity in the crystal lattice.
2	Analyze a given x-ray diffraction pattern to deduce the crystal structure of the material and calculate the values of the basic structural parameters.
3	Classify solids, and in turn semiconductors, based on electron occupancy and calculate basic quantities related to charge transport in them.
4	Analyze simple ideal fluid flows by applying the continuity equation and Bernoulli's equation.
5	Describe the basic behaviour of viscous flows and the relationships between various flow parameters.
6	Understand simple models that are used to describe viscoelastic flows.
	List of Prerequisite Courses
1	Standard XI and XII Physics course
2	Standard XII Chemistry course
	List of Courses where this course will be prerequisite
1	Applied Physics Laboratory (Sem-II)
2	Materials Science Minor program courses (Sem-III, IV, V, VI, VII, VIII)
3	Open Elective courses from Physics Department (Sem-II, IV, V)
	Description of relevance of this course in the B. Chem.Tech. Program
The physics of solids and fluids play a key role in the various areas of chemical technology. The Applied Physics course will provide the students with the necessary fundamentals to develop a broad understanding of various aspects related to solids and fluids, and thereby equip them with the ability to apply it wherever required in their course of study.	

	Course Contents (Topics and subtopics)	**Reqd. hours**
	Solid State Physics	
1	Crystal Structure of Solids: A revision of concepts of a lattice, a basis, unit cell, different crystal systems (SC, BCC, FCC, HCP), co-ordination number and packing fractions. Single crystalline, Polycrystalline, and Amorphous materials.	3
2	Crystallographic planes and directions: concept of Miller indices and its determination, examples; calculation of inter-planar spacing in terms of Miller indices.	3
3	Determination of crystal structure using X-rays: Bragg's law of X-ray diffraction, types of diffractometers, Indexing diffraction peaks and calculation of various lattice parameters and crystallite size	4
4	Energy band in solids and classification of solids, the concept of Fermi level and Fermi distribution function, Intrinsic and extrinsic semiconductors, Transport properties of semiconductors: Conductivity in semiconductors and its dependence of carrier concentration and mobility.	5
	Physics of Fluids	
5	A revision of the basic concepts of hydrostatics and ideal fluid flow: Equation of continuity and Bernoulli's equation.	4

6	The concept of viscosity, Newton's law of viscosity, Reynold's number, Poiseuille's equation for streamline flows	4
6	An introduction to Rheology: Parameters of viscous flows, Newtonian and non-Newtonian behaviour, Variation of viscosity with shear rate, shear time, temperature, and pressure (qualitative ideas with illustrative examples), measuring properties of viscous flows. The concept of viscoelasticity, Maxwell and Kelvin models of relaxation, relaxation spectrum, creep testing.	7
	Total	**30**

	List of Textbooks/Reference books
1	Fundamentals of Physics – Halliday, Resnick, Walker – 6th Edition – John Wiley
2	Sears and Zeemansky's University Physics – Young and Freedman – 12th Edition – Pearson Education
3	A Textbook of Engineering Physics – M N Avadhanulu, P G Kshirsagar, TVS Arun Murthy – 11th Edition – S. Chand Publishers
4	Solid State Physics – S. O. Pillai – 10th Edition – New Age Publishers
5	Solid State Physics – A. J. Dekker – MacMillan India
6	Engineering Physics – V Rajendran – 6th Edition – McGraw Hill Publishers
7	Introduction to Rheology – H. A. Barnes, J. F. Hutton and K. Walters – 4th Edition – Elsevier Science.
8	Viscoelastic Properties of Polymers – J. D. Ferry – 3rd Edition – Wiley

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

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

List of Prerequisite Courses

Mathematics, Geometry, basic drawing and visualization

List of Courses where this course will be prerequisite

Industrial drawing, Equipment Design, Manufacturing and designing of any component, industrial 3D product modelling etc.

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

Drawing is a language used by engineers and technologists. A student is required to know the various processes and the equipment used to carry out the processes. Some of the elementary areas like product sizing, manufacturing etc., are very common to all the branches of technology. These and many other processes require machines and equipment's. One should be familiar with the design, manufacturing, working, maintenance of such machines and equipments. The subject of "drawing" is a medium through which, one can learn all such matter, because the "drawings" are used to represent objects and various processes on the paper. Through the drawings, a lot of accurate information is conveyed which will not be practicable through a spoken word or a written text. This course is required in many subjects as well as later in the professional career.

	Course Contents (Topics and Subtopics)	Required Hours
1	**Orthographic projections**: Introduction, Principles of Projection, Methods of Projection, Planes of projection, Quadrants, First-angle method of projection, Third-angle method of projection, and concept of orthographic projections.	20
2	**Sectional Projections and Missing Views**: Need for the drawing sectional views, concept of sectioning and section lines, Sectional drawings of different solids and machine components, Auxiliary planes, and views. **Missing Views**: Concept of recognizing missing views and their interpretation, drawing of missing views from given orthographic drawings.	15
3	**Isometric projections**: Concept of isometric views, isometric projections and isometric scale, Iso metric projections of different solids and machine components	15
4	**Computer Aided Drafting and Assembly drawing**: Basic introduction to CAD softwares, Design and Development of new products, Application of CAD, 2D, 3D part modelling on softwares, drawing modification and dimensioning, modelling of different machine components. Basics of Assembly drawing, preparation of 2D, 3D components and assembling on CAD software, conversions, labelling and table creation for bill of materials.	25
	Total	**75**

List of Textbooks/Reference Books

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

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

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

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

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

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

	Course Code: PST1101	Course Title: Spl 1 -Polymer Science & Technology I	Credits = 2		
			L	T	P
	Semester: I	Total Contact Hours: 30	1	1	0

List of Prerequisite Courses
HSC (Science)

List of Courses where this course will be Prerequisite
Raw materials Analysis & Characterization for Resin and Polymers, Analysis & Characterization of Resin and Polymers, Technology of Thermoset, Technology of Thermoset Polymers

Description of relevance of this course in the B. Tech (Polymer Tech.) Programme
To train the students with respect to basics of polymers, Overview of Polymer and Coating Industry Manufacturing Chemistry, properties applications of monomers for synthetic and natural polymers and their handling hazards.

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	Overview of Polymer and Coating Industry, Historical developments in polymeric materials with introduction and classification of polymers	5
2	Basic concepts & definitions: monomer & functionality, oligomer, polymer, repeating unites, degree of polymerization, molecular weight & molecular weight distribution commodity engineering polymers specialty polymer definitions	15
3	Manufacturing Chemistry, properties applications of raw material for synthetic polymers like Ethylene, propylene, butadiene, vinyl chloride, vinylidene dichloride, styrene etc.	10
	Total	**30**

List of Text Books/ Reference Books	
1	Raw Materials for Industrial Polymers by H Ulrich, Hanser Publication1989.
2	Principles of Polymer Science, by Bahadur and Sastry, Narosa Publishing House 2002.
3	Polymer Science by Gowarikar, Johan wiley and Sons 1986.
4	Encyclopedia of Polymer Science and Technology, Johan Wiley and Sons, Inc 1965.
5	Encyclopedia of Polymer Science and Engineering, Johan Wiley and Sons, Inc 1988.
6	Petrochemicals: The Rise of an Industry by Peter H. Spitz, Johan Wiley and sons 1988.
7	Polymer Chemistry by Malcolm P. Stevens, Oxford University Press, Inc, 1990

Course Outcomes (Students will be able to…..)	
CO1	Describe the basic concept of monomer, polymer and repeating units and their properties (K2)
CO2	Interpret the physical and chemical properties of raw materials (K3)
CO3	Analyze the manufacturing routes and impurities in monomers and raw materials (K4)
CO4	Propose plan about evaluation of raw materials and reactants for synthesis & manufacturing of resins and polymers. (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	3	2	3	3	3	2	1	1	1	1	2	2	2
CO2	K3	3	3	1	1	1	3	3	1	1	2	2	3	3	3
CO3	K4	3	3	3	3	2	3	3	2	2	1	1	3	3	3
CO4	K5	2	3	3	2	3	1	3	3	2	2	3	2	2	1
Course	K5	3	3	3	3	3	3	3	3	2	2	3	3	2	3

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

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

List of Prerequisite Courses

Applied Physics

List of Courses where this course will be prerequisite

Independently set up, handle, and use basic setups to measure and obtain various physical quantities.
Use basic instruments like vernier-caliper, screw-gauge, travelling microscope, thermometer, etc. to make accurate measurements. Correlate and use directly measured quantities to obtain the relevant parameters through appropriate formulae, calculations, and/or graphical plotting, thereby understand the measurement principle involved in the experimental setups. Preliminarily treat the obtained datasets statistically to obtain errors in the experiments.

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

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

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	Determination of Co-efficient of Viscosity by Poiseuille's method	5
2	Thermistor characteristics: Determination of Bandgap of a semiconductor	6
3	Determination of compressibility of liquids using an Ultrasonic Interferometer	5
4	Measurement of thermal conductivity of a solid: Lee's disc method	6
5	Photoelectric effect: Determination of h/e	5
6	Hall effect: Determination of carrier type and concentration in a semiconductor	6
7	Newton's rings: Determination of wavelength of light	5
8	Laser Diffraction: Determination of particle size	8
9	Determination of Co-efficient of Viscosity by Poiseuille's method	8
10	Thermistor characteristics: Determination of Bandgap of a semiconductor	6
Total		**60**

List of Text Books/ Reference Books

1	Fundamentals of Physics - Halliday, Resnick, Walker - 6th Edition - John Wiley
2	Sears and Zeemansky's University Physics - Young and Freedman - 12th Edition - Pearson Education
3	A Textbook of Engineering Physics - M N Avadhanulu, P G Kshirsagar, TVS Arun Murthy - 11th Edition - S. Chand Publishers
4	Engineering Physics - V Rajendran - 6th Edition - McGraw Hill Publishers
5	Concepts of Modern Physics - A. Beiser, McGraw-Hill.
6	Ultrasonics: Methods and Applications - J. Blitz, Butterworth.
7	Optics - Ajoy Ghatak - 7th Edition - McGraw Hill
8	Fundamentals of Optics - F. Jenkins and H. White - 4th Edition McGraw Hill
9	ICT Physics Laboratory Manual (supplied to students)

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

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

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

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

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

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

List of Prerequisite Courses
Standard XIIth English

List of Courses where this course will be prerequisite
All courses in this and subsequent semesters

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

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

List of Text Books/ Reference Books	
1	Elements of Style – Strunk and White

Course Outcomes (students will be able to…..)	
CO1	write grammar error free technical reports in MS Word or equivalent software.(K3)
CO2	make power point slides in MS PowerPoint or equivalent software.(K3)

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

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

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

Semester-II

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

List of Prerequisite Courses

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

List of Courses where this course will be Prerequisite

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

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

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

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	**Chemistry of Carbonyl Compounds** Concept of acidity and tautomerism of carbonyl compounds, General methods of preparation and Nucleophilic Addition reactions Enolate chemistry, Aldol and related condensation reactions, Michael reaction, Robinson annulation, Claisen condensation, Dieckmann condensation, Mannich reaction.	**9**
2	**Aromatic Substitution Reactions** **A) Electrophilic Substitution Reactions** Nitration, Halogenation, Alkylation, Acylation and Sulfonation Activating, deactivating and orienting effects of functional groups in mono- and poly-substituted benzenes Friedel-Crafts alkylation, Acylation, Gattermann, Gattermann-Koch, Riemer-Tiemann reactions. **B) Nucleophilic Substitution Reactions** Addition and elimination mechanism, Benzyne mechanism, Sandmeyer reaction.	**10**
3	**Heteroaromatic Compounds** IUPAC nomenclature, structures and common names, comparison with benzenoid compounds, reactivity and synthesis – pyrroles, furans, thiophenes and pyridines	**8**
5	**Named Organic Reactions** Perkin reaction (Mauvine synthesis-dyes), Fischer indole synthesis, (dyes), Jacobson Corey epoxide synthesis (Pharmaceutical), Ziegler Natta polymerisation (polymer), Multicomponent reactions, Mailard reaction (foods), Strecker amino acid synthesis (Pharmaceuticals & Food), Wittig reactions, Prilezhaev reaction	**10**
6	**Stereochemistry of Organic Compounds** Containing one and two asymmetric carbon atoms, Stereo descriptors – R/S, E/Z, erythro and thero, Conformation – Ethane and butane. Enantiomers and Diastereomers, meso compounds, different representations of stereoisomers – Saw-horse, Newmann, Wedge and dash and Fischer and their interconversions	**8**
	Total	**45**

List of Text Books/Reference Books

1	Clayden, J., Greeves, N., Warren, S.; Organic Chemsitry; 2nd ed.; Oxford University Press (2012)
2	Graham Solomons, T. W.; Fryhle, Craig B.; Snyder, Scott A. Organic Chemistry; 12th Ed.; John Wiley & Sons. Inc. (2016)
3	Smith, M. B.; March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure; 7th ed.; Wiley, India (2015)
4	Carey F. A., Sundberg, R. J. Advanced Organic Chemistry: Part A: Structure and Mechanisms; 5th ed.; Springer (2005)

5	Carey F. A., Sundberg, R. J.; Advanced Organic Chemistry: Part B: Reaction and Synthesis; 5th ed.; Springer (2007)
6	Wade, L. G.; Simek, J. W.; Singh, M. S. Organic Chemistry; 9th ed.; Pearson Education (2019)
7	Eliel, E. L. Stereochemistry of Carbon Compounds; Mcgraw-Hill (2001)
8	Bruice, Paula, Y. Organic Chemistry; 8th Ed.; Pearson Education (2020)

Course Outcomes (Students will be able to…..)	
CO1	Draw structures of organic compounds and write their IUPAC names correctly (K2).
CO2	be well versed with aromatic chemistry and interpret the outcome of general transformations (K3).
CO3	Understand the importance of heterocycles, learn the properties and synthetic routes, interpret the IUPAC of compounds and decipher outcomes of various transformations involving heterocycles (K3).
CO4	Apply the knowledge obtained through the course to predict the outcome of reactions and devise solutions to unknown problems (K3).
CO5	Appreciate the stereo-chemical implications of organic compounds and visualize and appreciate the chirality concept (K2).
CO6	Understand organic chemistry reactions related to aliphatic as well as aromatic compounds as well as decipher the outcome of a given organic transformation (K3).
CO7	Interpret and analyze reactions having different functionalities, deduce and solve problems related to the reactions as well as apply them, if need be (K4).

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

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

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

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

List of Prerequisite Courses
Standard XII Inorganic Chemistry
List of Courses where this course will be Prerequisite
Material Technology, Environment Science and Technology
Description of relevance of this course in the B. Tech. Programme
To acquaint the students with synthesis, properties and applications of various industrial inorganic chemicals

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	Introduction to Chemical Industry: Bulk chemicals, fine chemicals, intermediates, active pharmaceutical ingredients (API), etc.	**3**
2	Petrochemical Industry: operations and processes in manufacture of ethers, hydrocarbons, aromatic compounds, etc.	**6**
3	PRIMARY INORGANIC MATERIALS: Water, Hydrogen, Hydrogen Peroxide and Inorganic Peroxo Compounds, Nitrogen and Nitrogen Compounds, Phosphorus and its Compounds, Sulfur and Sulfur Compounds, Halogens and Halogen Compounds,	**8**
4	MINERAL FERTILIZERS: Phosphorus-Containing Fertilizers, Nitrogen-Containing Fertilizers, Potassium-Containing Fertilizers	**4**
5	METALS AND THEIR COMPOUNDS: Alkali and Alkaline Earth Metals and their Compounds Aluminum and its Compounds, Chromium Compounds and Chromium, Silicon and its Inorganic Compounds, Manganese Compounds and Manganese	8
6	ORGANIC BULK CHEMICALS: Manufacture of methanol, acetic acid, ethanol, ethylene, propylene, butadiene, acetaldehyde, acetylene, BTX, alkyl benzenes, acetone, phenol, styrene, esters, ethylene oxide, phthalic acid, Vinyl-Halogen and Vinyl-Oxygen Compounds, azo dyes, Polyamides, Propene Conversion Products, Aromatics - Production and Oxidation Products of Xylene and Naphthalene	**8**
7	Important pharmaceutically active ingredients, agrochemicals, insecticides, pesticides, perfumery chemicals.	**8**
	Total	**45**

List of Text Books/ Reference Books	
1	Industrial Organic Chemistry, 3rd, Completely Revised Edition, Klaus Weissermel, Hans-Jürgen Arpe ISBN: 978-3-527-61459-2 July 2008.
2	Industrial Inorganic Chemistry, 2nd Completely Revised Edition, Karl Heinz Buchel, Hans-Heinrich Moretto, Dietmar Werner, ISBN: 978-3-527-61333-5, 667 pages, November 2008, Wiley-VCH.
3	Inorganic Chemistry – an industrial and environmental perspective, T.W. Swaddle, ISBN 0-12- 678550-3 , 482 pages, Academic Press

Course Outcomes (Students will be able to…..)	
CO1	Understand the important of chemical principles applied to various industrial processes
CO2	Describe the fundamental processes underlying manufacture of important organic and inorganic chemicals
CO3	Review and assess the impact of the chemical factors on the efficiency of industries and feedstock manufacturing
CO4	Modify existing applications for improving the efficiencies in terms of yields, energy requirement and environmental impact

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

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

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

	Course Code: PET1201	Course Title: Spl 2 - Introduction to polymer engineering and technology	Credits = 2		
			L	T	P
	Semester: II	Total Contact Hours: 30	1	1	0

List of Prerequisite Courses
HSC (Science), Polymer science and technology I
List of Courses where this course will be Prerequisite
Raw materials Analysis & Characterization for Resin and Polymers, Analysis & Characterization of Resin and Polymers, Technology of Thermoset, Technology of Thermoset Polymers
Description of relevance of this course in the B.Tech (Polymer Tech.) Programme
The course "Introduction to Polymer Engineering and Technology" is highly relevant in today's world due to the widespread use of polymers in various industries. Polymers have become integral materials in everyday life, including packaging, automotive, electronics, medical devices, and many more. Understanding the properties, processing methods, and applications of polymers is crucial for aspiring engineers and technologists to design innovative products, reduce production costs, and address environmental challenges associated with polymer waste and disposal. Additionally, with the growing demand for sustainable materials, this course equips students with knowledge about eco-friendly polymers and their potential in future industries.

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	Introduction to materials and polymer	6
2	Polymer industry	6
3	Various types of polymers	6
4	Introduction to polymer processing	6
5	Various applications of polymers	6
	Total	**30**

List of Text Books/ Reference Books	
1	Polymer chemistry- Charles E Carraher Jr., 2003
2	Introduction to Polymer Science- Robert J. Young, Peter A. Lovell, 2011
3	Plastic Materials and Processing- A. Brentstrong, 2006

Course Outcomes (Students will be able to…..)	
CO1	Explain the fundamental principles of polymer engineering and technology, including the molecular structure and properties of various types of polymers, and their applications in different industries. (K2)
CO2	Illustrate the manufacturing processes involved in the production of polymers, and analyze their impact on the final properties of the materials. (K3)
CO3	Develop an understanding of the diverse applications of polymers in everyday products and advanced technologies, and evaluate their advantages over traditional materials. (K4)
CO4	Compare and classify different types of polymers based on their chemical structure, physical properties, and processing techniques to determine their suitability for specific applications. (K5)
CO5	Discuss the environmental and sustainability aspects related to the use of polymers in industry and evaluate potential solutions for mitigating their impact on the ecosystem. (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	K2	3	3	3	2	2	3	3	2	2	2	3	3	3	3
CO2	K3	3	3	2	2	3	3	2	2	1	2	3	3	2	3
CO3	K4	3	3	2	3	3	2	2	3	3	3	3	3	2	3
CO4	K5	2	3	1	3	3	2	3	3	3	2	3	3	3	2
CO5	K6	3	3	2	2	3	3	3	2	2	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

ESC	Course Code: GET1306	Course Title: Basic Mechanical Engineering	Credits = 2		
			L	T	P
	Semester: II	Total Contact Hours: 30	1	1	0

List of Prerequisite Courses
Physics, Basic Mathematics

List of Courses where this course will be Prerequisite
Energy Engineering, Unit Operations, Mechanical design of chemical equipments

Description of relevance of this course in the B. Tech. Programme
Students will be able to understand various equipments like steam turbine, gas turbine, pumps, compressors, and power transmission system.

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	**Introduction- Concept of Stress**: Condition of Equilibrium for concurrent coplanar and non-concurrent coplanar forces. Deformation in solids- Hooke's law, stress and strain- tension, compression and shear stresses, Stress Strain Diagram, elastic constants and their relations volumetric, linear and shear strains.	6
2	**Introduction to Thermodynamics**: First Law of Thermodynamics, Steady-flow energy equation, Second Law of Thermodynamics	4
3	**Basics of Power Station** -Steam Generators Fire tube and Water tube boiler, Low pressure, and high-pressure boilers, Mountings and accessories, Boiler efficiency -Steam Turbines Working principle of steam, gas and water turbines, Concept of impulse and reaction steam turbines. -Compressors/Pumps Different Types of Compressors and their applications, Different Types of Pumps, and their applications	8
4	**Transmission of Power**: Introduction to various drives such as belt, rope, chain and gear drives, Introduction to mechanical elements such as keys, couplings, and bearings in power transmission (No numerical)	4
5	**Refrigeration and Air-conditioning** Vapour compression refrigeration cycle, Vapour absorption refrigeration systems, Properties of air such as DBT, WBT, DPT, relative humidity, Psychometric chart.	4
6	**Renewable Energy** Role and importance of non-conventional and alternate energy sources such as solar, wind, ocean, bio-mass and geothermal, hydrogen energy	4
	Total	**30**

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

Course Outcomes (Students will be able to…..)	
CO1	Understand different types of stresses and their effects on bodies. (K2)
CO2	Describe the working of steam boilers, mountings, and accessories. (K2)
CO3	Explain the working principles of power developing systems such as steam turbines, gas turbines and internal combustion engines. (K2)
CO4	Describe the working principle of vapour compression and vapour absorption refrigeration systems. (K2)
CO5	Discuss different types of power transmission systems and their typical applications. (K2)
CO6	Explain the working principles of power absorbing devices such as pumps and compressors. (K2)

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

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

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

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

List of Prerequisite Courses
Standard XII Physics and Mathematics courses
List of Courses where this course will be prerequisite
Various Technology Courses and Professional Career
Description of relevance of this course in the B. Tech. Program
In this course, Students will get an insight to the importance of Electrical Energy in Chemical Plants. The students will understand the basics of electricity, selection of different types of drives for a given application process. They will get basic knowledge as regards to Power supplies, instrumentation amplifiers and thyristor application in industries.

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	**Fundamentals of DC Circuits** Voltage and Current Sources, Basic Laws, Network Theorems, Superposition Theorem and Thevenin's Theorem,	4
2	**AC Fundamentals:** A.C. through resistance, inductance and capacitance, simple RL, RC and RLC circuits. Power, power factor	4
3	**Three Phase Systems**: Three phase system of emfs and currents, Star and Delta connections, three phase power	5
4	**Single phase transformers**: Principle of working, Efficiency, regulation.	5
5	**Electrical drives**: Basic concepts of different types of Electrical motors as drives, Their suitability for various applications.	5
6	**Regulated power supplies**, Diodes as rectifiers, Half wave and Full wave rectifier, Filters and Regulators	5
7	**Bipolar junction transistors**: Different configurations, Characteristics, Concept of basic amplifier circuits, Amplifier gain, Transistor as switch	3
8	**Introduction to Integrated circuits:** Basic concepts of ICs	2
9	**Introduction to data acquisition and signal conditioning,** Basic concept and Block diagram, Concept of conversion of physical quantity to electrical signal, signal conditioning, Introduction to A/D and D/A converters	3
10	**Introduction to instrumentation amplifiers and their applications** Operational Amplifier – Notation, Pin diagram, Differential and common mode gain, CMRR, Introduction to various applications such as Non-inverting, inverting amplifiers, adder,subtractor, integrator, differentiator,	3
	Total	**45**

List of Textbooks/Reference Books	
1	Electrical Engineering Fundamentals by Vincent Deltoro
2	Electronic devices and circuits by Boylstead, Nashelsky
3	Electrical Machines by Nagrath, Kothari
4	Electrical Technology by B.L.Theraja, A.K.Theraja vol I,II,IV
Course Outcomes (Students will be able to…..)	
CO1	understand the basic concepts of D.C circuits. Solve basic electrical circuit problems.(K3)
CO2	understand the basic concepts of single phase and three phase AC supply and circuits.(K2)
CO3	understand the basic concepts of transformers and motors used as various industrial drives.(K2)
CO4	understand the basic concepts of electronic devices and their applications.(K2)

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

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

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

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

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

This is a basic course. This knowledge will be required in almost all subjects later. This subject introduces the various concepts used in Chemical Engineering to the students. The knowledge of this subject is required for in All B. Tech. courses, etc. It can be applied in various situations such as process selection, economics, sustainability, environmental impacts

Sr. No.	Course Contents (Topics and subtopics)	Reqd. Hours
1	Introduction to Chemical process calculations, overview of single stage and multistage operations, concept of process flow sheets	2
2	Revision of Units and Dimensions, Dimensional analysis of equations, Mathematical techniques	4
3	Mole concept, composition relationship, types of flow rates	2
4	Material balance in non-reacting systems: application to single and multistage processes	8
5	Stoichiometry	2
6	Material balance in reacting systems: application to single and multistage processes	6
7	Behavior of gases and vapors	4
8	Introduction to psychrometry, humidity and air-conditioning calculations.	6
9	Calculation of X-Y diagrams based on Raoult's law.	2
10	Applications of material balances to Multiphase systems	6
11	Basic concepts of types of Energy and calculations	2
12	Application of Energy balance to non-reacting systems	6
13	Application of Energy balance to reacting systems	6
14	Fuels and combustion.	4
	Total	**60**

List of Text Books/ Reference Books	
	Elementary Principles of Chemical Processes, Felder, R.M. and Rousseau,
	Chemical Process Principles, Hougen O.A., Watson K. M.
	Basic Principles and Calculations in Chemical Engineering, Himmelblau,
	Stoichiometry, Bhatt B.I. and Vora S.M.

Course Outcomes (students will be able to…..)		
1	Students will be able to convert units of simple quantities from one set of units to another set of units	
2	Students will be able to calculate quantities and /or compositions, energy usages, etc. in various processes and process equipment such as reactors, filters, dryers, etc.	

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

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

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

BSC	Course Code: CHP1343	Course Title: Physical and Analytical Chemistry Laboratory	Credits = 2		
			L	T	P
	Semester: II	Total Contact Hours: 60	0	0	4

List of Prerequisite Courses
Standard XIIth Chemistry Laboratory courses
List of Courses where this course will be prerequisite
This is a basic Course. This knowledge will be required in Applied Chemistry subjects later.
Description of relevance of this course in the B. Tech. Program
Students will become familiar with laboratory experimental skills, plan and interpretation of experimental tasks, understand the relevance of principles of physical chemistry in chemical processes

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

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

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

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

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

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

List of Prerequisite Courses
Standard XIIth Organic Chemistry Laboratory
List of Courses where this course will be prerequisite
All the Applied Chemistry Practicals
Description of relevance of this course in the B. Tech. Program
The course is relevant for training the students for working with binary mixtures. The students are exposed to basics of organic separations and identification of organic compounds based on their physicochemical properties. The laboratory training is crucial for the students to carry out work-up of organic reactions leading to separation of crude products followed by purification using recrystallization and/or distillation or related methods.

	Course Contents (Topics and Subtopics)	Required Hours
1	a) Principles of qualitative separation of organic mixtures using physical properties, chemical properties and their combination b) Principles of quantitative separation of organic mixtures using physical properties, chemical properties and their combination	4 4
2	a) Separation of solid-solid water insoluble binary organic mixtures b) Separation of solid-solid partly water soluble binary organic mixtures c) Separation of solid-solid mixtures by fractional crystallization d) Separation of liquid-liquid mixtures by distillation e) Separation of liquid-liquid mixtures by solvent extraction	5X4 2X4 2X4 2X4 2X4
	Total	**60**

List of Textbooks/Reference Books	
1	Arthur, Vogel. Textbook of Practical Organic Chemistry, 5th edition, publishers Longman group Ltd, 1989
2	F.G. Mann and B.C. Saunders, Practical Organic Chemistry, 4th edition published by Orient Longman
3	Keese, R, Martin P. B, and Trevor P. Toube. Practical Organic Synthesis: A Student's Guide. John Wiley & Sons, 2006.
Course Outcomes (Students will be able to…..)	
CO1	work safely in the organic chemistry laboratory.(K3)
CO2	separate binary organic mixtures by multiple techniques.(K4)
CO3	understand basic principles for separation of binary organic mixtures qualitatively and quantitatively.(K3)

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

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

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

Semester-III

	Course Code: PST1303	Course Title: Spl 3- Polymer Chemistry & Technology	Credits = 4		
			L	T	P
	Semester: III	Total Contact Hours: 60	3	1	0

List of Prerequisite Courses

HSC (Science) polymer science and technology I, Introduction to polymer engineering and technology

List of Courses where this course will be Prerequisite

High Polymer Chemistry, Structure Property Relationship, Compounding and Polymer Processing, Technology of Thermoplastics, Technology of Thermosets

Description of relevance of this course in the B. Tech. (Surface coating Tech.) Programme

To teach students basic concepts of Polymer chemistry & Technology so that they can have good base to learn other subjects

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	Detailed classification of polymers Addition, condensation, commodity engineering and speciality copolymers, Monomer structure and Polymerizability, Crystalline/amorphous, step growth /chain growth, homochain / heterochain, crystalline / amorphous polymers, confirmation etc.	5
2	Homo& copolymers, graft, block alt, ladder etc. & nomenclature, configuration: cis/trans; tacticity, branched/ crosslinked, Addition and condensation polymerization mechanism	5
3	Techniques of polymerization: bulk, solution, suspension, emulsion, plasma etc.	5
4	Molecular weight and its distribution determination methods (Mn to Mz+1& MWD, Polydispersity Index), calculations & problems based on it,	5
5	Carothers equation for condensation polymers & conditions to get high or desired molecular weight, calculations & problems based on it.	5
6	Transition temperatures such as Tg, Tc, Tm, their relevance to properties &processing and factors affecting them	5
7	Solubility parameter, solution properties, temperature, good/ bad solvent.	5
8	Different initiating systems such as free radical polymerization, redox with examples & their use choice of initiator half-life period. Measurement of polymer viscosity by different method	5
9	Copolymerization, reactivity ratios & kinetics of copolymerization (copolymer composition equation). Polymerization: Probability and statistics-statistics of polycondensation, chain polymerization, branching and gelation. Copolymer sequence distribution	5
10	Basic Rheological concepts of polymer solutions and melts, Newtonian / non Newtonian, time dependent/ independent	5
11	Mixing operations: Typical agitation system, dissolution, suspension, removal of water condensates high speed (low viscosity) stirring, low speed (high viscosity) stirring selection criterion, power consumption. Heat transfer characteristics, powder mixing times etc	5
12	Commercial applicability of Polymers as Plastics, paints, rubbers, fibers & adhesives	5
	Total	**60**

List of Text Books/ Reference Books

1	Principles of Polymer Science, Bahadur and Sastry, Narosa Publishing House 2002
2	Polymer Science, Gowarikar, Johan wiley and Sons 1986

3	Encyclopedia of Polymer Science and Technology, Johan Wiley and Sons, Inc 1965
4	Encyclopedia of Polymer Science and Engineering, Johan Wiley and Sons, Inc 1988
5	Polymer Chemistry, Malcolm P. Stevens, Oxford University Press, Inc, 1990.
6	Text book of polymer Science, Billmeyer, John Wiley ans Sons 1984.
7	Principles of Polymer Systems, Rodriguez, Hemisphere Publishing Corpn, 1982
8	Introduction to Polymer Science and Technology, H. S. Kaufman and J. J. Falcetta, Wiley – Inter science Publication, 1977
9	Principles of polymerization, G. Odian, Wiley – Inter science (1981)
Course Outcomes (Students will be able to…..)	
CO1	Describe the basics of polymers and various terminologies. (K2)
CO2	Solve the problems regarding Calculation of MW – MWD & its relevance (K4)
CO3	Explain the basics of rheology & its effect on processing & application, mixing operations. (K2)
CO4	Compare various techniques of polymerization & initiating systems (K4)
CO5	Differentiate the various types of copolymerization & their commercial 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+P	K3	K3+A	K2+ A	K3	K6 +A+Psy	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	3	3	3	3	3	3	2	3	3
CO3	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO4	K4	3	3	2	3	2	3	3	3	3	3	3	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: PST1304	Course Title: Spl 4-Polymer Science & Technology II	Credits =2		
			L	T	P
	Semester: III	Total Contact Hours: 30	1	1	0

List of Prerequisite Courses

HSC (Science), polymer science and technology, Introduction to polymer engineering and technology

List of Courses where this course will be Prerequisite

Raw materials Analysis & Characterization for Resin and Polymers, Analysis & Characterization of Resin and Polymers, Technology of Thermoset, Technology of Thermoset Polymers

Description of the relevance of this course in the B. Tech. (Surface coating Tech.) Program

To train the students with respect to basics of polymers, Overview of Polymer and Coating Industry Manufacturing Chemistry, properties applications of monomers for synthetic and natural polymers and their handling hazards.

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	Natural Polymers: Chemical & Physical structure, properties, source, important chemical modifications, applications of polymers such as Lignin, starch, rosin, shellac, latexes etc.	5
2	Ethyl Cellulose, Methyl Cellulose, Nitro cellulose, Cellulose acetates etc.	2
3	Vegetable oils and gums, proteins etc.	2
4	Polyols like ethylene glycol propylene-ethylene glycol and their modification etc	3
5	Acrylic monomers like acrylic acid, acrylonitrile, methacrylic acid, methacrylates, acrylamide etc	3
6	Azelic acid, Sabacic acid, Aminododacnoic acid etc	2
7	Phenol-modified, phenols Formaldehyde, Epichlorohydrin Bisphenol-A, Melaminene, Isocynates etc	5
8	Storage Handling Hazards of monomers	3
9	Evaluation of raw materials and reactants for synthesis & manufacturing of resins and polymers.	5
	Total	**30**

List of Text Books/ Reference Books

1	Raw Materials for Industrial Polymers by H Ulrich, Hanser Publication1989.
2	Principles of Polymer Science, by Bahadur and Sastry, Narosa Publishing House 2002.
3	Polymer Science by Gowarikar, Johan wiley and Sons 1986.
4	Encyclopedia of Polymer Science and Technology, Johan Wiley and Sons, Inc 1965.
5	Encyclopedia of Polymer Science and Engineering, Johan Wiley and Sons, Inc 1988.
6	Petrochemicals: The Rise of an Industry by Peter H. Spitz, Johan Wiley and sons 1988.
7	Polymer Chemistry by Malcolm P. Stevens, Oxford University Press, Inc, 1990

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

CO1	Describe the basic concept of monomer, polymer and repeating units and their properties (K2)
CO2	Interpret the physical and chemical properties of raw materials(K3)
CO3	Analyze the manufacturing routes and impurities in monomers and raw materials (K4)
CO4	Discuss about the environmental concerns handling Safety and Hazards of Monomers

	(K2)
CO5	Propose plan about evaluation of raw materials and reactants for synthesis & manufacturing of resins and polymers. (K5)

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	PO9	PO1 0	PO1 1	PO12	PSO 1	PSO 2
		K3	K4	K6	K5	K6	K3	K3+P	K3	K3+ A	K2+ A	K3	K6 +A+Ps y	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	3	3	3	3	3	2	3	3
CO3	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO4	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO5	K5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Cours e	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

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

List of Prerequisite Courses		
Course Outcomes (students will be able to…..)		
1	Students will be able to know and apply accounting and finance theory.	
2	Students will be able to understand the mechanics of preparation of financial statements, their analysis and interpretation	
3	Students will be able to explain basic economic terms, concepts, and theories	
4	Students will be able to identify key macroeconomic indicators	
List of Prerequisite Courses		
	MATHS-1 AND MATHS -2 OF FIRST YEAR COURSEWORK	
List of Courses where this course will be prerequisite		
	PROJECT ECONOMICS **FUNDAMENTALS OF MARKETING MANAGEMENT AND MARKET RESEARCH**	
Description of relevance of this course in the BACHELOR'S Program		

	Course Contents (Topics and subtopics)	Reqd. hours
1	INTRODUCTION Explaining the Economy The Supply and Demand Model Using the Supply and Demand Model	3
2	THE COMPETITIVE EQUILIBRIUM MODEL Deriving Demand Deriving Supply Market Equilibrium and Efficiency	5
3	DEVIATIONS FROM COMPETITION Monopoly and Market Power Between Monopoly and Competition Antitrust Policy and Regulation	5
4	MACRO FACTS AND MEASURES	5

	Getting Started with Macroeconomic Ideas Measuring Production, Income and Spending of Nations	
5	ACCOUNTING TRANSACTIONS Journal entries Debit credit rules Compound journal entry Journal and ledger Rules of posting entries Trial balance	5
6	CAPITAL AND REVENUE Income and expenditure Expired costs and income Final accounts Manufacturing accounts Trading accounts Profit and Loss account Suspense account Balance sheet	5
7	CONCEPT OF DEPRECIATION	2
List of Textbooks		
	Finance and Accounting for Nonfinancial Managers: All the Basics You Need to Know -William G. Droms and Jay O. Wright Microeconomics: Basic Principles and Applications- A A Temu, D W Ndyetabula, et al PRINCIPLES OF ECONOMICS(12e)- E. Case Karl, C. Fair Ray, et al	
List of Additional Reading Material / Reference Books		
	Basic Finance for Nonfinancial Managers: A Guide to Finance and Accounting Principles for Nonfinancial Managers- Kendrick Fernandez Microeconomic Theory: Basic Principles and Extensions- Walter Nicholson and Christopher Snyder Macroeconomics(10e) Part of: Pearson Series in Economics (23 books) - by Froyen	

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: PSP1301	Course Title: Pr 1- Raw Materials analysis for Resins and Polymers	Credits = 2		
			L	T	P
	Semester: III	Total contact hours: 60 hrs	-	-	4
List of Prerequisite Courses					
Physical Chemistry I, Physical Chemistry II, Analytical Chemistry, Applied Mathematics- I					
List of Courses where this course will be prerequisite					
	The technology of Thermoplastic Polymers, The technology of Thermoset Polymers, Synthesis & Characterization of Resins & Polymers Lab, Analysis and characterisation of Resins and polymers Lab				
	Description of the relevance of this course in the B. Tech (Coatings)				
	To train the students with respect to various raw materials used in resin synthesis and characteristics of the same, various test methods for determining the purity of the RMs for application in polymer & resin synthesis				
Sr. No.	**Course Contents (Topics and subtopics)**		**Required Hours**		
	1) To Check the colour of oil & resins. 2) To Check the colour of oils & resins on heating. 3) To check the viscosity of oils & resins solution using Ford Cup or Brookfield viscometer. 4) To check the melting range of given resin by capillary tube method. 5) To find the acid value of given sample. 6) To find Aniline point of given solvent. 7) To find the distillation large of given solvent. 8) To find the evaporation rate of given solvent. 9) To find flash point of given solvent. 10) To find moisture content of solvent (qualitative analysis) 11) To find specific gravity of solvent by pycnometer. 12) To find the moisture content of pigment. 13) To find the water-soluble matter of pigment. 14) To check the Acidly & Alkalinity of pigment. 15) To check bleeding of pigment. 16) To find oil absorption value of pigment. 17) To find minimum surfactant demand by the Daniel flowpoint method 18) Analysis and Determination of purity of Phenols and substituted phenols by Bromination,Formaldehyde Phthalic Anhydride, Hexamine, Epichlorohydrine Melamine etc. 19) Analysis of Water Glycerine Calcium Chloride Sodium / Potassium dichromate Hydrogen peroxide etc.		**1x4hr/week**		
	List of Text Books/ Reference Books				
1	Testing of Paints by S.Patil, Current Awareness Service Publisher, 1993				
2	Vogel's Qualitative Inorganic Analysis (7th Edition) By Svehla Prentice Hall; 7 edition (March 7, 1996)				
3	Quantitative organic analysis via functional groups. Second Edition. SIDNEY SIGGIA. Wiley, New York, 1954				

4	Quantitative organic analysis via functional groups. Second Edition. SIDNEY SIGGIA. Wiley, New York, 1954 publication Code No. PCN, Philadelphia, Thirteenth edition, 1972
5	Qualitative Organic Analysis-Author: Arthur I. Vogel Publisher: Longman Group Ltd. London Sixth Edition, 1970
	Course Outcomes (students will be able to…..)
CO1	Examine raw material purity and its significance in polymer synthesis (K4)
CO2	Calculate the physical parameters of raw materials including viscosity, specific gravity, melting point etc. (K3)
CO3	Analysis of functional group and to determine the purity of functional raw materials (K3)
CO4	Manage to separate various solvents from their mixture (K5)
CO5	Design experiment to determine the purity of pigments with respect to their physical parameters (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+P	K3	K3+A	K2+ A	K3	K6 +A+Psy	K3	K4
CO1	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO2	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO3	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO4	K5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO5	K5	3	3	3	3	3	3	3	3	3	3	3	3	3	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: PSP1302	Course Title: Pr 2- Synthesis and Characterization of Resins and Polymers Common I	Credits = 2		
			L	T	P
	Semester: III	Total contact hours: 60 hrs	0	0	4

List of Prerequisite Courses

Polymer science and Technology, Polymer chemistry and Technology, Technology of Thermoset, Technology of Thermoplastics, Raw material Analysis of resins and polymers, Analysis and characterization of resins and polymers lab

List of Courses where this course will be prerequisite

Compounding and Polymer Processing Project I, (Environment Health and Safety of Polymers and Coating, Evaluation and testing of Polymers and Coatings, Structure Property relationship. Paint Processing II, Project I, Project II

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

To give understanding of laboratory scale synthesis processes, properties and applications of various types of thermoplastic and thermoset polymers. Knowledge of subject will help student to carry out Production, Research and development in the areas of polymer Synthesis, Polymer nanocomposites, coating formulation developement, Fiber reinforced composites, Polymer processing etc.To make them aware of Environmental concerns of Polymer Synthesis. Handling Hazards of raw materials monomers, Work ethics in group, Ability design and conduct experiments, Ability to analyze and interpret data, process parameters. To understand and do calculations observations formulations involved team work and understanding practical problems related to the experiment

	Course Contents	Reqd. hours
1	Bulk, Solution and Suspension polymerization of monomers like styrene, MMA etc. and to analyses % solids, %yield, melting range etc	1x4hr/Week
2	Emulsion polymerization of monomers like vinyl acetate, styrene etc and to analyse polymer content, %solids etc.	
3	Aqueous polymerization of monomers like AA, Acrylamide etc. and ananalyse %of solids, %yield, melting range etc.	
4	Synthesis of phenolic resin such as novalac, resol and to analyse free formaline, free phenol content, %solids, curing charecterestics etc.	
5	Synthesis of epoxy resin and to find epoxy value, epoxy equivalent yield etc.	
6	Synthesis of Unsaturated polyesters and to analyse Acid value, yield etc.	
7	Synthesis of copolymer of styrene and acrylate and to analyse yield melting range	
8	Polymer nanocomposites via insitu polymerization	
9	To study kinetics of free radical polymerization	
10	To synthesis superabsorbant, hydrogels and its analysis	
11	Plastisol core and shell polymers and its analysis	
12	Synthesis of amino resins like Melamine formaldehyde and urea formaldehyde resin And its analysis and application.	

List of Text Books/ Reference Books	
	1.Polymer Chemistry: A Practical Approach (The Practical Approach in Chemistry Series)1st Edition Fred J. Davis Oxford University Press 2004 2.A Practical Course in Polymer ChemistryS. H. Pinner, Borough Polytechnic,London, Pergamon Press,he., New York, 1961 3. PVC Technology, A. S. Athalye and Prakash Trivedi, Multi-Tech Publishing Co, 1994 4.Polymer Science by Gowarikar,John Wiley and Sons 1986. 5.Encyclopedia of Polymer Science and Technology, Johan Wiley and Sons, Inc 1965. 6.Encyclopedia of Polymer Science and Engineering, Johan Wiley and Sons, Inc 1988. 7. PVC Technology, A. S. Athalye and Prakash Trivedi, Multi-Tech Publishing Co, 1994 8. Principles of polymerization, G.Odian, Wiley – Interscience (1981) 9. PVC Technology 4th edition by W.V.Titow Elsevier Applied Science Publishers, London, 1984 **10.Phenolic Resins chemistry, Applications, Standardization, Safety and Ecology L.Knop,Springer-Verlag Berlin Heidelberg 2000** 11. Chemistry and Technology of Epoxy Resins by Eliss Brayn, Springer Nethelands,1993 12. Plastics Materials, 7th Edition by John Brydson, Elsevier 1999 13.Experimental Plastics A practical course for students by C.A.Redfran, Interscience Bublisher Inc.NY 1971 14.Testing of Paints by S.Patil, Current Awareness Service Publisher, 1993

Course Outcomes (students will be able to…..)	
1	Perform laboratory scale experiment for synthesis of polymers like PS PMMA polyacrylamide Epoxy Polyesters nanocomposites .etc (K5)
2	Design and conduct experiments for synthesis of Resins and polymers and understand the practical problems related to the experiment (K5)
3	Analyze and characterize polymers by finding yield melting point epoxy value acid value % solid etc within realistic constraints of the experiment (K4)
4	Interpret and compare data, process parameters within realistic constraints of the experiment (K4)
5	Collect various experimental results, manage to work effectively in team work and understanding of professional and ethical responsibility(K5)

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

Semester-IV

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

List of Prerequisite Courses

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 offluids, heat and mass transfer, etc.

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

This basic course introduces concepts of momentum, heat and mass transfer to students. Various other concepts such as pressure, momentum, energy are introduced as well. Laws related to conservation of momentum, energy, mass are taught. Applications of these laws to various engineering and technological situations and process equipments are explained with the help of several problems.

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	Fluid Statics and applications to engineering importance.	4
2	Applications of Bernoulli's Equation, Pressure drop in pipes and Fittings,meters, and fluid moving machinery such as pumps.	10
3	Particle Dynamics, Flow through Fixed and Fluidised Beds	4
4	Equations of Continuity and Motion in laminar flows and its applicationsfor simple Couette flow and Poiseuille flow applications	6
5	Heat conduction. Convective heat transfer and concept of heat transfercoefficient.	4
6	Design and constructional aspects of exchangers: Types of flows: Concurrent, counter-current and cross flows, log mean temperature difference, double pipe and Shell and tube heat exchangers. Introduction to other heat exchangers like, PHE, finned tube heat exchangers, graphite block, etc.	10
7	Heat transfer aspects in agitated tanks, condensers, reboilers and evaporators.	6
8	Fundamentals of mass transfer: Molecular diffusion in fluids, concept ofmass transfer coefficients, and interface mass transfer.	4
9	Theories of Mass transfer, Analogies for heat and mass transfer, Empirical correlations	4
10	Mass transfer applications in simple 1-D situations.	8
	Total	**60**

List of Text Books/ Reference Books

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

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

CO1	Students should be able to calculate friction factor, pressure drop, power requirements of singe phase flow in a circular pipe
CO2	Students will be able to calculate flow and power required for pumps
CO3	Students should be able to calculate heat transfer coefficients and do basicsizing of double pipe and shell and tube heat exchangers
CO4	Students should be able to calculate mass transfer coefficients and estimatemass transfer rates in simple situations

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

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

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

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

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

	Course Code: PST1401	Course Title: Spl 5-Technology of Thermoplastic Polymers	L	T	P
	Semester: IV	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

Polymer science and Technology, Polymer chemistry and Technology, Raw material Analysis of resins and polymers, High Polymer Chemistry

List of Courses where this course will be Prerequisite

Compounding and Polymer Processing, Environment Health and Safety of Polymers and Coating, Evolution and testing of Polymers and Coatings, Technology of Plastic Packaging

Description of relevance of this course in the B. Tech. (Surface coating Tech.) Program

To give understanding of industrial manufacturing processes, properties and applications, processing of various types of thermoplastic polymers. Knowledge of subject will help student to carry out research and development in the areas of polymer blends polymer nanocomposites, coating formulation development, Fiber reinforces composites, Polymer processing, Rheology of polymers etc.
To make aware of Environmental concerns of Polymer products, Recycling of Polymers, industrially produced different grades trade names of polymers.

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	Industrial Manufacturing processes, properties and applications, processing environmental concerns of various types of polymers polyolefins like LDPE HDPE etc.	5
2	Polypropylene and copolymer of PP Plastomers	3
3	Copolymer of polyolefines like EVA LLDPE EAA etc.	2
4	Polystyrene, HIPS, SAN	2
5	ABS, important copolymers of styrene maleic anhydride and styrene acrylics copolymers, toughening mechanism of impact modified plastics.	5
6	Saturated Polyesters such as PET, PBT, PTT	3
7	Polycarbonates, Polyacetals	2
8	Polymamides- Nylon 6, Nylon 6,6, Nylon 11 etc., aromatic polyamide such as Kevlar	5
9	Acrylic polymers & copolymers, Polyacrylamide, PMMA, Polyacrylonitrile etc.	5
10	Polyvinyl chloride & its copolymers Compounding of PVC	3
11	Cellulose esters and ethers such as Ethyl cellulose, CMC, CN, cellulose acetates etc.	5
12	Thermoplastic PU, Poly vinyl acetate, Polyvinyl alcohol etc.	5
	Total	**45**

	List of Text Books/ Reference Books
	Plastics Materials, 7th Edition by John Brydson, Elsevier 1999.
	Text book of polymer Science by Bill Meyer, John Wiley and Sons 1984
	Principles of Polymer Science, by Bahadur and Sastry, Narosa Publishing House 2002.
	Polymer Science by Gowarikar, John Wiley and Sons 1986.
	Encyclopedia of Polymer Science and Technology, Johan Wiley and Sons, Inc.1965.
	Encyclopedia of Polymer Science and Engineering, Johan Wiley and Sons, Inc1988.
	Handbook of Thermoplastics, Second Edition Olagoke Olabisiby CRC Press2015

	Thermoplastic Materials by Ibeh, Christopher C, Taylor Francis Inc 2013
	Introduction to Polymer Science and Technology by H. S. Kaufman and J. J. Falcetta, Wiley Inter science Publication, 1977
	Handbook of Polyethylene, A. J. Peacock, Marcel Dakker Inc,2000
	PVC Technology, A. S. Athalye and Prakash Trivedi, Multi-Tech Publishing Co, 1994.
	Engineering Thermoplastics Polycarbonates Polyacetals Cellulose Esters, L. Bottenbruch, Hanser Publishers, 1996.
	Polymer and Resins; Their Chemistry and Chemical Engg, Brage Golding, D. Van Nostrand Company Inc, 1959.
	Structures of Cellulose, Atlla, American Chemical society, 2003.
	Course Outcomes (Students will be able to…..)
CO1	Inspect the industrial manufacturing process, compare the advantages disadvantages of such processes, define the process parameters of the thermoplastics polymers and discuss the environmental concerns of their products (K4)
CO2	Analyze properties like physical mechanical thermal rheological etc (K4)
CO4	Describe the basic processing methods related to of the thermoplastics polymers. (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+P	K3	K3+A	K2+ A	K3	K6 +A+Psy	K3	K4
CO1	K4	3	3	2	3	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	3
CO3	K2	3	2	1	2	1	3	3	3	3	3	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: PST1505	Course Title: Spl 6- Technology of Thermoset Polymers	Credits = 3		
			L	T	P
	Semester: IV	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

Polymer science and Technology, Polymer chemistry and Technology, Raw material Analysis of resins and polymers, High Polymer Chemistry

List of Courses where this course will be Prerequisite

Processing of Paint lab -I, Processing of Paint lab- I, Project I, Project II, Environment Health and Safety of Polymers and Coating, Evolution and testing of Polymers and Coatings, Technology of Plastic Packaging.

Description of relevance of this course in the B. Tech. (Surface coating Tech.) Programme

To give understanding of alkyd resins, types, synthesis, properties and modification of alkyd resins. Understanding of polyester resins, raw materials used and various curing systems. Basics of Phenolics, polyurethane, silicone and acrylics resins. Their
synthesis, modification, processing, chemistry and applications.

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	Alkyd resins Basic components like polyfunctional alcohols, poly- basic acids, vegetable oils/fatty acids. Different types of drying oils: drying, semi-drying and non-drying with examples. Influence of all these components in the synthesis and properties of the final alkyds obtained. Modification of alkyds: modifications with rosin,maleic anhydride, acrylics, vinyls, imides, etc.	5
2	Polyesters Resins – unsaturated polyesters resins: Raw material: poly-basic acids, polyfunctional glycols. Curing of resins through unsaturation of the resin/polymer backbone. Curing systems, catalysts and accelerators. Molding compositions, fibre and film forming compositions	5
3	Phenolics. Basic Components of the polymer. Different kinds of phenols to aldehyde on the nature and the property of the polymer. Theory of resinification and effect of pH on the reaction mechanism and the reaction product. Curing of Phenolics.	5
4	Modification of Phenolics such as oil soluble and oil reactive. Phenolic moulding compounds ingredients, compounding and applications	3
5	Polyurethanes Theromoplastic and Thermoset: Basic components diisocyanates and diols, different diisocyanates and diols used Reactions of isocyanates with various other functional groups synthesis of polymers polyurethane foams, polyester and polyether foams.	5
6	Processes like one-shot process, Polyether pre-polymers, Quasi- pre-polymer polyether foams, etc. Flexible foams Polyurethanes in Coatings Polyisocyanates IPN using polyurethanes-acrylicblends.	5
7	Silicones Theromoplastic and Thermoset; Preparation of intermediates, Grignard's method, directs method, olefin addition method, sodium condensation method, rearrangement of organochlorosilanes.	2
8	Nature and effect of Si-H, Si-O, Si-Si, and Si-C bond. Silicone fluids, resins, elastomers.	3
9	Compounding, Processing and applications of Silicone resins. Modified silicone resins.	5
10	Thermosetting acrylics: Synthesis of acrylic polymers and co- polymers, different techniques. Structure property relationship application of thermosetting acrylics, like anaerobic adhesives, laminating resins, etc	5
11	Miscellaneous thermosetting polymers.	2
	Total	**45**

List of Text Books/ Reference Books

1. Text book of Polymer Science by Bill Meyer, John Wiley Ans Sons 1984.

2.	Encyclopedia of Polymer Science and Technology, Johan Wiley and Sons, Inc 1965.
3.	Encyclopedia of Polymer Science and Engineering, Johan Wiley and Sons, Inc 1988.
4.	Polymer Chemistry by Malcolm P. Stevens, Oxford University Press, Inc, 1990.
5.	Introduction to Polymer Science and Technology by H. S. Kaufman and J. J. Falcetta, Wiley – Interscience Publication, 1977
6.	Handbook of Thermoplastics, O. Olabisi, Marcel Dekker, 1997.
7.	Resins for Surface Coatings, Polyurethanes Polyamides PhenolplastsAminoplasts Maleic Resins (Waterborne & Solvent Based Surface Coatings Resins & Applications) (Volume III) Volume III Edition
8.	Resins for Surface Coatings, Volume 1 2nd Edition, Resins for Surface Coatings: Acrylics and Epoxies 2nd Edition by H. Coyard (Author), P. Deligny (Author), N. Tuck (Author), P. K. T. Oldring (Editor)
9.	Resins for surface coating- Oldring series
10.	Basics of Paint Technology Part I, V. C. Malshe.
11.	Organic coatings science and technology, third edition, Zeno Wicks, 2007
12.	Plastics Materials J. A. Brydson, Butterworth Scientific, 1990.
13.	Polymer chemistry, Seymour and Carraher, Marcel Dekker, 2003.
14.	Polymer and Resins; Their Chemistry and Chemical Engg, Brage Golding, D. Van Nostrand Company Inc, 1959.
15.	Structures of Cellulose, Atlla, American Chemical society, 2003.
16.	Polymer Technology by Miles and Briston Falcetta, Wiley – Interscience Publication, 1977
17.	Polymer Technology by Miles and Briston
	Course Outcomes (Students will be able to…..)
CO1	To study the basics of alkyd resins and differentiate between the various types of alkyds. To understand the chemistry of alkyd resins and provide inputs for modification of alkyds. (K4)
CO2	To study the chemistry of polyurethanes. Compare the various raw materials and their reactivity for polyurethanes and provide inputs for modification (K4)
CO3	Interpret the importance of silicones resins. (K3)
CO4	Identify the role of various types of phenolic resin in polymer and paint industry (K2)
CO5	Distinguish between various Chemistries of acrylic and polyester(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+P	K3	K3+A	K2+ A	K3	K6 +A+Psy	K3	K4
CO1	K4	3	3	2	3	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	3
CO3	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO4	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
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; S, Psychomotor domain

	Course Code: HUT1206	Course Title: Environmental Sciences	Credits = 2		
			L	T	P
	Semester: III	Total contact hours: 30	2	0	0

	Course Outcomes (students will be able to…..)	
1	Describe the methods of industrial effluent treatment	
2	apply the learning for selection and implementation of appropriate waste management technique for sustainable development	
	List of Prerequisite Courses	
	Course Contents (Topics and subtopics)	**Reqd. hours**
1	(a) Concept of circular economy, EHS management (b) Environment management systems in the chemical industry (c) Legal provisions for environmental management: EP Act 1986; Air Act, 1981; Water Act, 1974; Hazardous waste management Rules, 2019	6
2	Importance of ecology, effluent treatment and discharging norms for treated water	6
3	SPCB consent parameters, monitoring and analysis	4
4	External monitoring of ambient air, noise, stacks, etc	4
5	Air pollutants, sources and effects on human health and environment, monitoring and analysis	6
6	Life cycle analysis, environmental impact assessment	4
	List of Text Books	
1	Introduction to Environmental Engineering and Science by Gilbert M Masters and Wendell P Ela	
2	Environmental Pollution Control Engineering, C. S. Rao	
3	Principles of Instrumental Analysis by D. A. Skoog, F. James Holler and S. R. Crouch, Cengage Learning, 2007	
	List of Additional Reading Material / Reference Books	

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

List of Prerequisite Courses

Material and Energy Balance Calculations, Equip Design and Drawing I, Energy Engineering, Ind Eng Chem.

List of Courses where this course will be prerequisite

Home Paper I and II

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

This course is required for the future professional career

	Course Contents (Topics and subtopics)	Reqd.
1	Estimation of Plant and Machinery cost, Capacity Index, Cost Indices	8
2	Relationship between price of a product and project cost and cost of production, EV Analysis. Elements of cost of production, monitoring of the same in a plant, Meaning of Administrative expenses, sales expenses etc. Introduction to various components of project cost and their estimation. Project financing, debt: equity ratio, promoters, contributors, shareholders	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.	8
5	Estimate of working results of proposed project. Capacity utilization, Gross profit, operating profit, profit before tax, Corporate tax, dividend, Net cash accruals. Project evaluation: Cumulative cash flow analysis Break-Even analysis, incremental analysis, various ratios analysis, Discounted cash flow analysis	6
	List of Text Books/ Reference Books	
1	Chemical Project Economics, MahajaniV.V.andMokashi SM.	
2	Plant Design and Economics for Chemical Engineers, Peters M.S.,TimmerhausK.D.	
3	Process Plant and Equipment Cost Estimation, Kharbanda O.P.	
	Course Outcomes (students will be able to…..)	
1	Calculate working capital requirement for a given project	
2	Calculate cost of equipment used in a plant total project cost	
3	Calculate cashflow from a given project	
4	Select a site for the project from given alternatives	
5	List out various mile stones related to project concept to commissioning	

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

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

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

	Course Code: PSP1401	Course Title: Pr 3- Synthesis and Characterization of Resins and Polymers Common II	Credits = 2		
			L	T	P
	Semester: IV	Total contact hours: 60 hrs	0	0	4

List of Prerequisite Courses

Polymer science and Technology (PST1301), Polymer chemistry and Technology (PST1303), Technology of Thermoset(PST1506), Technology of Thermoplastics(PST1504), Raw material Analysis of resins and polymers(PSP1301), Analysis and characterization of resins and polymers lab (PSP1504)

List of Courses where this course will be prerequisite

Compounding and Polymer processing (PET1607) Project I (PSP1713), Environment Health and Safety of Polymers and Coating (PST1712) , Evaluation and testing of Polymers and Coatings(PST1711), Structure Property relationship(PST1609). Paint Processing II (SCP1610), Project I (PSP1714), Project II (PSP1811)

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

To give understanding of laboratory scale synthesis processes, properties and applications of various types of thermoplastic and thermoset polymers. Knowledge of subject will help student to carry out production, Research and development in the areas of polymer Synthesis, Polymer nanocomposites, coating formulation developement, Fiber reinforced composites, Polymer processing etc.To make them aware of Environmental concerns of Polymer Synthesis. Handling Hazards of raw materials monomers, Work ethics in group, Ability design and conduct experiments, Ability to analyze and interpret data, process parameters.
To understand and do calculations observations formulations involved team work and understanding practical problems related to the experiment

	Course Contents	Reqd. hours
1	Bulk, Solution and Suspension polymerization of monomers like styrene, MMA etc. and to analyses % solids, %yield, melting range etc	1x4hr/Week
2	Emulsion polymerization of monomers like vinyl acetate, styrene etc and to analyse polymer content, %solids etc.	
3	Aqueous polymerization of monomers like AA, Acrylamide etc. and analyse %solids, %yield, melting range etc.	
4	Synthesis of phenolic resin such as novalac, resol and to analyse free formaline, free phenol content, %solids, curing charecterestics etc.	
5	Synthesis of epoxy resin and to find epoxy value, epoxy equivalent yield etc.	
6	Synthesis of Unsaturated polyesters and to analyse Acid value, yield etc.	
7	Synthesis of copolymer of styrene and acrylate and to analyse yield melting range	
8	Polymer nanocomposites via insitu polymerization	
9	To study kinetics of free radical polymerization	
10	To synthesis super-absorbant, hydrogels and its analysis	
11	Plastisol core and shell polymers and its analysis	
12	Synthesis of amino resins like Melamine formaldehyde and urea formaldehyde resin And its analysis and application.	

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

1	Perform laboratory scale experiment for synthesis of polymers like PS, PMMA, polyacrylamide ,Epoxy, Polyesters nanocomposites .etc (K5)
2	Design and conduct experiments for synthesis of Resins and polymers and understand the practical problems related to the experiment (K5)
3	Analyze and characterize polymers by finding yield melting point epoxy value acid value % solid etc within realistic constraints of the experiment (K4)
4	Interpret and compare data, process parameters within realistic constraints of the experiment (K4)
5	Collect various experimental results, manage to work effectively in team work and understanding of professional and ethical responsibility (K5)

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

Semester-V

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

	List of Prerequisite Courses
	Physical Chemistry I and II, Transport Phenomena
	List of Courses where this course will be prerequisite
	Environmental Engineering and Process Safety, Chemical Project Economics

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

Chemical Reaction Engineering is concerned with the utilization of chemical reactions on a commercial scale. This course is very relevant but not limited to the following industries: Inorganic chemicals, organic chemicals, petroleum & petrochemicals, Pulp & paper, Pigments & paints, rubber, plastics, synthetic fibres, Foods, Dyes and intermediates, Oils, oleo chemicals, and surfactants, Minerals, clean sing agents, Polymers and textiles, Biochemicals and biotechnology, pharmaceuticals and drugs, Microelectronics, energy from conventional and non-conventional resources, Metals

	Course Contents (Topics and subtopics)	Reqd. hours
1	Kinetics of homogeneous reactions, Interpretation of batch reactor data, Single ideal reactors including design aspects	8
2	Multiple reactions, Temperature, and pressure effects	3
3	Introduction to Non ideal flow, RTD measurements, Models to predict conversions	2
4	Homogeneous and Heterogeneous Catalysis, Kinetics of Solid Catalyzed Reactions. Design of gas – solid catalytic reactors	8
5	Introduction to Multiphase reactors	4
6	Mass transfer with chemical Reactions: Regimes of operation and Model contactors	5
	Total	**30**
	List of Textbooks	
1	Elements of Chemical Reaction Engineering – H.Scott Fogler	
	List of Additional Reading Material / Reference Books	
1	Heterogeneous Reactions, Vol.I and II –L.K. Doraiswamy, M.M.Sharma	
	Course Outcomes (students will be able to…..)	
1	Describe and discuss principles of various types of reactors	
2	Calculate rates of reactions based on given reaction scheme	
3	Design various components of reactors used in industrial practice	
4	Compare various reactors and select an appropriate reactor for a given situation	
5	Describe and discuss principles of various types of reactors	

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

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

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

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

PCC	Course Code: CET1807	Course Title: Chemical Engineering Operations	Credits = 2		
			L	T	P
	Semester: V	Total contact hours:30	1	1	0

	List of Prerequisite Courses	
	Process Calculations, Transport Phenomena	
	List of Courses where this course will be prerequisite	
	This is a basic course. It is required in many other courses that involve physical processes	
	Description of relevance of this course in the B. Tech. Program	
This is a basic Chem Engg. course. The principles learnt in this course are required in almost all the courses and throughout the professional career of student		
	Course Contents (Topics and subtopics)	**Reqd. hours**
1	Distillation: Fundamentals of flash, batch and continuous distillation, distillation columns internals, steam and azeotropic distillation	10
2	Liquid-Liquid Extraction: Solvent selection, construction of ternary diagrams, staged calculations, types of extraction equipment.	5
3	Crystallization: Phase diagram (temp/solubility relationship), evaporative and cooling crystallization, introduction to different types of crystallizers	5
4	Filtration: Mechanism of filtration, basic equation, constant volume, constant pressure filtration, rate expressions with cake and filter cloth resistances, compressible and incompressible cakes, introduction to various types of filters	5
5	Drying: Drying mechanism, drying rate curves, estimation of drying time and types of dryers	5
	Total	**30**
	List of Text Books/ Reference Books	
1	Richardson, J.F., Coulson, J.M., Harker, J.H., Backhurst, J.R., 2002. Chemical engineering: Particle technology and separation processes. Butterworth-Heinemann, Woburn, MA.	
2	Seader, J.D., Henley, E.J., 2005. Separation Process Principles, 2 ed. Wiley, Hoboken, N.J.	
3	Svarovsky, L., 2000. Solid-Liquid Separation. Butterworth-Heinemann, Woburn, MA.	
4	McCabe, W., Smith, J., Harriott, P., 2004. Unit Operations of Chemical Engineering, 7 ed. McGraw-Hill Science/Engineering/Math, Boston.	
5	Green, D., Perry, R., 2007. Perry's Chemical Engineers' Handbook, Eighth Edition, 8 ed. McGraw-Hill Professional, Edinburgh.	
6	Dutta, B.K., 2007. Principles of Mass Transfer and Separation Process. Prentice-Hall of India Pvt. Ltd, New Delhi.	
	Course Outcomes (students will be able to…..)	
1	Do basic sizing of continuous and batch distillation columns	
2	Analyze filtration data and select systems based on requirements, estimate filtration area for given requirements, understand filter aids and their usage	
3	Describe few industrial crystallization, filtration and drying equipment	
4	Describe the need and importance of other separation processes like adsorption, ion exchange and membrane	
5	Gain a practical perspective of unit operation in chemical industries	

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

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

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

	Course Code: PET1501	Course Title: SPL 7 - Recycling and reprocessing of polymers	Credits = 3		
			L	T	P
	Semester: V	Total contact hours: 45	2	1	0

List of Prerequisite Courses

Polymer science and Technology (PST1301), Polymer chemistry and Technology (PST1303), Technology of Thermoset (PST1506), Technology of Thermoplastics (PST1504), Raw material Analysis of resins and polymers (PSP1301), Analysis and characterization of resins and polymers lab (PSP1504)

List of Courses where this course will be prerequisite

Processing of Paint lab -I (SCP 1606), Processing of Paint lab- II (SCP 1609), Project I (PSP1713), Project II (PSP 1811) Environment Health and Safety of Polymers and Coating (PST1712), Evolution and testing of Polymers and Coatings (PST1711), Technology of Plastic Packaging (PET1712).

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

This course on Recycling and Reprocessing of Polymers is highly relevant in the current global context due to the escalating concerns about plastic pollution and its impact on the environment. With increasing plastic waste generation, recycling and reprocessing of polymers have become imperative to mitigate the environmental challenges posed by plastic disposal. This course equips students with the knowledge and techniques to manage plastic waste effectively, contribute to sustainability efforts, and foster a circular economy by converting waste materials into valuable resources. Moreover, given India's efforts to address plastic waste management through various policies and regulations, this course provides critical insights into the social, economic, and environmental aspects of plastic recycling, making it relevant for professionals, policymakers, and industries seeking sustainable solutions to the plastic waste crisis.

	Course Contents	Reqd. hours
1	**Introduction to plastic recycling:** Global policies, and regulations. Social and environmental challenges of plastic waste in India. Plastics and environment. Salient features of the plastic waste management (PWM) rules. Waste treatment of various plastic plants, estimation of power requirement and efficiency of size reduction operation of plastics. Recycling and recovery of multiple plastics items/materials-their effect on the environment. Waste collection and recycling methods. Comparative study of the conversion of plastic waste into value-added products. Implementation of 3R and 5S techniques for the recycling of plastics. Need for recycling – Sorting and segregation of waste – Plastics identification-Plastics production and composition – Plastics waste – Composition, quantities, and disposal alternatives.	10
2	**Biodegradable plastics-an overview:** Environmental issues, policies and legislation in India. Plastics-Energy saving, Eco-Friendly-Case studies. Life cycle analysis-a model. Biodegradable polymers - prospects & utilization, prospects for biodegradable plastics based on renewable resource polymers. Biodegradable polymers for various applications viz. food packaging, agriculture, etc.	10
3	**Primary recycling:** Equipment for primary recycling. Specific recycling techniques for Crushing and separation of plastic waste. Recycling of plastics from urban waste – rheology, density, mechanical behaviour.	3
4	**Secondary recycling:** Secondary recycling of plastic wastes containing paper – hydrolytic treatment – processing methods – processing of mixed plastics waste – household waste – industrial sector**.**	3
5	**Tertiary Recycling:** Pyrolysis, Introduction to pyrolysis and its advantages Introduction to pyrolysis reactors of plastics waste – Union Carbide System, Reactor by Japan Steel Works,	3
6	**Quaternary Recycling:** Introduction to quaternary recycling b. Constructional features of incinerators c. Incineration of plastic waste and its problems	3

7	Mechanical recycling of commonly used plastics, such as PP, PE. PET, etc., mixed waste recycling-co-extruded films waste, commingled waste Extrusion flow moulding for production of plastics lumber, Use of recyclable plastics in motor vehicles – recoverable materials – disposal of residuals – recyclable plastic components – virgin and recycled HDPE – Fluorinated and nonfluorinated HDPE – fuel tanks. Use of recyclable plastics in automobiles.	10
8	Chemical Recycling Method For PET, PA, and PU through different catalysis and Solvolysis	3

List of Text Books/ Reference Books

1.	Plastic Waste Management" Marcel Dekker, New York, 1995. Edited by Nabil Mustafa, Plastic waste management, 1st edition, Marcel Decker, New York,1993
2.	Plastics Waste Management: Processing and Disposal, 2nd Edition, Muralisrinivasan, Natamai Subramanian, ISBN: 978-1-119-55587-2 September 2019
3.	Plastic Waste and Recycling Environmental Impact, Societal Issues, Prevention and Solutionsm Book Edited by Trevor M. Letcher, ISBN: 978-0-12-817880-5, 2020

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

CO1	Explain the global policies, regulations, and social/environmental challenges associated with plastic waste, particularly in India. (K2)
CO2	Illustrate the salient features of plastic waste management rules and the various waste treatment methods employed in recycling polymers. (K3)
CO3	Develop a comparative understanding of different recycling techniques and their impact on the environment, focusing on the conversion of plastic waste into value-added products. (K4)
CO4	Analyze the application of 3R (Reduce, Reuse, Recycle) and 5S techniques in the recycling of plastics, emphasizing the importance of waste sorting, segregation, and identification. (K4)
CO5	Evaluate the potential and utilization of biodegradable plastics, exploring their environmental benefits and their applications in different sectors, such as food packaging and agriculture. (K5)

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

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
		K3	K4	K6	K5	K6	K3	K3+P	K3	K3+A	K2+ A	K3	K6 +A+Ps y	K3	K4
CO1	K2	3	3	3	3	2	3	2	3	3	3	3	3	3	3
CO2	K3	3	3	3	3	1	3	2	3	3	3	2	2	3	2
CO3	K4	3	3	3	2	3	3	2	3	1	2	3	3	3	3
CO4	K5	3	2	3	3	3	2	2	1	3	3	3	3	3	3
CO5	K5	3	3	1	3	3	3	2	3	3	3	3	3	3	2
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: PST1609	Course Title: Spl 8 - Structure property Relationship	Credits = 3		
			L	T	P
	Semester: V	Total contact hours: 45	2	1	0

List of Prerequisite Courses

Polymer Science & Technology (PST1301), Polymer Chemistry & Technology (PST1303), Technology of Thermoplastics (PST1504), Technology of Thermosets (PST1506)

List of Courses where this course will be prerequisite

Project I (PSP1714), Project II (PSP1811) Seminar (PSP1712), Speciality Polymers (PET1816)

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

To study the General structural features of polymers: Effects of atoms types of bonds, bond dissociation energy and functional groups on properties of polymers. To study the Configuration and conformation and structure properties of polymers and Molecular mass heterogeneity and structure properties. To study the Polymers solutions: thermodynamics of dissolution, factors effecting dissolution and swelling of polymers, phase equilibrium of polymer-solvent systems, polymer solution, Florry-Huggins theory

	Course Contents	Reqd. hours
1	General structural features of polymers: Effect of types of bonds, bond dissociation energy and functional groups on properties of polymers	10
2	Configuration and conformation and structure properties of polymers	5
3	Molecular mass heterogeneity and structure properties	5
4	Polymers solutions: thermodynamics of dissolution, factors effecting dissolution and swelling of polymers, phase equilibrium of polymer-solvent systems, polymer solution, Florry- Huggins theory	5
5	Polymer Chain flexibility: concept of flexibility, various factors deciding flexibility of polymers with case studies, properties of polymers affected by flexibility	5
6	Intermolecular orders: Amorphous, crystalline and oriented forms of polymers, crystallinity in polymers, factors affecting crystallinity, properties affected by crystallinity of polymers	5
7	Thermal properties of polymers: fire retardant polymers, factors affecting glass transition temperature, heat stability etc. with case studies	5
8	Degradation and stabilization: Various stresses acting on polymers and their influence, method of improving the stability of polymers with case study	5

List of Text Books/ Reference Books

1	Polymer Structure, Properties and application, R.D. Deanin, American Chemical Society, 1974.
2	Relating Materials, Properties to Structure; Handbook and Software for Polymer calcilations and Materials Properties, D. J. david and Ashok Mishra, Technical Publishing Componey, Inc, 1999.
3	Properties of Polymer; Correlations with Chemical Structurees and their numerical Estimation and Predication from Additive Group Contribution van Krevelen, Elsevier Publication Company, 1990.
4	Relating Materials Properties to structure, D. J. David, Technical Publishing Company Inc, 1999.
5	Polymer Chemistry, C. E. Carrshar, Marcel Dakker Inc, 2003.
6	Physical chemistry of Polymers, A. Tager, Mir Publishers, 1978.
7	Polymer Association Structures M. A. EL-Nokally, American Chemical Society, 1989.
8	Polymer Solutions; Introduction to Physical Properties, Teraoka, Iwao, John Wiley and Sons. Inc, 2002.

9	Polymer Chemistry; An Introduction, M. P. Stevens, Oxford University Press, 1990.
Course Outcomes (students will be able to…..)	
CO1	Explain the general structural features of polymers (K2)
CO2	Desrcibe the concept of Configuration and conformation and structure properties of polymers and Molecular mass heterogeneity and structure properties (K2)
CO3	Discuss the thermodynamics characteristics and identify factors affecting dissolution, polymer chain flexibility and thermal properties of polymers (K2)
CO4	Interpret about the intermolecular orders and the crystallinity properties. (K3)
CO5	Apply knowledge to understand the degradation/stabilization of polymers and to analyses the respective case studies (K4)
CO6	Describe the various thermal properties and factors affecting these properties (K2)

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	PO9	PO1 0	PO1 1	PO12	PSO 1	PSO 2
		K3	K4	K6	K5	K6	K3	K3+P	K3	K3+ A	K2+ A	K3	K6 +A+Ps y	K3	K4
CO1	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO2	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO3	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO4	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO5	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO6	K2	3	3	2	3	2	3	3	3	3	3	2	2	3	3
Cours e	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: PST1501	Course Title: Honour Course I - High Polymer Chemistry	Credits = 4		
			L	T	P
	Semester: V	Total contact hours: 60	3	1	0

List of Prerequisite Courses

Polymer chemistry and Technology (PST1404) Raw material Analysis of resins and polymers (PSP1301)

List of Courses where this course will be prerequisite

Compounding and Polymer Processing (PET1607), Project I (PSP1713) and Project II (PSP1811), Environment Health and Safety of Polymers and Coating (PST1712), Evaluation and testing of Polymers and Coatings (PST1711), Technology of Plastic Packaging (PET1712).

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

To give understanding of the mechanisms of free radical and ionic polymerization. To make aware of polymer synthesis via CRP, ROP, GTP etc, they will learn about catalyst used in polymers synthesis like Zieglar Natta, metallocene etc.

	Course Contents	Reqd. hours
1	Kinetics of free radical polymerization along with different examples & its efficiency, effect on molecular weight/ MWD & effect on tacticity Thermodynamics of free radical polymerization, effect of temp and pressure, enthalpies, entropies, free energies, activation energies of polymerization	5
2	Introduction to anionic polymerization with examples of different systems, Kinetics of anionic polymerization along with different examples & its efficiency, effect on molecular weight/ MWD & effect on tacticity	5
3	Introduction to cationic polymerization with examples of different systems, Kinetics of cationic polymerization along with different examples & its efficiency, effect of counter ion, effect on molecular weight/ MWD & effect on tacticity	5
4	Interfacial polymerization, Melt polycondensation, Solution polycondensation.	5
5	Advanced polymer synthesis and mechanisms, Ring opening metathesis polymerization (ROMP), ring forming polymers,	5
6	Group transfer Polymerization, Photopolymerization, Mini-dispersion polymerization,	5
7	Cyclo-polymerisation, Oxidative polymerization, Dispersion polymerization, Metal catalyzed olefin polymerization	5
8	Introduction to Zieglar-natta catalyst its Mechanism with examples of different systems, Effect of catalyst,co-catalyst their ratio, types of metals used their form & pendant groups	5
9	Supported unsupported catalysts, soluble insoluble system, efficiency& rate affecting factors like catalyst/ co catalyst, effect on molecular weight/ MWD & effect on tacticity	5
10	Introduction to Metallocene catalysts with examples of different systems	5
11	Hyperbranched polymers, Dendrimers, Interpenetrating Networks	5
12	Microbial synthesis of polymers, Template polymerization	5

List of Text Books/ Reference Books

1.	Principles of Polymer Science, Bahadur and Sastry, Narosa Publishing House 2002.
2.	Polymer Science, Gowarikar, Johan wiley and Sons 1986.
3.	Encyclopedia of Polymer Science and Technology, Johan Wiley and Sons, Inc 1965.
4.	Encyclopedia of Polymer Science and Engineering, Johan Wiley and Sons, Inc 1988.
5.	Polymer Chemistry, Malcolm P. Stevens, Oxford University Press, Inc, 1990.
6.	Textbook of polymer Science, Bill Meyer, John Wiley and Sons 1984.
7.	Principles of Polymer Systems, Rodriguez, Hemisphere Publishing Corpn, 1982.
8.	Introduction to Polymer Science and Technology, H. S. Kaufman and J. J. Falcetta, Wiley – Interscience Publication, 1977
9.	Principles of polymerization, G.Odian, Wiley – Interscience (1981)
Course Outcomes (students will be able to…..)	
CO1	Explain about Kinetics of polymerization & how to control it (K2)
CO2	Explain the effect of reaction parameters on polymer properties for different advanced polymerization techniques (K2)
CO3	Describe and Design advanced techniques of polymerization (K5)
CO4	Distinguish about various catalyst used in polymers synthesis like Ziegler-natta, Metallocene etc. (K4)
CO5	Interpret the importance of advanced polymer synthesis and its commercial implications. (K3)

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	PO9	PO1 0	PO1 1	PO12	PSO 1	PSO 2
		K3	K4	K6	K5	K6	K3	K3+P	K3	K3+ A	K2+ A	K3	K6 +A+Ps y	K3	K4
CO1	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO2	K2	2	3	2	2	2	3	1	3	3	2	3	2	3	3
CO3	K5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO5	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
Cours e	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: PEP1607	Course Title: Pr 4- Processing of Polymers Lab	Credits = 2		
			L	T	P
	Semester: V	Total contact hours: 60 hrs	0	0	4

List of Prerequisite Courses

Compounding and Polymer Processing (PET1607), Polymer chemistry and Technology (PST 1302), Technology of Thermosets (PST 1505), Technology of Thermoplastics (PST 1504)

List of Courses where this course will be prerequisite

Polymer fabrication, Project I (PSP1713), Project II (PSP 1075)

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

To give understanding of laboratory scale polymer processing and compounding operations of various types of thermoplastic and thermoset polymers. Knowledge of subject will help student to carry out, Research and Development in the areas of polymer blends, Polymer nanocomposites,Fiber reinforced composites, Polymer processing etc. Work ethics in group, Ability design and conduct experiments, Ability to analyze and interpret data, process parameters. To understand and do calculations observations formulations involved team work and Uderstanding practical problems related to the experiment

	Course Contents	Reqd. hours
1	To find residence time and output of twin screw Extruder	1x4hr/Week
2	Compounding of PVC	
3	Manufacturing of FRP composites like epoxy, polyester resin.	
4	Manufacturing of Novolac molding powder and its processing	
5	Injection molding of thermoplastics polymers like PP HIPS PBT etc	
6	To study Blown film Extrusion plant.	
7	To study thermoforming, corona discharge treatment method	
8	To study batch mixture and extrusion process.	
9	Compounding of Rubber using Two Roll Mill.	
10	Casting of epoxy, PMMA UPR resin etc	

List of Text Books/ Reference Books

1	Polymer Morphology: Principles, Characterization and Processing by Qipeng Guo Wiely 2016	
2	Encyclopedia of Composites, 2nd Edition by Stuart Lee Wiely 2012.	
3	Principles of polymer processing by Fenner R.T., Chemical publishing N.Y. (1979)	
4	Polymer Extrusion5th Edition by Chris Rauwendaal Hanser Publishers 2006	
5	SPE Injection molding and Extrusion by Chris Rauwendaal Hanser,Publications, 2000	
6	Encyclopedia of Polymer Science and Engineering, Johan Wiley and Sons,1988.	
7	Handbook of Thermoplastics, Second Edition Olagoke Olabisi by CRC Press,2015	
8	Thermoplastic Materials by Ibeh, Christopher C, Taylor Francis Inc 2013	

9	Plastics Materials, 7th Edition by John Brydson, Elsevier 1999	
10	Polymer Processing: Principles and Design 1st Edition by Donald G. Baird (Author), Dimitris I. Collias (Author	
11	Phenolic Resins chemistry, Applications, Standardization, Safety and Ecology by L.Kop,Springer-Verlag Berlin Heidelberg 2000	
12	Extrusion of Polymers: Theory and Practice by C.Chung, Hanser Publications,2000	

Course Outcomes (students will be able to…..)	
CO1	Perform polymer processing and compounding techniques, modern engineering tools like twin screw extruder injection molding etc.so as to be easily adaptable to polymer industry (K4)
CO2	Design the formulation with polymer, required suitable additive to make it perfect for the processing (K5)
CO3	Design the process parameters like temperature, pressure within realistic constraints of the experiment based on sample polymer (K5)
CO4	Discover the various processing techniques suitable for different Resins and polymers based on their types and final applications and to understand the practical problems related to the experiment. (K4)
CO5	Operate casting, thermoforming, corona discharge etc and modern engineering tools so as to be easily adaptable to polymer industry (K3)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO1	PO2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO9	PO1 0	PO1 1	PO12	PSO 1	PSO2
		K3	K4	K6	K5	K6	K3	K3+P	K3	K3+ A	K2+ A	K3	K6 +A+Ps y	K3	K4
CO1	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO2	K5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3	K5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO5	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
Cour se	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: PSP1504	Course Title Pr 5- Analysis and characterization of Resins and Polymers Lab	Credits = 2		
			L	T	P
	Semester: V	Total Contact Hours: 60 hrs	0	0	4

List of Prerequisite Courses

Analytical Chemistry Lab, Polymer science and Technology (PST1301), Polymer chemistry and Technology (PST1303), Technology of Thermoset (PST1506), Technology of Thermoplastics (PST1504), Raw material Analysis of resins and polymers (PSP1301), Analysis and characterization of resins and polymers lab (PSP1504)

List of Courses where this course will be Prerequisite

Project I (PSP1714), Project II (PSP1811) Research and Development in the area of Polymer Synthesis, analysis and characterization.

Description of relevance of this course in the B. Tech. (Surface Coating Tech.) Programme

To understand the laboratory scale quality control analysis. Research and Development of Polymer Synthesis. Ability to analyze and interpret data, process parameters. It helps to improve the ability to identify an unknown resin.

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	To determine Acid value, amine value, iodine value, hydroxyl, epoxy, SAP value, ester value of polymers.	1x4hr/Week
2	Refractive Index of resins	
3	Viscosity of resins by various analysis	
4	K- Value of PVC	
5	Analysis of emulsion polymer	
6	End group analysis of polymers	
7	To determine the melting range and softening range of polymers like polyolefines, styrenics, engineering polymers.	
8	Determine the chlorine content of the chlorinated polymers	
Total		60 Hrs

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

CO1	To characterize various resins and polymers (K4)
CO2	Calculate Acid value, amine value, iodine value, hydroxyl, epoxy, SAP value, ester value of polymers (K4)
CO3	Analyze and characterize polymers and resin for viscosity, refractive index, melting point etc. (K4)
CO4	Analyze various emulsions and resin (K4)
CO5	Collect various experimental results, manage to work effectively in team work and understanding of professional and ethical responsibility. (K5)
CO6	To analyze end groups of different resins and polymers (K4)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO1	PO2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO9	PO1 0	PO1 1	PO12	PSO 1	PSO2
		K3	K4	K6	K5	K6	K3	K3+P	K3	K3+ A	K2+ A	K3	K6 +A+Ps y	K3	K4
CO1	K4	3	3	2	3	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	3
CO3	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO4	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO5	K5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO6	K4	3	3	3	3	2	3	3	2	3	3	3	3	2	3
Cour se	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

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

Semester-VI

	Course Code: PET1502	Course Title: Spl 9- Additives and compounding of polymers	Credits = 4		
			L	T	P
	Semester: V	Total contact hours: 60	3	1	0

List of Prerequisite Courses

Polymer Chemistry and Technology (PST 1303), Polymer chemistry and Technology (PST1303), Raw material Analysis of resins and polymers (PSP 1301),

List of Courses where this course will be prerequisite

Compounding and Polymer Processing (PET1607), Project I (PSP1714), Environment Health and Safety of Polymers and Coating (PST1712), Evalution and testing of Polymers and Coatings (PST1711), Technology of Plastic Packaging (PET1712).

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

To give understanding of various additives used in polymer. To understand the chemistry and mechanism of additives

	Course Contents	Reqd. hours
1	An overview of additives, type of additives, main trends of additives and world market of additives	3
2	Fillers, mechanical properties due to fillers	3
3	UV stabilizers, Resistance to Heat Stabilizers	2
4	Flame Retardents	2
5	Conductivity, Antistatic and conductive Polymers	3
6	Curing & Curing agents	2
7	Coupling agents and Compatibilization agents	3
8	Plasticizer	2
9	Blowing Agents	2
10	Processing and modifier aid	2
11	Lubricants Mould Release Agents, antislip and antiblocking additives	
12	Appearance Colorants Pigments Dyes Special Effects, Appearance Black and White Pigmentation	3
13	Additives for rubber and recycling, mixing, compounding, Health and Safety	2
14	Polymer compounding and Requirements, Fundamentals of Compounding and processin, Essentials of Compounding like Ingredients, Formulation, Morphology, Temperature, Polymer Melt, Processing requirements	5
15	Mechanisms and theory of mixing, Basic Concepts, Dispersive Mixing of Solid Additives, Distributive Mixing Distribution, Functions and Measures of Mixing, Mixing of Miscible Fluids, Mixing of Immiscible Fluids	5
16	Blenders, Internal Mixers - Single Screw Extruders - Twin Screw Extruders - Intermeshing Twin Screw Extruders - Reciprocating Screws - Reactive Compounding - Farrel Continuous Mixer, Batch mixers.	5
17	Material Consideration, Properties and Characterization Solid additives (inorganic) - Solid additives (organic), Compatibalizer (mechanisms, theory) - Material Consideration for Mixing at Nanoscale, Effect of Mixing on Properties of Compounds -Effect of Mixing on Rubber Properties	5

18	Reactive compounding, Phase Morphology Variations in Processing Operations, High-performance compounding, Various Feeding processes.	5
19	Classification and Discussion of Melting Mechanisms, Devolatilization Equipment	3

List of Text Books/ Reference Books

1	Text book of Polymer Science by Billmeyer, John Wiley ans Sons 1984.
2	Additives for plastic by Raymond B. Seymour, Academic Press 1978.
3	Additives for plastic handbook by John Murphy, Elsevier advance technology 1996.
4	Determination of Additives in Polymers and Rubbers by T R. Crompton, Rapra Technology Ltd 2007.
5	Polymer Modifiers and Additives by Richard F. Grossman , John T. Lutz Jr, CRC Press 2000.
6	The Complete Technology Book on Industrial Polymers, Additives, Colourants and Fillers by NIIR Board of Consultants & Engineers. Asia Pacific Business Press Inc. 2006.
7	Additives in Polymers: Industrial Analysis and Applications by Jan C. J. Bart John Wiley and Sons 2005.

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

CO1	Discuss about polymer additives depending upon their requirement and final applications (K2)
CO2	Use proper dosage of additives based on their requirements and chemistries (K3)
CO3	Distinguish between the various additive chemistries (K4)
CO4	Solve the problems during processing, end application by selecting proper additives, their dosage, combination based on requirement (K4)
CO5	Formulate the batch for any processing with proper quantity of each and every ingredient such as fillers and additives etc. (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+P	K3	K3+A	K2+ A	K3	K6 +A+Psy	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	3	3	3	3	3	2	3	3
CO3	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO4	K4	3	3	2	3	2	3	3	3	3	3	3	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: PST1609	Course Title: Spl 10 - Polymer Processing	Credits = 3		
			L	T	P
	Semester: VI	Total contact hours: 45	2	1	0

List of Prerequisite Courses

Polymer science and Technology (PST 1301), Polymer chemistry and Technology (PST 1303), Raw material Analysis of resins and polymers (PSP1301), Analysis and characterization of Resins and polymers Lab (PSP1504)

List of Courses where this course will be prerequisite

Environment Health and Safety of Polymers and Coating (PST1712), Evaluation and testing of Polymers and Coatings (PST1711), and Technology of Plastic Packaging (PET1712).

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

The course gives an insight into the processing techniques of polymers. It will help in troubleshooting the various problems faced during processing. The need for compounding of polymer and techniques involved.

	Course Contents	Reqd. hours
1	Extruders: single screw and twin-screw extruders, Film blowing, co-extrusion of multilayered films, Fiber spinning, Pipe extrusion, Extrusion of profiles, co-extrusion of pipes, Extrusion of cable material, extrusion of sheet, Calendaring, Thermoforming	10
2	Molding: Injection molding,	5
3	Blow molding, Compression molding	10
4	Injection stretch blow molding, Resin transfer molding, Gas and water assisted injection molding and other three-dimensional molding.	10
5	One-dimensional process is like Coating and Adhesives.	10
	Total	45

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

CO1	Process the polymers by various technique and able to solve the problems observed during processing. (K4)
CO2	Analyze effect of temperature during processing, screw dimensions, the rate of addition as well as concentration of addition of filler etc. (K4)
CO3	Formulate the master batches and process it using various polymer processing 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+P	K3	K3+A	K2+ A	K3	K6 +A+Psy	K3	K4
CO1	K4	3	3	3	3	2	3	1	3	3	3	3	2	3	3
CO2	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO3	K5	3	3	3	2	3	2	2	3	3	3	3	3	2	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: PST1712	Course Title: Spl 11- Environment Health and Safety of Polymers and Coating	L	T	P
	Semester: VI	Total Contact Hours: 60	2	1	0

List of Prerequisite Courses

Polymer chemistry and Technology (PST 1303), High Polymer Chemistry (PST1404), Paint Technology II (SCT1610)

List of Courses where this course will be Prerequisite

Synthesis of Polymer and resins at laboratory scale and at industrial level. For recycling industry, plastic waste management

Description of relevance of this course in the B. Tech. (Surface Coating Tech.) Programme

To give understanding of basics of care to be taken while handling polymer and resin. Safety and hazardous of their manufacturing processes. Knowledge of subject will help student to see the environmental impact by plastic and resin. Current understanding of the benefits and concerns surrounding the use of plastics and look to future priorities, challenges and opportunities. It is evident that plastics bring many societal benefits and offer future technological and medical advances. However, concerns about usage and disposal are diverse and include accumulation of waste in landfills and in natural habitats, physical problems for wildlife resulting from ingestion or entanglement in plastic, the leaching of chemicals from plastic products and the potential for plastics to transfer chemicals to wildlife and humans.

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	Introduction to Health and safety	1
2	Plastics and coatings in the society	1
3	Plastics and coating in the environment	2
4	Plastic waste and coating waste management	2
5	Plastic waste in the marine and terrestrial environment	3
6	Plastic and coating material degradation Regulations for hazardous chemicals in articles/plastic products, coated article.	4
7	Plastic and coating composition and hazardous chemicals like phthalate base plasticizers and Release potential Degradation products Exposure	5
8	Effects Hazard and risk assessment.	4
9	Toxicity Product leaching tests	2
10	Toxicity Identification Evaluations (TIEs)	2
11	Hazard ranking and assessment of plastic and coating Chemicals in plastic and coating formulations	4
12	Polymer Production, Paint production and hazard classifications	4
13	Toxicity of discarded electronic products	3
14	Recycling methods of plastic waste and coating waste and their environmental impact	5
15	Health safety and environment related to Solvent based coating UV coatings	5
16	Hygiene coatings Industrial coatings wood coatings, marine coatings etc.	5
17	Cytotoxicity of nano particles	2
18	Environment Health and Safety Indian and world Policy of Polymers and Coating	3
19	A more sustainable use of plastics and coatings.	3
	Total	**60**

List of Text Books/ Reference Books

1	Plastics Materials by *J.A. Brydson*, Butterworth-Heinemann, 1999 - Technology & Engineering - 920 pages
2	Handbook of Industrial Chemistry: Organic Chemicals by Mohammad Farhat Ali, Ph.D., Bassam M. El Ali, Ph.D., James G. Speight, Ph.D. McGraw-Hill Education: New York, Chicago, San Francisco, Athens, London, Madrid, Mexico City, Milan, New Delhi, Singapore, Sydney, Toronto, 2005.
3	SPI Plastics Engineering Handbook of the Society of the Plastics Industry, Inc. by Berins, Michael L., 1991.

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

CO1	Apply knowledge to understand the environmental and safety issues in chemical industry. (K3)
CO2	Examine various handling precautions for safely handling monomer and resins (K4)

CO3	Plan activities to reduce the impact of final product of polymer and coating on environment after use and its waste management. (K5)
CO4	Identify, formulate and know Polymer & Resins (K5)
CO5	Practice safety rule and regulation for polymer and resins. Manufacturing process and application impact and health hazards study of polymer and resins. (K3)
CO6	Discuss various hazard, risk and toxicity evaluation and assessment techniques (K2)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO1	PO2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO9	PO1 0	PO1 1	PO12	PSO 1	PSO2
		K3	K4	K6	K5	K6	K3	K3+P	K3	K3+ A	K2+ A	K3	K6 +A+Ps y	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	3
CO3	K5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	K5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO5	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO6	K2	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Cour se	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: PET1815	Course Title: Spl 12 - Composites and Post Polymer Processing	Credits = 4		
			L	T	P
	Semester: VI	Total contact hours: 60	3	1	0

List of Prerequisite Courses

Polymer science and Technology (PST 1301), Polymer chemistry and Technology (PST 1304) Compounding and Polymer Processing (PET1607), Additives for Polymers (PET1507),

List of Courses where this course will be prerequisite

Composite manufacturing Industry, Printing Industry, Decoration of Plastics. Technology of Plastic Packaging (PET1712)

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

To give understanding of basics of composites, matrix, reinforcement, mechanics of fiber reinforce composite, Their manufacturing processes, properties and applications. Processing of various types composites. Knowledge of subject will help student to carry out research and development in the areas of high performance Polymers, nanocomposites, polymer composites Composite processing, aerospace applications etc. To make them aware of Environmental concerns of composite products, Recycling of composites. To give understanding of Industrial process for Joining methods and decoration of Plastics, Troubleshooting guide etc.

	Course Contents	Reqd. hours
1	Definition of fiber reinforcement composites, Its constituents, General Characteristics Applications Material Selection Process	5
2	Reinforcement such as inorganic material like glass fiber and their types, boron fiberetc, Surface Treatments of fibers.	5
3	Reinforcement such as organic material like carbon fiber, aramide fibers, natural fibers etc	5
4	Thermoset and thermoplastic matrix, Fillers and Other Additives, Recycling and environmental concerns of fiber reinforced composites	5
5	Incorporation of Fibers into Matrix Prepregs, Sheet-Molding Compounds, DMC Incorporation of Fibers into Thermoplastic Resins	5
6	Fiber Content, Density, and Void Content, Composites Mechanics	5
7	Composite manufacturing process like Pultrusion, Pull winding, Handlay up technique, Resin Transfer molding, vacuum bag molding etc	5
8	Composite Testing destructive and non-destructive, Degree of Cure, Viscosity, Gel-Time Test, Shrinkage	5
9	Post polymer processing techniques such as Electroplating, Vacuum metallization	5
10	Joining, Welding, Bonding of polymers	5
11	Hot foil stamping process, In mold decoration of plastic	5
12	Printing on Plastic substrates like screen printing, offset printing, flexo/gravure printing	5

List of Text Books/ Reference Books

1	Encyclopedia of Composites,2nd Edition by Stuart Lee Wiely 2012

2	Fundamentals of Fibre Reinforced Composite Materials, Bunsell, Anthony R., Renard, J., Berger, M.H.Taylor Francis Ltd 2000
3	Encyclopedia of Polymer Science and Technology, Johan Wiley and Sons, Inc1965
4	Joining of Plastics By K.W. Allen Smithers Rapra Publishing 1988
5	Plastics finishing and decoration by Donatas Satas,Van Nostrand Inc, 1986
6	Designing with Plastics and Composites: A Handbook By Donald Rosato Springer Science & Business Media 2014
7	Composite Polymeric Material, R. P. Sheldon, Applied SciencePublishers,1982
8	Composites: Design Guide, Industrial Press Inc, 1987
9	Composite Material Handbook, M. M. Schwartz, McGraw-Hill company, 1984
10	**Decoration and Assembly of Plastic PartsBy Edward A. Muccio, ASM International 1999.**
Course Outcomes (students will be able to…..)	
CO1	Apply the concept of fiber reinforce composites, practice the reinforcement manufacturing of its constituents like glass fibers carbon fibers etc (K3)
CO2	Analyze the polymer Composites, Mechanics their structure properties and relation as well as to analyze and interpret data, their practical applications of Composite in real world and compare recycling methods of composite and their impact on environment, engineering community and society. (K4)
CO3	Formulate and know practical applications of Polymer Composites (K5)
CO4	Design Joining, Welding, decoration and coating of plastic substrate, so as to be easily adaptable to polymer industry, coating industry, Composite industry. (K5)
CO5	Identify the defects observed during processing and suggest remedies for the same (K2)

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	PO9	PO1 0	PO1 1	PO12	PSO 1	PSO 2
		K3	K4	K6	K5	K6	K3	K3+P	K3	K3+ A	K2+ A	K3	K6 +A+Ps y	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	3
CO3	K5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	K5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO5	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
Cour se	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 ContributionK, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

	Course Code: PST1610	Course Title: Honors Course 2 – Biopolymers	Credits = 3		
			L	T	P
	Semester: VI	Total contact hours: 45	2	1	0

List of Prerequisite Courses

Polymer chemistry and Technology (PST 1303), High Polymer Chemistry (PST1404), Paint Technology II (SCT1610)

List of Courses where this course will be prerequisite

Synthesis of Polymer and resins at laboratory scale and at industrial level. For recycling industry, plastic waste management

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

The course on Biopolymers is highly relevant as it equips students with a deep understanding of the environmental impact of polymer industries and the significance of sustainable materials in various engineering applications. With the knowledge gained, B. Tech. students can contribute to designing eco-friendly products, developing efficient waste management strategies, and implementing green technologies, fostering a sustainable approach in the field of engineering and technology.

	Course Contents	Reqd. hours
1	Environmental issues related to polymer industry, Design for environment, Life cycle approach, Contribution to energy, feedstock, transport, Gross and net calorific values.	10
2	Polymers in packaging, Common packaging plastics, Waste Stream Categories, Source reduction, Reuse and recycling. Separation and Identification of Plastics Process Technologies for Plastics Recycling	10
3	Polymers in agriculture, Greenhouse films, Plastics in Mulch films, Plastics in silage, Disposal of waste plastic films, Drip irrigation system**.**	5
4	Flammability of polymers, Release of polymer vapours, Ignition, Combustion of polymer vapours, Fire propogation, Thermal destruction of waste plastics.	10
5	Biopolymers, biobased, bio sourced, compostable, Carbohydrates, polysaccharides, lactides,	5
6	Bio additives, starch, cellulose, chitosan, vegetable oils	5

List of Text Books/ Reference Books

1	"The Environment and Sustainable Development" - Adisa Azapagic, Alan Emsley, Ian Hamerton, University of Surrey, Guildford, UK, Edited by Ian Hamerton
2	Handbook of Biopolymer-Based Materials: From Blends and Composites to Gels and Complex Networks, By Prof. Dr. Sabu Thomas, Prof. Dominique Durand, Prof. Christophe Chassenieux, Dr. P. Jyotishkumar, 2013
3	Handbook of Biopolymers and Biodegradable Plastics, By Sina Ebnesajjad, December 2012

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

CO1	Explain the environmental impact of polymer industries and apply the principles of design for the environment and life cycle approach. (K2)
CO2	Illustrate sustainable packaging strategies, including source reduction, reuse, and recycling of common packaging plastics. (K3)
CO3	Analyze the application of polymers in agriculture, such as greenhouse films, mulch films, silage protection, drip irrigation systems, and discuss waste plastic disposal methods. (K4)

CO4	Compare and evaluate the flammability and thermal properties of polymers, along with measures to mitigate flammability risks and thermal destruction of waste plastics. (K3)
CO5	Develop a comprehensive understanding of biopolymers, including biobased, bio-sourced, and compostable types, and discuss the use of carbohydrates, polysaccharides, lactides, hydroxy-alkanoates, and bio isoprene, as well as bio additives like starch, cellulose, chitosan, and vegetable oils for enhancing biopolymer properties. (K5)

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	PO9	PO1 0	PO1 1	PO12	PSO 1	PSO 2
		K3	K4	K6	K5	K6	K3	K3+P	K3	K3+ A	K2+ A	K3	K6 +A+Ps y	K3	K4
CO1	K2	3	3	2	3	3	2	2	2	3	3	3	3	3	3
CO2	K3	3	3	3	3	3	3	3	3	3	3	3	1	3	3
CO3	K4	3	3	3	2	3	3	3	3	3	3	3	3	3	3
CO4	K3	3	3	3	3	3	3	3	1	3	2	3	3	3	3
CO5	K5	3	3	3	3	3	3	3	3	3	3	2	3	3	3
Cous e	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

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

List of Prerequisite Courses		
	Process Calculations, Transport Phenomena, Chemical Engineering Operations, Chemical Reaction Engineering	
List of Courses where this course will be prerequisite		
	Other B. Tech. courses	
Description of relevance of this course in the B. Tech. Program		
Chemical Engineering lab provides students the firsthand experience of verifying various theoretical concepts learnt in theory courses. It also exposes them to practical versions of typical chemical engineering equipment's and servers as a bridge between theory and practice. This particular lab focuses on fluid dynamics, distillation, filtration, drying and sedimentation.		
	Course Contents (Topics and subtopics)	**Reqd. hours**
1	4 - 6 Experiments on fluid dynamics and heat transfer	24
2	3 - 5 Experiments on Chemical Engineering Operations	16
3	2 – 4 Experiments on Reaction Engineering	12
4	1 – 3 Experiments on process dynamics and control	8
	Total	**60**
List of Text Books/ Reference Books		
1	McCabe W.L., Smith J.C., and Harriott P. Unit Operations in Chemical Engineering, 2014	
2	Bird R.B., Stewart W.E., and Lightfoot, E.N. Transport Phenomena, 2007	
3	Coulson J.M., Richardson J.F., and Sinnott, R.K. Coulson & Richardson's Chemical Engineering: Chemical engineering design, 1996.	
4	Green D. and Perry R. Perry's Chemical Engineers' Handbook, Eighth Edition, 2007.	
Course Outcomes (students will be able to…..)		
1	Learn how to experimentally verify various theoretical principles	
2	Visualize practical implementation of chemical engineering equipment's	
3	Develop experimental skills	

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

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

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

	Course Code: PEP1606	Course Title: Pr 6- Identification of Resins and Polymers Lab	Credits = 2		
			L	T	P
	Semester: VI	Total contact hours: 60 hrs	0	0	4

List of Prerequisite Courses

Polymer science and Technology (PST 1301), Polymer chemistry and Technology (PST 1302), Technology of Thermoset (PST 1506), Technology of Thermoplastics (PST1504) Raw material Analysis of resins and polymers (PSP 1301)

List of Courses where this course will be prerequisite

Project I (PSP1714), Project II (PSP1811) Environment Health and Safety of Polymers and Coating (PST1712), Evolution and testing of Polymers and Coatings (PST1711),

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

To give understanding of laboratory scale synthesis processes, properties and applications of various types of thermoplastic and thermoset polymers. Knowledge of subject will help student to carry out Production, Research and development in the areas of polymer Synthesis, Polymer nanocomposites, coating formulation developement, Fiber reinforced composites, Polymer processing etc. To make them aware of Environmental concerns of Polymer Synthesis. Handling Hazards of raw materials monomers, Work ethics in group, Ability design and conduct experiments, Ability to analyze and interpret data, process parameters. To understand and do calculations observations formulations involved team work and understanding practical problems related to the experiment

	Course Contents	Reqd. hours
	Identification of Polymers like	1x4hr/Week
	Virgin PP, LDPE, HDPE, LLDPE	
	Virgin PS, HIPS, ABS, SAN	
	Virgin PVC, PVF, PVB, CPVC	
	Phenolic resin, MF, UF, Alkyds, Epoxy resin Rosin Shellac	
	Cellulosic polymers like NC, CAB, HEC CMC	
	Elastomers like natural rubber, nitrile rubber, silicone rubber, SBR	
	Engineering polymers like PA Polyesters PC polyacetals	
	Speciality polymer like PPO PEEK	

List of Text Books/ Reference Books

1	Polymer Chemistry: A Practical Approach (The Practical Approach in Chemistry Series) 1st Edition Fred J. Davis Oxford University Press 2004.
2	A Practical Course in Polymer Chemistry S. H. Pinner, Borough
3	Polytechnic, London, Pergamon Press,he., New York, 1961
4	Polymer Science by Gowarikar,John Wiley and Sons 1986.
5	Encyclopedia of Polymer Science and Technology, Johan Wiley and Sons, Inc 1965.
6	Testing of Paints by S.Patil, Current Awareness Service Publisher, 1993.
7	Polymer Analysis by Barbara H. Stuart, John Wiley & Sons, 2002.
8	Polymer Synthesis and Characterization by Stanley R. Sandler, Wolf Karo, Jo-Anne Bonesteel and Eli M. Pearce, Academic Press 1998.

Course Outcomes (students will be able to…..)	
CO1	Analyze unknown polymer sample in any given form. (K4)
CO2	Design and test polymer sample to differentiate them from each other such as PVC, PP, PE, carry out elemental analysis, analysis of results and draw a conclusion from the same. (K5)
CO3	Plan a systematic testing route to identify any unknown sample of polymer, perform the step by step analysis and reaching to the conclusion by observing combine effects of all results (K5)
CO4	Analyze thermal characterization, solubility, correlation of solubility and structure of polymers, flammable or inflammable test various polymers. (K4)
CO5	Collect the results from various test and apply the logic from obtained results to interpret the unknow polymer (K3)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO1	PO2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO9	PO1 0	PO1 1	PO12	PSO 1	PSO2
		K3	K4	K6	K5	K6	K3	K3+P	K3	K3+ A	K2+ A	K3	K6 +A+Ps y	K3	K4
CO1	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO2	K5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3	K5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
Cour se	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: PEP1608	Course Title: Pr 7- Recycling and reprocessing of polymers	Credits = 2		
			L	T	P
	Semester: VI	Total contact hours: 60 hrs	0	0	4

List of Prerequisite Courses

Polymer science and Technology (PST 1301), Polymer chemistry and Technology (PST 1302), Technology of Thermoset (PST 1506), Technology of Thermoplastics (PST1504) Raw material Analysis of resins and polymers (PSP 1301)

List of Courses where this course will be prerequisite

Project I (PSP1714), Project II (PSP1811) Environment Health and Safety of Polymers and Coating (PST1712), Evolution and testing of Polymers and Coatings (PST1711),

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

The course "Recycling and Reprocessing of Polymers" holds great significance in today's world due to the mounting concerns about environmental sustainability and waste management. With the ever-increasing consumption of plastic-based products, proper recycling and reprocessing techniques are essential to minimize environmental pollution and reduce the strain on natural resources. This course equips students with knowledge of various recycling methods, their efficiencies, and limitations, enabling them to make informed decisions and contribute to a more sustainable future. Moreover, it prepares them to address the challenges faced in the recycling industry and explore innovative solutions to tackle plastic waste. As industries and individuals strive to adopt more eco-friendly practices, professionals trained in this field will play a crucial role in driving the transition towards a circular economy and a greener planet.

	Course Contents	Reqd. hours
	1. Recycling 2. Chemical recycling of PET 3. Aminolysis of PET 4. Glycolysis of PET 5. Study of impact of various parameters on depolymerisation of PET 6. Chemical recycling of PU 7. Mechanical recycling of polymers such as Olifins, ABS, PS and various other polymers	**1x4hr/Week**

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

CO1	Explain the principles and processes involved in recycling of polymers, focusing on PET and PU, and their environmental impact. (K2)
CO2	Illustrate the chemical recycling techniques, including aminolysis and glycolysis of PET, and compare them with mechanical recycling methods for various polymers such as Olefins, ABS, and PS. (K3)
CO3	Develope an understanding of the factors influencing the depolymerization of PET and evaluate the impact of different parameters on the recycling efficiency. (K4)
CO4	Analyze the challenges and opportunities associated with the recycling and reprocessing of polymers, discussing their economic and environmental implications. (K5)
CO5	Determine the best-suited recycling approach for specific types of polymers, considering factors like polymer composition, contamination levels, and end-use applications. (K5)

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	PO9	PO1 0	PO1 1	PO12	PSO 1	PSO 2
		K3	K4	K6	K5	K6	K3	K3+P	K3	K3+ A	K2+ A	K3	K6 +A+Ps	K3	K4

													y		
CO1	K2	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO2	K3	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO3	K3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	K4	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO5	K5	3	2	1	2	1	3	3	3	3	3	3	1	3	2
Cour se	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

Semester-VII

	Course Code: PST1711	Course Title: Spl 13 - Evaluation and testing of polymer and coatings	L	T	P
	Semester: VII	Total Contact Hours: 45	2	0	0

List of Prerequisite Courses

Polymer science and Technology (PST1301), Polymer chemistry and Technology (PST1303) Technology of Thermoset polymers (PST1506), Analysis and characterization of resins and polymers lab (PSP1504)

List of Courses where this course will be Prerequisite

Project I (PSP1714), Project II (PSP1811), Analysis and characterization of Resins and polymers Lab (PSP1504)

Description of relevance of this course in the B. Tech. (Surface Coating Tech.) Programme

Student will able to design the product. Suggest the product for suitable applications. Subject will help student to carry out work in the area of material sciences

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	Glass transition temperature, melting temperature, heat distortion temperature, etc. Sample preparation, standardization, conditioning of sample, processability test, dynamic mechanical analysis, melt flow rate, Vicat softening temperature. Study of a dilatometer. Study of thermo-chemical analysis and differential scanning calorimeter, GPC.	5
2	Fourier transform infrared spectrometry, Ultraviolet - visible spectrometry, Nuclear magnetic resonance spectrometry, Mass spectrometry, X-ray diffraction spectrometry, Gas chromatography. Scanning electron microscopy, travelling electron microscope Molecular weight determination Viscosity of polymer solutions and polymers: Their significance, application to polymers using different viscometers.	5
3	Surface volume resistivity, Breakdown voltage, Arc resistance, Tan Delta, Tensile strength, flexural strength, impact resistance, percentage elongation, tear test, fatigue and wear, hardness, compressive strength time dependant properties like creep, stress, relaxation, etc. Refractive index, gloss, color matching, haze, limiting oxygen index, smoke density, Tests for adhesives Identification of polymers using chemical methods ESCR.	5
4	Analysis of Paints, Theory and practice in testing of paints, Paint film defects and their remedies. Analytical instruments in paints technology, UV, IR, GCMS, X-Ray Diffraction, LCMS MS, Microscopy	5
5	Particle size analysis of pigments, Accelerated weathering of paints Evaluation and Testing of Synthetic Enamel, Primer, Emulsion paint, Intermediate Coat.	5
6	NVM, Viscosity, WPL, Grind, Hiding, Drying Time, Scratch Hardness, Impact Test, Flexibility, Gloss Dry Film Thickness.	5
7	Acid Alkali, and Water Resistance, Adhesion As per IS101, Corrosion Resistance by Salt Spray and Humidity Cabinet	5
8	Accelerated Exposure of Paints in QUV and Atlas Apparatus, % Solids, Scrub Resistance, Stain Resistance	5

9	Rheology of Paint system, Colour Matching of Synthetic Enamel, Plastic Emulsion Paint and Distemper.	5
Total		**45**
List of Text Books/ Reference Books		
1	Polymer Chemistry: A Practical Approach (The Practical Approach in Chemistry Series) 1st Edition Fred J. Davis Oxford University Press 2004	
2	A Practical Course in Polymer Chemistry S. H. Pinner, Borough Polytechnic, London, Pergamon Press, he., New York, 1961	
3	PVC Technology, A. S. Athalye and Prakash Trivedi, Multi-Tech Publishing Co,1994	
4	Polymer Science by Gowarikar, John Wiley and Sons 1986.	
5	Encyclopedia of Polymer Science and Technology, Johan Wiley and Sons, Inc1965	
6	Encyclopedia of Polymer Science and Engineering, Johan Wiley and Sons, Inc1988	
7	PVC Technology, A. S. Athalye and Prakash Trivedi, Multi-Tech Publishing Co,1994	
8	Principles of polymerization, G.Odian, Wiley – Interscience (1981)	
9	PVC Technology 4th edition by W. V. TitowElsevier Applied Science	
Course Outcomes (Students will be able to…..)		
CO1	Interpret the significance for polymer characterization technique such as NMR (K3)	
CO2	Analyse and understand the properties of polymers such as mechanical, electrical etc. hence they can suggest the various polymer depending upon specific application (K4)	
CO3	Illustrate the significance of rheology is well understood by student and correlation of rheology and temperature is understood hence student can apply this knowledge while processing of polymer (K3)	
CO4	Interpret theoretically importance of FTIR, NMR etc. hence in case of any hand on experiment with such equipment they can relate this knowledge to practice. (K4)	
CO5	Relate theoretical knowledge to identify any unknown sample. (K4)	
CO6	Analyze and evaluate variety of wet paint and film properties including mechanical, chemical, corrosion, adhesion and rheology (K4)	

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

		PO 1	PO2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO9	PO1 0	PO1 1	PO12	PSO 1	PSO2
		K3	K4	K6	K5	K6	K3	K3+P	K3	K3+ A	K2+ A	K3	K6 +A+Ps y	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	3
CO3	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO4	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO5	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO6	K4	3	3	3	2	3	3	3	3	3	3	3	2	3	3
Cour se	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: PET1701	**Course Title: Spl 14 -Technology of Plastic Packaging**	**Credits = 2**		
			L	**T**	**P**
	Semester: VII	**Total contact hours: 30**	**2**	**0**	**0**

List of Prerequisite Courses		
	Technology of Thermoplastics (PST 1504), Additives in Polymers (PET 1507), Compounding and Polymer processing (PET1607),	
List of Courses where this course will be prerequisite		
	Project I (PSP1714), Project II (PSP1811) Specialty Polymers (PET 1816), Research and development of new polymer product.	

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

The course helps us to understand the various means of packaging. It also tells us about various processing techniques that are used for manufacturing the packaging. Trouble-shooting the problems with packaging

	Course Contents	**Reqd. hours**
1	Introduction of plastic packaging, basic concept and definitions, Plastics performance all wrapped up, ASTM terminology, Indian scenario, Selection criteria for flexible packing materials	**5**
2	Manufacturing Multilayer films, laminates, Lamination Techniques troubleshooting Printing on films/ laminates, print evaluation, troubleshooting in print lamination, extrusion coating and lamination	**5**
3	Designing a packaging line, important accessories for packaging machine, sealing methods. Product performance requirements for laminates. Flexible pouches. Aluminum foil-based laminates. co-extruded films / sheets. Barrier packaging.	5
4	Environment regulations and packaging, Testing of packaging material Foam packaging	5
5	Mass transfer in polymeric packaging systems like diffusion sorption permeation and shelf life	5
6	Adhesion Adhesives and Heat sealing	2
7	Applications of packaging in Food, Pharma, Polymer industries.	3

List of Text Books/ Reference Books

1	Technology of Polymer Packaging Paperback – Import, Jun 2015 by Arabinda Ghosh.
2	Plastics in Packaging: Western Europe and North America (RAPRA market report) Paperback – Import, 1 Jun 2002 by Richard Beswick (Author), David J. Dunn (Author)
3	Plastics in Packaging by Beswick, Richard, Dunn.
4	Plastic Packaging material for food by O.G.Pirinjer, Wiley-VCH. 2000
5	Packaging technology by Anne Emblem and Henry Emblem, Woodhead publishing limited, 2012
6	Technology of Polymer Packaging by Arabinda Ghosh, Hanser; First edition (June 1, 2015) Polymers for Packaging Applications by Sajid Alavi, Sabu Thomas, K. P. Sandeep, Nandakumar Kalarikkal, Jini Varghese, Srinivasarao Yaragalla, Apple Academic Press, 2014

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

CO1	Explain the concept of adhesion, adhesive, adhesive forces (K2)

CO2	Describe the concept of packaging line, tools and accessories of packaging machine and line, concept of printing inks (K2)
CO3	Explain the importance of packaging in various sectors (K2)
CO4	Compare various packaging materials and types such as multilayers, laminates etc. Test the various packaging based on ASTM standards (K4)
CO5	Design the packaging for particular application considering conventional routes as well as recent developments such as biodegradable packaging, active packaging, smart packaging etc (K5)

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	PO9	PO1 0	PO1 1	PO12	PSO 1	PSO 2
		K3	K4	K6	K5	K6	K3	K3+P	K3	K3+ A	K2+ A	K3	K6 +A+Ps y	K3	K4
CO1	K2	3	3	1	2	1	3	3	3	3	3	3	1	3	2
CO2	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO3	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO4	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO5	K5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Cour se	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: PET1816	Course Title: Dept Elective 3- Specialty Polymers 50 marks)	Credits = 3		
			L	T	P
	Semester: VII	Total contact hours: 45	2	1	0

List of Prerequisite Courses

Technology of Thermoplastics (PST 1504), Technology of Thermosets (PST 1506), Polymer Science and Technology (PST 1301), Polymer Chemistry and Technology (PST 1303), Compounding and Polymer processing (PET1607), Structure property Relationship of Polymers (PST1609)

List of Courses where this course will be prerequisite

Research and Development of Synthesis of polymer.

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

Able to learn about the manufacturing processing of Specialty Polymers

	Course Contents	Reqd. hours
1	Specialty plastics- PES, PAES, PEEK, PEAK etc	5
2	Processing, properties and its application	5
3	Introduction to Polymer blends & alloys & polymer composites and nanocomposites	5
4	SANP Hydrogels	5
5	Hyper branched polymers	
6	Shape memory Polymers	5
7	Specialty polymers such as LCPs & conducting polymers,	5
8	Inorganic polymers, IPNs, smart polymers, etc.	5
9	polymers for fuel cells	5

List of Text Books/ Reference Books

1.	Encyclopedia of Polymer Science and Technology, Johan Wiley and Sons, Inc 1965.
2.	Encyclopedia of Polymer Science and Engineering, Johan Wiley and Sons, Inc 1988.
3.	Specialty Polymers: Materials and Applications BY Faiz Mohammad, I. K. International Pvt Ltd, 2007
4	Industrial Polymers, Specialty Polymers, and Their Applications by Manas Chanda, Salil K. Roy, CRC Press July 18, 2008.
5	Specialty Polymer Additives, S. Al Malaika, Amos Golovoy, C. A Wilkie, Wiley, 15-Aug-2001
6	Speciality polymers by Dyson R. W., Chapman and hall publications, 1982.
7	An Introduction to Speciality Polymers by Norio Ise, Iwao Tabushi, CUP Archive, 1983

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

CO1	Categorize various specialty of polymers (K4)
CO2	Discover and learn Processing of specialty of polymers (K4)
CO3	Formulate the speciality polymer-based formulation based on their application (K5)
CO4	Prepare and synthesis speciality polymers as well as learn about their tread names (K5)
CO5	Discover smart applications of polymers (K4)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO1	PO2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO9	PO1 0	PO1 1	PO12	PSO 1	PSO2
		K3	K4	K6	K5	K6	K3	K3+P	K3	K3+ A	K2+ A	K3	K6 +A+Ps y	K3	K4
CO1	K4	3	3	2	3	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	3
CO3	K5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	K5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO5	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
Cour se	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

PEC	Course Code: PHT1440	Course Title: Intellectual Property Rights	Credits = 2		
			L	T	P
	Semester: VII	Total Contact Hours: 30	1	1	0

List of Prerequisite Courses
Nil

List of Courses where this course will be Prerequisite
Nil

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

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	Introduction to Intellectual Property: overview describing definition, need and evolution	2
2	IPR related laws: Biodiversity	2
3	Introduction to WIPO and Treaties under WIPO	2
4	**Type of Intellectual Property: Copyright** Introduction, Process of filing, rights achieved	2
5	**Type of Intellectual Property: Trademarks** Introduction, Process of filing, rights achieved	2
6	**Type of Intellectual Property: Geographical Indications** Introduction, Process of filing, rights achieved	2
7	**Type of Intellectual Property: Industrial Design** Introduction, Process of filing, rights achieved	2
8	**Type of Intellectual Property: Trade Secret** Introduction, Process of filing, rights achieved	3
9	**Type of Intellectual Property: patent** Introduction Patent and traditional knowledge Indian patent Act Process of filing Rights achieved	4
10	Patentability w.r.t. regional requirements	2
11	Patent filing under Paris Convention Treaty (PCT)	3
12	Role of IPR in Pharmaceuticals	4
	Total	**30**

List of Text Books/Reference Books	
1	All documentation from World Intellectual Property Organization (www.wipo.int)
2	Indian Patent Act (www. ipindia.nic.in)
3	Pharmaceutical Product Development: Insights into Pharmaceutical Processes, Management and Regulatory Affairs, Patravale V, Rustomjee M, Dsouza J. 2016, CRC press

Course Outcomes (Students will be able to…..)	
CO1	explain various types of Intellectual Property Rights.(K2)
CO2	explain the importance of Intellectual Property Rights in relevance to pharmaceutical inventions.(K2)
CO3	implement the desired practises during professional activities for preserving IPRs.(K4)
CO4	interpret and analyze reactions having different functionalities, deduce and solve problems related to the reactions as well as apply them, if need be.(K4)

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

	Course Code: PET2502	Course Title: Smart Polymers	Credits = 3		
			L	T	P
	Semester: III	Total Contact Hours: 30	1	1	0

List of Prerequisite Courses

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

	Course Contents (Topics and Subtopics)	Required Hours
1	Definitions, shape memory polymers**,** polymers responding to various stimuli such as heat, light, pressure, fluids/chemicals etc.	10
2	Conducting polymers classification/ requirements for conductivity, doping of polymers, light emitting polymers, liquid crystal polymers, and their classification (LCPs).	10
3	Advantages & limitations of these polymers. Synthesis of some of these polymers & their structure-property relationships.	10
	Total	**30**

List of Textbooks/Reference Books	
1	Smart Polymers: Applications in Biotechnology And Biomedicine by Igor. Galaev, Bo Mattiasson
2	Smart polymers for bioseparation and bioprocessing by Igor Yu Galaev, Igor Galaev, Bo Mattiasson
3	Coated Textiles: Principles and Applications by Ashish Kumar Sen
4	Bioconjugation protocols: strategies and methods by Christof M. Niemeyer
Course Outcomes (Students will be able to…..)	
CO1	Describe the concept of smart polymers like shape memory, which respond to different stimuli like heat, light, pressure etc. The principle and mechanism of smart polymers. (K2)
CO2	Relate the classification of conducting polymers with their application and use. Principle and mechanism of conducting polymers along with doping of polymers to make them conduct. (K3)
CO3	Illustrate the light emitting polymers and liquid crystal polymers along with their classification. (K4)
CO4	Summarise the advantages and disadvantages of these polymers along with their structural property relationship. (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	2	3	2	3	3	3	2	1	1	1	1	2	2	2
CO2	K3	3	3	1	1	1	3	3	1	1	2	2	3	3	3
CO3	K4	3	2	2	3	2	3	3	2	2	1	1	3	3	3
CO4	K2	2	3	3	2	3	1	3	3	2	2	3	2	2	1
Course	K4	3	3	3	3	3	3	3	3	2	2	3	3	2	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: PST1714	Course Title: Honors Course III- Nanomaterials and their Applications	Credits = 4		
			L	T	P
	Semester: VII	Total Contact Hours: 60	3	1	0

List of Prerequisite Courses

Polymer science and Technology (PST1301), Polymer chemistry and Technology (PST1303), Technology of Thermoset polymers (PST1506), Analysis and characterization of resins and polymers lab (PSP1504) Environment Health and Safety of Polymers and Coating (PST1712), Evaluation and testing of Polymers and Coatings (PST1711).

List of Courses where this course will be Prerequisite

None

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

Able to understand the significance of nano-size. Able to synthesized various nanomaterials and nanocomposites Gets aware about new and emerging technology in Polymer and Coating industry such as carbon nanotubes and anticorrosive coating with the use of same.

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	Definition,Classification of nanomaterial and its unique properties.	7
2	Synthesis, properties and applications of Carbon nanotubes.	7
3	Synthesis, properties and applications fulleneres.	7
4	Synthesis, properties and applications in organic nanomaterials like titanium dioxide, zinc oxide etc.	7
5	Synthesis, properties and applications of nanoparticles of gold, silver cellulosics etc.	10
6	Dendrimers, Nanoclay sand its differnt treatment.	7
7	Polymer nanocomposites and its processing properties, application sand charecterization.	8
8	Nanocoatings,safety regulations of nanomaterials.	7
	Total	**60**

List of Text Books/ Reference Books

1	Structural Nanocomposites: Perspectives for Future Applications (Engineering Materials) Hardcover – Import, 16 Dec 2013by James Njuguna.
2	Multifunctional Polymer Nanocomposites, ISBN13: 9781439816820, ISBN10: 1439816824, Publisher: Taylor & Francis Inc Pages : 466..
3	Nanocomposites Organiques a Matrice de Silicium Poreux (French, Paperback, Diyana Badeva)
4	Thermoset Nanocomposites for Engineering Applications, Author: Kotsilkova, R..

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

CO1	Identify the significance of nano-size. (K3)

CO2	Design various nanomaterials and nanocomposites (K5)
CO3	Discover safety measurements and to deal with any emergency when working with nanoparticles (K4)
CO4	Examine property variation with differentiation of particle size of any filler, pigment etc. in polymer composite, coating etc. (K4)
CO5	Inspect about new and emerging technology in Polymer and Coating industry, such as carbon nanotubes and anticorrosive coating with the use of the same. (K4)
CO6	Discuss the concepts of surface phenomena, surface properties and importance of surface preparation in coatings

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO1	PO2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO9	PO1 0	PO1 1	PO12	PSO 1	PSO2
		K3	K4	K6	K5	K6	K3	K3+P	K3	K3+ A	K2+ A	K3	K6 +A+Ps y	K3	K4
CO1	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO2	K5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO4	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO5	K4	3		3	3	3	2	33	3	3	3	3	3	3	3
CO6	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
Cour se	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

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

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

Description of relevance of this course in the B. Chem. Engg. Program

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

	Course Contents (Topics and subtopics)	Reqd. hours
1	Introduction of Course Academic Honesty Practices General philosophy of science & Arguing About Knowledge Case studies in science history	3
2	Motivation and Background Motivation/Demotivation for Research, Building Background for Research and How to read research papers	3
3	Time Management (Academic and Non-academic time), Effort Management, Plan execution, Energy Management Issue, Role and expectation of research supervisor and student	4
4	Finding and Solving Research Problems What is Research, How to start?, Approaches to find research problems and psychological experiments Literature survey, Textbooks, Review and research papers How to ask Questions What is worthwhile research problem, Analytical and synthetic research approach	4
5	Finding and Solving Research Problems What is Research, How to start?, Approaches to find research problems and psychological experiments Literature survey, Textbooks, Review and research papers, critical review of research papers, how to write literature survey report, How to ask Questions, formulating research questions,	4
6	What is worthwhile research problem, Analytical and synthetic research approaches How to solve research problems, designing work plan, importance of objectives, activity and strategizing research work. Design of timeline for work plan (Gnatt Chart etc), Grant Writing Guidelines	4
7	Experimental Research Inventory Management, Material Management Learning required skills for research, Documentation and lab notebook guidelines, Safety aspects in chemical/biological research	4
8	Methods and Tools used in Research: Qualitative studies; Quantitative studies; Simple data organization; Descriptive data analysis; Limitations and sources of error; Inquiries in form of Questionnaire, Opinionnaire or by interview; Statistical analysis of data including Variance, Standard deviation, Students 't' test and Analysis of variance (ANOVA), Correlation data and its interpretation, Computer data analysis	6
9	Scientific Writing Skeleton of research paper, author guidelines, good writing skills, importance of discussion, Macro-level discussion. Structure of the documents. General issues of presentability. Micro-level discussion. Stylistic issues. Examples of bad and good writings.	6
10	Publishing and Reviewing Publication process, How to publish papers, where to submit, Review process and reacting to a review report Reviewing scientific papers	4

11	Scientific Norms and Conventions Authorship. Plagiarism. Simultaneous submissions. Reviewing norms. Referring to other papers. Use of data. Collaborative Research Work	3
List of Textbooks		
	Menzel, D.; Writing a Technical Paper; McGraw-Hill, United States (1961).	
	Best, J. W., Kahn, J. V., Jha, A. K.; Research in Education; 10th ed.; Pearson, New Delhi, India (2005)	
List of Additional Reading Material / Reference Books		

Course Outcomes (Students will be able to…..)	
CO1	Understand the basic concepts of research and the components therein, formally (K2)
CO2	Understand and appreciate the significance of statistics in Chemical Technology, Pharmacy and Chemical Engineering (K2)
CO3	Understand and apply importance of literature survey in research design (K3)
CO4	Understand an in-depth knowledge on the documentation in research(K2)
CO5	Evaluate importance of various parts of a research report/paper/thesis in presentation of research results(K4)
CO6	**Prepare and Deliver a model research presentation (K5)**
CO7	Understand the significance of various types of IPRs in research(K1)
CO8	Create a model research project(K6)

	Course Code: PHP1443	Course Title: Design and Analysis of Experiments (Research Methodology – II)	Credits =2		
			L	T	P
	Semester: VII	Total contact hours: 45	1	-	2
List of Prerequisite Courses					
	Applied Mathematics I				
List of Courses where this course will be prerequisite					
	This course is required for graduating engineers to function effectively in Industry, Academia and other professional spheres. This course is in Semester VIII				
Description of relevance of this course in the B.Tech. Program					
Modern day manufacturing activities and R&D activites need decisions taken with a scientific rigour and should be well-supported by 'statistics'. Chemical Technologist graduates who will serve industry as well as postgraduate research students who will serve industry, R&D organisations, or academic research should have a reasonably good background of statistical decision making. This also involves extraction of meaningful data from well-designed minimal number of experiments at the lowest possible material costs. This course will also help the students in all domains of their life by imparting them a vision for critical appraisal and analysis of data.					
	Course Contents (Topics and subtopics)		**Reqd. hours**		
1	Fundamental principles of classical design of experiments Strategy of Experimentation, Typical applications of Experimental design, Basic Principles, Guidelines for Designing Experiments.		4		
2	Review of Probability and basic statistical inference: Concepts of random variable, probability, density function cumulative distribution function. Sample and population, Measure of Central tendency; Mean median and mode, Measures of Variability, Concept of confidence level. Statistical Distributions: Normal, Log Normal & Weibull distributions, Hypothesis testing.		3		
3	Experiments with a Single Factor: The Analysis of Variance Fixed effect model and Random effect model, Model adequacy checking, Contrasts, Orthogonal contrasts, Regression Models and ANOVA, Violation of Normality Assumption: Kruskal-Wallis test. Randomized block designs, Latin square designs, Balanced Incomplete Block Designs		6		
4	Factorial designs: Definition, Estimating model parameters, Fitting response curves and surfaces.		3		
5	The 2^k Factorial Design, Blocking and Confounding in the 2k Factorial Design; Focus of 2^2 and 2^3 designs, Blocking and Confounding in the 2^k Factorial Design.		6		
6	Plackett Burman methods, Central Composite Design (CCD)		3		
7	Descriptive Statistics, Probability Distribution and testing of Hypothesis using R		4		
8	Regression techniques, diagnostic checks, ANOVA using R and implementation of contrasts.		4		
9	Construction of Balanced Incomplete Block Designs and data analysis using R		4		
10	Analysis of factorial designs using R, understanding output and interpretation.		4		
11	Factorial designs, Data analysis and interpretation.		4		
List of Text Books / Reference Books					
1	Douglas C. Montgomery, Design and Analysis of Experiments, 8th Edition, John Wiley & Sons, Inc. 2013				
2	Box, G. E., Hunter, W.G., Hunter, J.S., Hunter, W.G., Statistics for Experimenters: Design, Innovation, and Discovery, 2nd Edition, Wiley, 2005.				
3	John Lawson, Design and Analysis of Experiments with R, CRC Press, 2015				
4	Dieter Rasch, Jürgen Pilz, Rob Verdooren, Albrecht GebhardtOptimal Experimental Designs with R. CRC Press, 2011.				
5	José Unpingco, Python for Probability, Statistics, and Machine Learning, Springer, 2019				
6	Response Surface Methodology: Process and Product Optimization using Designed Experiments: R. H. Myers, D. C. Montgomery.				
7	Introduction to Statistical Quality Control: D. C. Montgomery.				
8	Design of Experiments in Chemical Engineering: Živorad R. Lazić.				
Course Outcomes (students will be able to…..)					
1	Students should be able to understand basic principles of design of experiments.				
2	Students should be able to perform statistical analysis of single experiments and do post hoc analysis.				
3	Students should be able to conduct experiment and analyse the data using statistical methods.				
4	Students should be able to choose an appropriate design given the research problem.				

5	Students should be able to perform statistical analysis of different designs using R and interpret the results.	

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

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

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

Project	Course Code: PHP1444	Course Title: Project – I	Credits = 4		
			L	T	P
	Semester: VII	Total Contact Hours: 120	0	0	8

List of Prerequisite Courses
Research Methodology

List of Courses where this course will be prerequisite
Project – II

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

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

List of Textbooks/Reference Books	
1	Relevant research articles, patents, review articles, conference proceeding, book chapters and books

Course Outcomes (Students will be able to…..)	
CO1	Develop critical thinking to identify the research gap for the project (K5)
CO2	Formulate a scientific question and approach to solve it (K6)
CO3	Plan the experimental methodology for the project (K5)
CO4	Develop skills to communicate the research plan effectively (K6)
CO5	Develop skills for writing a scientific document on the research work (K6)

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

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

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

	Course Code: PEP1701	Course Title: Pr 8 - Processing and characterization of polymers and polymer composites	Credits = 2		
			L	T	P
	Semester: VII	Total contact hours: 60 hrs	0	0	4

List of Prerequisite Courses

Technology of Thermoplastics (PST 1504), Additives in Polymers (PET 1507), Compounding and Polymer processing (PET1607),

List of Courses where this course will be prerequisite

Project I (PSP1714), Project II (PSP1811) Specialty Polymers (PET 1816), Research and development of new polymer product

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

This course on Processing and Characterization of Polymers and Polymer Composites is highly relevant due to the increasing demand for advanced polymer materials in various industries such as automotive, aerospace, electronics, packaging, and healthcare. Understanding the chemical and physical properties of polymers is crucial for tailoring their performance and enhancing their application range. By learning these characterization techniques, students will be equipped to design and optimize polymer formulations to meet specific industrial requirements, leading to advancements in material science and technology. Additionally, the knowledge gained in mechanical testing, electrical properties, and thermal behavior of polymers will aid in ensuring the safety, reliability, and sustainability of polymer-based products in real-world applications.

	Course Contents	Reqd. hours
1	Compression moulding	1x4hr/Week
2	Extrusion Process	
3	Injection Moulding	
4	Two roll Mill	
5	To find the MFI of Polyolefines, Styrenics etc	
6	Mechanical Testing of polymer sample like tensile, izod/charpy impact, % elongatioin	
7	To find Vicat softening point of given polymer sample	
8	To find the electrical properties of polymer BDV Arc Resistance etc.	

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

CO1	Analyze various moulding techniques. (K2)
CO2	Evaluate various physical, chemical and electrical properties of polymer samples. (K4)

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	PO9	PO1 0	PO1 1	PO12	PSO 1	PSO 2
		K3	K4	K6	K5	K6	K3	K3+P	K3	K3+ A	K2+ A	K3	K6 +A+Ps y	K3	K4
CO1	K2	3	3	2	3	3	2	2	2	3	3	3	3	3	3
CO2	K4	3	3	3	2	3	3	3	3	2	3	3	1	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-VIII

	Course Code: PST1801	Course Title: SPL-15: Adhesion and adhesives	L	T	P
	Semester: VIII	**Total Contact Hours: 45**	**3**	**0**	**0**

List of Prerequisite Courses

Polymer science and Technology (PST1301), Polymer chemistry and Technology (PST1303), Technology of Thermoset polymers (PST1506), Analysis and characterization of resins and polymers lab (PSP1504) Environment Health and Safety of Polymers and Coating (PST1712), Evaluation and testing of Polymers and Coatings (PST1711).

List of Courses where this course will be Prerequisite

None

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

The course on "Adhesion and Adhesives" holds significant relevance in various engineering and industrial sectors. It equips students with essential knowledge about adhesive bonding, joint design, and surface preparations, which are essential in industries like aerospace, automobile, construction, and electronics. Understanding different types of adhesives and coatings enables students to select appropriate materials for specific applications, contributing to efficient and cost-effective manufacturing processes. Additionally, knowledge of surface coatings and their evaluation is crucial for professionals in the paint and coating industry, ensuring the development of high-quality and durable surface finishes in a wide range of applications.

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	Concepts and terminology, functions of adhesives, Theories of adhesion, advantages and disadvantages of adhesive bonding, criteria for selection of adhesives, applications, advantages and limitations, troubleshooting, various polymers used in adhesive applications, Types of substrates.	8
2	Types of adhesives, structural adhesives, Urethane structured adhesives, Modified acrylic structural adhesives, phenolic adhesives and modifiers, anaerobic adhesives, cyanoacrylate adhesives, methods of adhesive, Hot melt adhesives, pressure sensitive adhesives, RTV Silicone adhesives, sealants, water based adhesives. Specialty adhesives, adhesives in aerospace, adhesive in automobile industry, conductive adhesives, adhesives in building construction, adhesive in electrical industry.	8
3	Joint design, stress, types of joints, selection of joint detail, joint criteria, surface preparation of adherend -metals, plastics and rubbers. Adhesive bonding process-methods for adhesives application and bonding equipment testing and quality control. Testing of adhesives Industrial adhesives	8
4	Fundamentals of surface phenomenon, surface energy and surface tension. Basics of adhesion. Surface preparations, Introduction to surface coatings –Components of paints. Pigments, pigment properties, different types, extenders, solvents, oils, driers, diluents, lacquers, varnishes, paint preparation, formulation, factors affecting pigment dispersion, and preparation of pigment dispersion.	8
5	Different types of paints- classification based on polymeric resin, emulsion, oil and alkyd paints, acrylic paints, epoxy coatings, polyurethane, silicones, chlorinated rubbers. Classification based on application, fluro polymers, vinyl resins, appliance furnishes, automotive finishes, coil coatings, can coatings, marine coatings, and aircraft coatings. Surface preparation and paint application	8
6	Paint properties and their evaluation – mechanism of film formation, factors affecting coating properties, methods used for film preparation – barrier properties, optical properties, ageing properties, rheological properties and adhesion properties of coatings.	5
Total		**45**

List of Text Books/ Reference Books	
1	Handbook of Adhesives – Skeist, Irvind, Van Nistrand, New York, 1990, 3rd Edition Gerald L. Schreberger, Adhesive in manufacturing, Marcel Dekker Inc., New York, 1983
2	W.C. Wake, Adhesion and the formulation of adhesives. Applied Science Publishers, London, 1976
3	Swaraj Paul, Surface Coatings, John Wiley & Sons, NY, 1985
4	George Mathews, Polymer Mixing Technology, Applied Science Publishers. Sheilds, Hand book of adhesives, Butterworths, 1984
Course Outcomes (Students will be able to…..)	
CO1	Explain the fundamental concepts and theories of adhesion and adhesives, including the functions, advantages, and limitations of adhesive bonding in various applications. (K2)
CO2	Illustrate the different types of adhesives and their classifications, such as structural adhesives, specialty adhesives, and water-based adhesives, while analyzing their specific properties and suitability for diverse substrates. (K3)
CO3	Develop an understanding of joint design and stress distribution, and determine appropriate joint details and surface preparation techniques for adherends made of metals, plastics, and rubbers in adhesive bonding processes. (K4)
CO4	Analyze the role of industrial adhesives in specific industries, including aerospace, automotive, electrical, and construction, evaluating the significance and challenges faced in their applications. (K4)
CO5	Compare various surface coatings, paints, and their formulations, examining factors affecting pigment dispersion, paint properties, and film formation, while discussing the evaluation of coating properties like adhesion, barrier properties, and optical properties. (K5)

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	PO9	PO1 0	PO1 1	PO12	PSO 1	PSO2
		K3	K4	K6	K5	K6	K3	K3+P	K3	K3+ A	K2+ A	K3	K6 +A+Ps y	K3	K4
CO1	K2	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO2	K3	3	2	2	3	3	3	3	3	3	3	3	3	3	3
CO3	K4	3	3	3	2	3	3	3	3	3	3	3	3	2	3
CO4	K4	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO5	K5	3	3	2	3	2	3	3	3	3	3	3	2	3	3
Cour se	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: PET1813	Course Title: Honors Course IV- Technology of Elastomers	Credits = 3		
			L	T	P
	Semester: VIII	Total contact hours: 45	2	1	0

List of Prerequisite Courses

Technology of Thermoplastics (PST 1504), Additives in Polymers (PST 1506), Compounding and Processing of Polymer (PET 1607)

List of Courses where this course will be prerequisite

None

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

To study the classification of different types of rubbers. Also study the introduction of various monomers used in rubbers. To Study the various salient features, requirement of for the polymers which is good elastomers.

	Course Contents	Reqd. hours
1	Definition of elastomers and requirements of polymer to be elastomer: effect of molecular weight, tie points and glass transition temperature (Tg) characteristics	5
2	Different types of monomers used in synthesis of elastomers, classifications of elastomers, different processes used during life cycle of rubber manufacture, storage, compounding, forming and vulcanization of rubbers, different ingredients used in it and functions of various compounding ingredient, various equipments used for compounding and their comparison	10
3	Definitions of different terms like scorch, cure/ over cure & study of curing	5
4	Different types of vulcanization systems used for compounding and fillers used in elastomers,	5
5	Measurement of Definition & mooney viscosity and state of cure for rubber compound. RTV	10
6	Synthesis of various rubbers natural rubber/ synthetic polyisoprene styrene butadiene rubber, SBS block copolymer, nitrile rubber, EPR and EPDM rubber, polybutadiene rubber, butyl and neoprene/ chloroprene rubber, silicone rubber, etc. and their properties and applications Use of carbon black in rubbers, Manufacture of tyres	10

List of Text Books/ Reference Books

1	Elastomers and plastomers by Houwink, R, Elseveir publishing co. inc. 1948.
2	Elastomers and rubber elasticity by J.E mark, American chemical society, 1982
3	Handbook of Elastomers by Anil K. Bhowmick, Howard Stephens, CRC Press, 2000
4	Elastomer Technology Handbook, Nicholas P. Cheremisin off, Paul N. Cheremisinoff
5	Elastomers and Rubber Compounding Materials Paperback – January 1, 1989 by I. Franta (Editor)
6	Handbook of Plastics, Elastomers, and Composites, Fourth Edition by Charles A. Harper, McGraw-Hill, 2002.

6	Elastomers and Components by V Coveney, Woodhead Publishing 2006.
7	Elastomers and Rubber Compounding Materials by I. Franta, Elsevier (December 3, 2012)
Course Outcomes (students will be able to…..)	
CO1	Describe about elastomer and describe about their properties and application (K2)
CO2	Explain about curing of elastomer, problems observed due to overcuring (K2)
CO3	Compare and distinguish various elastomer and types of it. (K4)
CO4	Interpret the various physical, chemical properties of elastomers and state their applications (K3)
CO5	Test for various additives required to be added in elastomer and able to solve problems observed during processing (K4)

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	PO9	PO1 0	PO1 1	PO12	PSO 1	PSO 2
		K3	K4	K6	K5	K6	K3	K3+P	K3	K3+ A	K2+ A	K3	K6 +A+Ps y	K3	K4
CO1	K2	3	3	3	2	2	2	3	3	3	3	3	2	3	3
CO2	K2	3	3	2	3	2	3	2	3	3	3	3	2	3	3
CO3	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO4	K3	3	3	2	3	2	3	3	2	3	3	3	3	3	3
CO5	K4	3	2	3	2	3	3	3	3	3	3	3	3	3	3
Cour se	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: PST 1713	Course Title: Honors Course V- Sustainability of polymers	Credits = 3		
			L	T	P
	Semester: VII	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses
Polymer science and Technology, Polymer chemistry and Technology, Technology of Thermoset polymer and characterization of resins and polymers lab, Environment Health and Safety of Polymers and Coating, Evaluation and testing of Polymers and Coatings
List of Courses where this course will be Prerequisite
Project II
Description of relevance of this course in the B. Tech. Programme
Able to understand the sustainability approach in polymer and coating industry

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	Polymers and Environment ─ Environmental issues related to polymer industries, design for environment life cycle approach, contribution to energy, feedstock, transport, gross and net calorific value. Effect of plastic waste on wildlife, aquatic life and water pollution, Positive impact of plastic on the environment. Effluent treatment at latex and rubber industries.	10
2	Polymers in agriculture ─ Greenhouse films, Plastics in mulch films, plastics in silage, drip irrigation systems. Polymers in packaging ─ Common packaging plastics.	7
3	Sustainability approach in paint – decorative paint, automotive paint, industrial coatings	10
4	Recycling ─ Polyethylene terephthalate and styrene based polymers, disposal of waste plastics films. Energy recovery from waste polymer products. Disposal of plastic goods, Reuse and recycling of household plastic, recycling of e-waste, disposal and recycling of biodegradable plastics and food waste, biogas production, and production of cooking gas from waste plastics. Tyre recycling, recycling of dipped goods and non-tyre products.	6
5	Flammability of polymers ─ Release of polymer vapours, ignition, combustion of polymer vapours. Fire propagation, fire-resistant polymers. Methods to improve the fire resistance of polymers. Carcinogenic polymers and rubber chemicals.	10
Total		**45**

List of Text Books/ Reference Books	
1	Handbook of Sustainable Polymers Structure and Chemistry by Edited By Vijay Kumar Thakur, Manju Kumari Thakur ,2016
2	Advances in Sustainable Polymers Processing and Applications by Vimal Katiyar, Amit Kumar, and Neha Mulchandani, Nov 14, 2019\
3	Recycling of Polymers: Methods, Characterization and Applications By Raju Francis, 7 October 2016
Course Outcomes (Students will be able to…..)	
CO1	Identify and explain the effect of plastic waste (K3)
CO2	Design the sustainable approach for polymers and coatings (K6)
CO3	Compare various approaches of recycling of polymers (K5)
CO4	Select the polymer chemistry for agriculture application (K4)
CO5	Understand Fire resistance and flammability of polymers (K3)

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	PO9	PO1 0	PO1 1	PO12	PSO 1	PSO 2
		K3	K4	K6	K5	K6	K3	K3+P	K3	K3+ A	K2+ A	K3	K6 +A+Ps y	K3	K4
CO1	K3	3	3	3	3	2	2	3	3	3	3	3	2	3	3
CO2	K6	3	2	3	3	3	3	3	3	3	3	3	2	3	3
CO3	K5	3	3	3	3	2	2	3	3	2	3	3	2	3	3
CO4	K4	3	3	2	3	2	3	3	2	3	3	3	3	3	3
CO5	K3	3	3	3	2	3	3	3	3	3	3	3	3	3	3
Cour se	K6	3	3	3	3	3	3	3	3	3	3	3	3	3	3

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

PCC	Course Code: PHP1449	Course Title: Project – II (Experiments)	Credits = 3		
			L	T	P
	Semester: VIII	Total Contact Hours: 90	0	0	12

List of Prerequisite Courses
Project – I

List of Courses where this course will be prerequisite
Relevant courses in previous courses (Sem. I to Sem. VII)

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

	Course Contents (Topics and Subtopics)	Required Hours
1	The topic of the research with clearly defined Objectives and Hypotheses should be explored systematically, in a scientifically planned rational set of experiments. Students should have actual experimental data collected on the chosen research topic.	60
2	Oral presentation of the proposed research work with data generated during actual laboratory work along with computational studies, if any, targeted towards fulfilling the objectives. The outcome is submitted in the form of a report.	30
	Total	**90**

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: PEP1801	Course Title: Pr 9- Advanced Characterization of Polymers and Composite	Credits = 2		
			L	T	P
	Semester: VIII	Total contact hours: 60 hrs	0	0	4

List of Prerequisite Courses

Evaluation and testing of Polymers and Coatings (PST1711), Analytical Chemistry and Technology, Technology of Thermoset (PST 1506), Technology of Thermoplastics (PST 1504)

List of Courses where this course will be prerequisite

None

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

To Use/select analytical and physical testing equipment to carry out suitable experiments. Knowledge of subject will help student to carry out Research and development in the areas of polymer Synthesis, Polymer nanocomposites, coating formulation development, Fiber reinforced composites, Polymer processing Polymer blends etc., Ability design and conduct experiments, Ability to analyze and interpret data, process parameters. To understand and do calculations observations formulations involved team work and understanding practical problems related to the experiment

	Course Contents	Reqd. hours
1	To find the MFI of Polyolefines, Styrenics etc	1x4hr/Week
2	To find Tg, Tc, and Tm of given resin by DSC.	
3	To find molecular weight & PDI of given resin urging GPC	
4	Mechanical Testing of polymer sample like tensile, izod /charpy impact, % elongation	
5	To find Vicat softening point of given polymer sample	
6	To find the electrical properties of polymer BDV Arc Resistance etc.	
7	Paticle size distribution of pigment powder etc	
8	Particle size analysis of emulsion powders by optical microscopy	
9	Charecterization of polymer nanocomposites by XRD	
10	Group analysis of polymers and resin by IR	
11	To Study DMTA, Accelerated weathering test	
12	Rheology of Polymer by Cone and plate Rheometer	
13	Electro-spinning of polymers	
14	TGA of polymer nanocomposite	

List of Text Books/ Reference Books

1	Polymer Morphology: Principles, Characterization,and Processing by Qipeng Guo, Wiely 2016
2	Handbook of Plastics Testing and Failure Analysis, 3rd Edition by Vishu Shah, Wiely 2007
3	Handbook of Plastics Analysis by H. Lobo CRC Press 2003
4	Polymer Charecterization Laboratory Techniques and Analysis by *Nicholas P. Cheremisinoff*, William Andrew Inc,1996
5	Polymer Characterization: Physical Techniques, 2nd Edition by Dan Campbell CRC Press 2000
6	Modern Methods of Polymer Characterization by Howard Barth John Wiley & Sons 1991
7	Encyclopedia of Polymer Science and Technology, Johan Wiley and Sons, Inc 1965.
8	Encyclopedia of Polymer Science and Engineering, Johan Wiley and Sons, Inc 1988.
9	Plastics Materials, 7th Edition by John Brydson, Elsevier 1999

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

CO1	Test polymers, polymer blends, polymer composite using analytical and physical testing equipment and modern engineering tools like DSC Molecular Weight IR and learn calculations related to it. (K4)
CO2	Analyze and interpret data and characterize additives and polymers within realistic constraints of the experiment (K4)
CO3	Test various properties like tensile strength impact strength glass transition etc and presenting these in a concise and scientifically meaningful way (K4)
CO4	Characterize material using XRD GPC DSC optical microscopy (K4)
CO5	Perform electrospinning of polymers and study the various factors affecting electrospinning (K5)

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

		PO1	PO2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO9	PO1 0	PO1 1	PO12	PSO 1	PSO2
		K3	K4	K6	K5	K6	K3	K3+P	K3	K3+ A	K2+ A	K3	K6 +A+Ps y	K3	K4
CO1	K4	3	3	2	3	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	3
CO3	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO4	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO5	K5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Cour se	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

OJT	Course Code: PHP1451	Course Title: Internship with Industry	Credits = 12		
			L	T	P
	Semester: VIII	Total Contact Weeks: 12-16	0	0	0

List of Prerequisite Courses

None

List of Courses where this course will be prerequisite

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

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

The course is designed to –

1. develop a systematic thinking about an industrial problem;

2. develop skills for communication, networking, personal grooming & professional conduct within an industrial environment, and

3. develop the attitude for individual and teamwork.

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

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

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

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

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

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

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