Preamble:

The undergraduate programmes at the Institute of Chemical Technology are reputed worldwide. Alumni from these programmes have found a place of pride in the Indian chemical industry including some top names and many as entrepreneurs, in Universities/ Institutes and Research Organisations throughout India and the world. The B.Tech. programmes in the then Department of Chemical Technology, University of Mumbai started in 1934 as post B.Sc., second graduation as B.Sc.(Tech.). Keeping national, societal needs in focus, post-independence, the programme grew into multiple branches keeping connection with chemical engineering content. Once the Institute became a University in 2009, these became independent B. Tech. Programmes retaining their dual core nature. The Institute of Chemical Technology is committed to keeping its syllabi updated and globally relevant for the industry. We have revamped the syllabi of all the B. Tech. programmes now in 2021. The 205 credit programmes each have around 6% humanities, 23% basic sciences, 8% engineering sciences, 12% chemical engineering plus 51% special subjects.

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

B. Tech. (Polymer Engineering and Technology)

PROGRAMME EDUCATIONAL OBJECTIVES for B. Tech. (Polym. 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 Engineering and Technology)

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 Polymer technology problems reaching substantiated conclusions using first principles of mathematics, polymer sciences, and polymer 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.
PSO2	Pertinent with Polymer industry: Able to develop skills about Polymer Processing and testing and examine its lifecycle with inculcating the thought of sustainable development

B. Tech (Polymer Engineering & Technology)

Syllabus Structure B. Tech. First Year									
Semester I									
Course Code	**Subjects**	**Credits**	**Hrs/Week**			**Marks for various Exams**			
			L	**T**	**P**	**C.A.**	**M.S.**	**E. S.**	**Total**
CHT1137	Organic Chemistry I	3	2	1	0	10	15	25	50
CHT1341	Physical Chemistry-I	3	2	1	0	10	15	25	50
CHT1139	Industrial Inorganic Chemistry	3	2	1	0	10	15	25	50
MAT1101	Applied Mathematics-I	4	3	1	0	20	30	50	100
PYT1101	Applied Physics-I	4	3	1	0	20	30	25	100
GEP1113	Engineering Graphics & Elementary Autocad	4	2	0	4	50		50	100
CHP1343	Physical and Analytical Chemistry Laboratory	2	0	0	4	25		25	50
	TOTAL:	**23**	**14**	**5**	**8**				**500**
Semester II									
Subject Code	**Subjects**	**Credits**	**Hrs/week**			**Marks for various Exams**			
			L	**T**	**P**	**C.A.**	**M.S.**	**E. S.**	**Total**
CHT1401	Analytical Chemistry	3	2	1	0	10	15	25	50
CHT1342	Physical Chemistry-II	3	2	1	0	10	15	25	50
CHT1138	Organic Chemistry II	3	2	1	0	10	15	25	50
PYT1103	Applied Physics-II	3	2	1	0	10	15	25	50
MAT1102	Applied Mathematics-II	4	3	1	0	20	30	50	100
CET1507	Process Calculations	4	3	1	0	20	30	50	100
PYP1101	Physics Laboratory	2	0	0	4	25		25	50
CHP1132	Organic Chemistry Laboratory	2	0	0	4	25		25	50
HUP1101	Communication Skills	2	0	0	4	50			50
	TOTAL:	**26**	**14**	**6**	**12**				**550**
Syllabus Structure B. Tech. Second Year									
Semester III									
Subject Code	**Subjects**	**Credits**	**Hrs /week**			**Marks for various Exams**			
			L	**T**	**P**	**C.A.**	**M.S.**	**E.S.**	**Total**
BST1110	Basics of Biology and Applications to Technology	3	2	1	0	10	15	25	50
GET1110	Basic Mechanical Engineering	3	2	1	0	10	15	25	50
PST1301	Spl 1: Polymer Science and Technology (Common)	4	3	1	0	20	30	50	100
CET 1704	Material Technology	3	2	1	0	10	15	25	50
CHT1133	Chemistry And application of Colorants	4	3	1	0	20	30	50	100
PYT 1203	Color Physics and Color	3	2	1	0	10	15	25	50

	Harmony								
PSP1301	Pr 1: Raw Material Analysis for Resins and Polymers (Common)	2	0	0	4	25		25	50
PYP1204	Pr 2: Color Physics Lab	2	0	0	4	25		25	50
	TOTAL:	**24**	**14**	**6**	**8**				**500**

Semester IV

Subject Code	Subjects	Credits	Hrs/week			Marks for various Exams			
			L	T	P	C. A.	M.S.	E. S.	Total
GET1117	Engineering Mechanics and Strength of Materials	3	2	1	0	10	15	25	50
CET1105	Transport Phenomena	4	3	1	0	20	30	50	100
GET1105	Electrical Engineering and Electronics	3	2	1	0	10	15	25	50
PST1303	Spl 2: Polymer Chemistry and Technology (Common)	4	3	1	0	20	30	50	100
PST1404	Spl 3: High Polymer Chemistry (Common)	3	2	1	0	10	15	25	50
PET1507	Spl 4: Additives for Polymers	3	2	1	0	10	15	25	50
GEP1106	Electrical Engineering and Electronics Laboratory	2	0	0	4	25		25	50
MAP1201	Computer Application Lab	2	0	0	4	25		25	50
		24	**14**	**6**	**8**				**500**

Regional Case Study Course or Social Entrepreneurship Course

1. The Course, which is being floated in optional mode and add-on-credit format, will be offered as 02 Credit course curriculum with total duration of 30 hours. At least 50% of the course is to be done compulsorily in the field for all students.
2. This course will be conducted during summer vacation after fourth semester of B Tech Programme. The second year B Tech students, desirous of pursuing said course, will submit request for registration to said course, to concerned Department Head at the beginning of fourth Semester.
3. Upon successful completion of Course, the Certificate reflecting assessment of performance will be awarded to student.
4. Since the course being optional, these credits will not be counted in calculations of SGPA and CGPA and hence the results of this course will not be reflected in Mark list. The course credits are thus primarily the add on Credits.

Course Objectives

i. To prepare B Tech students for real-life project work through development of case-studies on important regional problems.
ii. To develop skills of the student in problem identification, analysis and reporting, all in a social context.
iii. To catalyse acquisition of values of public service and active citizenship amongst students

Course Outcomes

After completing this course, student will be able to

i. gain an understanding of rural life, culture and social realities
ii. develop a sense of empathy and bonds of mutuality with local community
iii. Appreciate significant contributions of local communities to Indian society and economy
iv. Learn to value the local knowledge and wisdom of the community

v. Identify opportunities for contributing to community's socio-economic improvements

Mode of Evaluation of a Regional Case Study Course or Social Entrepreneurship Course

Module Unit Marks

Module	Unit	Marks
1	Basic structure of society, key definitions of problem area, analysis of preliminary data	15
2	Classroom-work - correspondence, formats, interactions, liaisoning	05
3	Field-work and data gathering	15
4	Analysis and Reporting	10
5	Feedback to Community	05
	Total	50

Syllabus Structure B. Tech. Third Year

Semester V

Subject Code	Subjects	Credits	Hrs /week			Marks for various Exams			
			L	T	P	C. A.	M.S.	E. S.	Total
CET1401	Chemical Engineering Operations	3	2	1	0	10	15	25	50
CET1212	Chemical Reaction Engineering	3	2	1	0	10	15	25	50
PST1504	Spl 5: Technology of Thermoplastic Polymers (common)	4	3	1	0	20	30	50	100
PST1506	Spl 6: Technology of Thermoset polymers (common)	3	2	1	0	10	15	25	50
PET1609	Spl 7: Design and Fabrication of Molds	3	2	1	0	10	15	25	50
MAT1106	Design and Analysis of Experiments	4	2	2	0	20	30	50	100
PSP1503	Pr 3: Synthesis and Characterization of Resins and Polymers Lab (Common)	4	0	0	8	50		50	100
PSP1504	Pr 4: Analysis and Characterization of Resins and Polymers Lab (Common)	2	0	0	4	25		25	50
	TOTAL:	**26**	**13**	**7**	**12**				**550**

Semester VI

Subject Code	Subjects	Credits	Hrs/week			Marks for various Exams			
			L	T	P	C.A.	M.S.	E. S.	Total
PET1607	Spl 8: Compounding and Polymer Processing	4	3	1	0	20	30	50	100

PST1712	Spl 9: Environmental health and Safety of Polymers and Coatings (Common)	4	3	1	0	20	30	50	100
PST1609	Spl 10: Structure property Relationship (Common)	3	2	1	0	10	15	25	50
HUT1103	Industrial Psychology & Human Resource Management	3	2	1	0	10	15	25	50
HUT1106	Environment Science and Technology	3	2	1	0	10	15	25	50
	Institute Elective – I	3	2	1	0	10	15	25	50
PSP1712	Seminar	3	0	0	6			50	50
PEP1608	Pr 5: Mold Designing Lab	2	0	0	4	25	-	25	50
PEP1606	Pr 6: Identification of Resins and Polymers Lab	2	0	0	4	25	-	25	50
	TOTAL:	**27**	**14**	**6**	**14**				**550**
	In-plant Training of 8 to 10 weeks after end of semester								

Internship

- After the end of the sixth semester examination and before the start of the seventh semester, every student will have to undergo an internship. The Internship would be of 6 credits.
- The internship (preferably Industrial Internship) would be assigned to the student by the Departmental Internship Coordinator, with the approval of the Head of the Department.
- The total duration of the internship would be for a period equivalent to 12 Calendar weeks. This period typically start from 1st May and end before 30th July every year. This means the end semester examination of T. Y. Tech (Semester VI) should be completed by 25th April every year. The Semester VII (4th Year B.Tech.) should commence w.e.f. 1st Aug every year. The internship may be completed in one or more organizations as described below.
- The internship could be of the following forms:
  (i) Industrial internship in a company (within India or Abroad) involved in R & D/design/ manufacturing (QA/QC/Plant Engineering/Stores and Purchase)/marketing /finance/consultancy /Technical services/Engineering / Projects, etc.
  (ii) Research internship in reputed Institutes (within India or Abroad) like, ICT, IITs, NITs, IISC, NCL, IICT etc.
- At the end of the internship, each student will submit a written report based on the work carried Out during the Internship. The report will be countersigned by the Supervisor from Industry/ Institute as the case may be.
- Performance of the student will be assessed based on the written report and a presentation to a committee consisting of two faculty members from the Department.
- Students will be assigned a grade based on the written report and a presentation; evaluated by a committee of faculty members.

Syllabus Structure B. Tech. Final Year

Semester VII

Subject Code	Subjects	Credits	Hrs/week			Marks for various Exams			
			L	T	P	C. A.	M.S.	E.S.	Tot al
CET1703	Chemical Process Control	3	2	1	0	10	15	25	50
PST1711	Spl 11: Evaluation and Testing of polymers and coatings (Common)	3	2	1	0	10	15	25	50
PET1712	Spl 12: Technology of Plastic Packaging	3	2	1	0	10	15	25	50
	Institute Elective- II	3	2	1	0	10	15	25	50
PSP1713	In-plant Training	6	0	0	0	0	0	0	50

HUT1203	Industrial Management	4	3	1	0	20	30	50	100
CEP1714	Chemical Engineering Laboratory	2	0	0	4	25		25	50
PEP1607	Pr 7: Processing of Polymers Lab	2	0	0	4	25	-	25	50
PSP1714	Project I	2	0	0	4			50	50
	TOTAL:	**28**	**12**	**5**	**12**				**500**

Semester VIII

Subject Code	**Subjects**	**Credits**	**Hrs /week**			**Marks for various Exams**			
			L	**T**	**P**	**C.A.**	**M.S.**	**E. S.**	**Total**
CET1504	Chemical Project Engineering and Economics	3	2	1	0	10	15	25	50
PET1815	Spl 13: Composites and Post Polymer Processing	4	3	1	0	20	30	50	100
PET1813	Spl 14: Technology of Elastomers	3	2	1	0	10	15	25	50
PST1814	Spl 15: Nano materials and their applications (Common)	3	2	1	0	10	15	25	50
PET1816	Program Elective Spl 16: Elective III Speciality polymers	3	2	1	0	10	15	25	50
	Pre-approved Open Electives from MOOOCs/NPTEL	3	2	1	0	10	15	25	50
PSP1075	Project II	4	0	0	8				100
PEP1812	Pr 8: Advanced characterization of Polymers and Composites Lab	4	0	0	8	50		50	100
	Total	**27**	**13**	**6**	**16**				**550**

Semester I

	Course Code: CHT1137	Course Title: Organic Chemistry - I	Credits = 3		
			L	T	P
	Semester: I	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

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

List of Courses where this course will be Prerequisite

Organic Chemistry – II (CHT1138), Biochemistry and several Special Subjects of individual 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	**a. IUPAC Nomenclature of Organic Compounds**	3
	b. Reactive intermediates Carbocations, Carbanions, Carbon radicals and Carbenes – Generation, Structure, Stability and Reactions	5
2	**Stereochemistry of Organic Compounds** containing one and two asymmetric carbon atoms, Stereo descriptors – R/S, E/Z, erythro and thero, Conformation – Ethane and butane Enantiomers and Diastereomers, meso compounds, different representations of stereoisomers – Saw-horse, Newmann, Wedge and dash and Fischer and their interconversions	8
3	**Haloalkanes** Aliphatic Nucleophilic Substitution Reactions: S_N1, S_N2 Elimination Reactions: E1, E2	7
4	**Chemistry of Carbonyl Compounds** Concept of acidity and tautomerism of carbonyl compounds, General methods of preparation and Nucleophilic Addition reactions Enolate chemistry, Aldol and related condensation reactions, Michael reaction, Robinson annulation, Claisen condensation, Dieckmann condensation, Mannich reaction	9
5	**Chemistry of Aromatic Compounds** Hückel rules, Aromatic, Non-aromatic and Anti-aromatic compounds, Benzenoid and non-benzenoid aromatic compounds	3
6	**Electrophilic Aromatic Substitution Reactions** Nitration, Halogenation, Alkylation, Acylation and Sulfonation Activating, deactivating and orienting effects of functional groups in mono- and poly-substituted benzenes Friedel-Crafts alkylation, Acylation, Gattermann, Gattermann-Koch, Riemer-Tiemann reactions	10
	Total	**45**

List of Text Books/Reference Books

1	Clayden, J., Greeves, N., Warren, S.; Organic Chemsitry; 2nd ed.; Oxford University Press (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	appreciate the stereochemical implications of organic compounds and visualize and appreciate chirality concept (K2)
CO3	understand organic chemistry reactions related to aliphatic as well as aromatic compounds as well as decipher the outcome of a given organic transformation (K3)
CO4	interpret and 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	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	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
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; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

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

List of Prerequisite Courses

Standard XII Chemistry

List of Courses where this course will be Prerequisite

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

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

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

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	**Introduction -** Thermodynamic systems, Work, Heat and Energy, State and Path functions, Intensive and Extensive variables	3
2	**First Law of Thermodynamics -** Enthalpy and heat capacities, Application of First Law to gases, Standard states, Enthalpy changes of chemical and physical conversions, Thermochemistry – Hess's Law	6
3	**Second and Third Laws of Thermodynamics -** Statements and applications of Second Law of thermodynamics, Clausius inequality, Entropy as a state function, Entropy changes for reversible and irreversible processes, Entropy and probability Third Law of Thermodynamics, Absolute entropies, Verification of Third Law	6
4	**Spontaneous Process and Equilibrium -** Combined statement of First and Second Laws of thermodynamics, Helmholtz and Gibbs free energy, Spontaneity and Free energy, Maxwell's relations, Effect of T and P on free energy, Van't Hoff equation, Free energy and equilibrium constant, Ellingham diagrams	7
5	**Multicomponent Systems -** Free energy and entropy of mixing, Partial molar quantities and chemical potential, Gibbs Duhem equation	5
6	**Phase Equilibria -** Gibbs Phase rule, Clausius- Clapeyron equation, Stability of phases, First and second order phase transitions, Phase diagrams of one and two two-component systems, l-L systems - TC, PC phase diagrams, distillation and azeotropes, L/S systems, S/S – eutectics and deep eutectics, Phase diagram of three-component systems	3
7	**Equilibrium in Solutions –** Ideal and non-ideal solutions, Henry's law and Raoult's law, Colligative properties Solubility Equilibria – Solubility constant, Common ion effect, Effect of added salts on solubility, pH, Weak and strong acids and bases, Buffer solutions, Ionic solutions, Activity and activity coefficients, Thermodynamic properties of electrolytes in solutions	6
8	Chemical Equilibria - Equilibrium constants, Le Chaterlier's principle, Effect of temperature, pressure and composition on equilibrium	6
9	Electrochemistry – Thermodynamics of electrochemical systems - Types of electrochemical cells, Determination of electrode potentials, Activity and activity coefficients, Dissociation of electrolytes, Ionic equilibria	3
	Total	**45**

List of Text Books/Reference Books

1	Atkins, Peter W.; Paula, Julio de; Keeler, James. Atkin's Physical Chemistry; 11th Ed.; Oxford University Press (2018)
2	Atkins, Peter W.; Paula, Julio de. Elements of Physical Chemistry; 7th Ed.; Oxford University Press (2017)
3	Levine, Ira. Physical Chemistry; 6th Ed.; McGraw-Hill Education (2009)

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

CO1	comprehend the laws of thermodynamics and related concepts and to explain the molecular basis for the same (K2)

CO2	apply the concepts of partial molar quantities to explain the behaviour of pure substances and solutions (K3)
CO3	apply principles of phase equilibria in two- and three-component systems (K3)
CO4	elucidate the effect of thermodynamic quantities on chemical equilibria and relate it to properties of chemical systems (K2)

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

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO2	K3	3	3	2	2	2	3	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
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; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: MAT 1101	Course Title: Applied Mathematics – I	Credits = 4		
			L	T	P
	Semester: I	Total Contact Hours: 60	3	1	0

List of Prerequisite Courses

HSC Standard Mathematics

List of Courses where this course will be prerequisite

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

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

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

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	**Linear Algebra:** Vectors in IR^n, Notion of linear independence and dependence. Vector subspaces of IR^n, Basis of a vector subspace, Row space, Null space, and Column space, Rank of a matrix, Determinants and rank of matrices Abstract vector spaces, Linear transformations in IR^n, Matrix of a linear transformation, Change of basis and similarity, Rank-nullity theorem, and its applications Inner product spaces, Orthonormal bases, Gram-Schmidt orthogonalization process, Eigenvalues and eigenvectors, Characteristic polynomials, Eigenvalues of special orthogonal projection and its application to least methods Diagonalization of matrices and its applications stochastic matrices, Solving initial value system of linear ordinary differential equations	15
2	**Differential Calculus:** Higher order differentiation and Leibnitz Rule for the derivative, Taylor's and Maclaurin's theorems, Maxima/Minima, Convexity of functions, Radius of Curvature. Functions of two or more variables, Limit and continuity, Partial differentiation, Total derivatives, Taylor's theorem for multivariable functions and its application to error calculations, Maxima/Minima	15
3	**Integral Calculus:** Beta and Gamma functions, Differentiation under the integral sign, Multiple integrals, Line and surface integrals, Applications of Green's, Gauss-Divergence and Stokes theorems	15
4	**Probability & Statistics:** Random variables and cumulative distribution function, Probability mass function and probability density function, Some common univariate distributions: Binomial, Poisson, Uniform, exponential, Normal, Expectation and Moments, Moment generating function, Multiple random variables and Joint distribution, Marginal distributions, Covariance and Correlation Concept of parameter estimation: Maximum likelihood estimation, Method of least squares and Simple linear regression, Nonlinear regression	15
	Total	**60**

List of Textbooks/Reference Books

1	Stang, G. Linear Algebra and its Applications; 4th Ed.; Thomson (2006)
2	Anton, Howard; Kaul, Anton. Elementary Linear Algebra; 12th Ed.; Wiley (2019)
3	Friedberg, Stephen H.; Insel, Arnold J.; Spence, Lawrence E. Linear Algebra; 5th Ed.; Pearson Education (2019).
4	Hughes-Hallett, Deborah; Gleason, Andrew M.; McCallum, William G. Calculus: Single and Multivariable; 6th Ed.; John Wiley & Sons, Inc. (2012)
5	Kreyszig, E.; Advanced Engineering Mathematics; 10th Ed.; Wiley Global Education (2010) (Officially Prescribed)
6	Iyengar, S. R. K.; Jain, R. K. Advanced Engineering Mathematics; 4th Ed.; Alpha Science (2014)
7	Ross, Sheldon M. A First Course in Probability; 10th Ed.; Pearson Education (2018)
8	Hines, William W.; Montgomery, Douglas C.; Goldsman, David M.; Borror, Connie M. Probability and Statistics in Engineering; 4th Ed.; John Wiley & Sons, Inc. (2003)
9	Boes, Duane C.; Graybill, Franklin A.; Mood, Alexander McFarlane. Introduction To the Theory of Statistics; 3rd Ed.; McGraw Hill Education (India) (2013)

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

CO1	understand the notion of differentiability and be able to find maxima and minima of functions of

	one and several variables (K3)
CO2	compute surface and volume integrals (K3)
CO3	Understand and explain the notion of vectors and vector spaces (K2)
CO4	solve systems of linear equations and eigenvalue problems analytically and numerically (K3)
CO5	fit relationship between two data sets using linear, non-linear regression (K3)

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

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

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

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

List of Prerequisite Courses

Standard XII Physics

List of Courses where this course will be prerequisite

Applied Physics – II, Physics Laboratory, Chemical Engineering Thermodynamics, Momentum and Mass Transfer, Heat Transfer, Material Science and Engineering, Structural Mechanics, etc.

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

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

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

List of Textbooks/Reference Books

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

Course Outcomes (Students will be able to…..)	
CO1	apply acoustic cavitation of Chemical Engineering Processes (K3)
CO2	apply Bernoulli equation in simple pipe flows (K3)
CO3	explain 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	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	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	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
Course	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: GEP1113	Course Title: Engineering Graphics and Elementary AUTOCAD	Credits = 4		
			L	T	P
	Semester: I	Total Contact Hours: 60	2	0	4

List of Prerequisite Courses

Basic Geometry

List of Courses where this course will be prerequisite

Engineering Graphics – II, Equipment Design and Drawing-I, Equipment Design and Drawing-II, Home Paper – II, Structural Mechanics

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

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

	Course Contents (Topics and Subtopics)	Required Hours
1	**Orthographic Projections:** Conversion of 3D object or pictorial view into front view, top view and side views using first angle method of projection Sectional views draw sectional front view, top view, and side view Problems with section plane cutting object exactly at centre or off centre Orthographic views of at least 15 machine parts using mini drafter and drawing board	10
2	**Isometric Projections and Isometric Views:** Isometric scale, draw pictorial view or 3D view using front and top view or front view and any one side view Machine parts with circle, semicircle in the orthographic views and slots on inclined planes At least 10 isometric drawings using mini drafter and drawing board	12
3	**Missing Views:** Draw top view when front and any one side view is given Draw any one side view or both the side views when front view and top view is given. Problems involving sectional views. At least 6 machine parts using mini drafter and drawing board.	12
4	**Assembly Drawing**: Draw front view and top view or side view of assembly after assembling all the details of machine parts Convert assembly into details Assembly drawing of Nut and bolt, footstep bearings, Plummer block, etc.	10
5	**Introduction to Computer-Aided Drawing:** Role of CAD in design and development of new products, Advantages of CAD. Creating two-dimensional drawing with dimensions using suitable software (Minimum 2 exercises mandatory) Introduction to Solid Modelling: Creating 3D models of various components using suitable modelling software (Minimum 2 exercises mandatory)	16
	Total	**60**

List of Textbooks/Reference Books

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

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

CO1	prepare multi view orthographic projections of objects by visualizing them in different positions. (K3)
CO2	draw sectional views and develop surfaces of a given object. (K3)
CO3	prepare pictorial drawings using the principles of isometric projections to visualize objects in three dimensions. (K3)
CO4	prepare assembly drawing. (K3)

CO5	obtain Multiview projections and solid models of objects using CAD tools (K3)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO2	K3	3	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	K3	3	3	2	2	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
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; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: CHT1139	Course Title: Industrial Inorganic Chemistry	Credits = 3		
			L	T	P
	Semester: I	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

Standard XII Inorganic Chemistry

List of Courses where this course will be Prerequisite

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

List of Text Books/ Reference Books

1	Büchel, Karl Heinz; Moretto, Hans-Heinrich; Woditsch, Peter. Industrial Inorganic Chemistry, Second, Completely Revised Edition; Wiley-VCH (2008)
2	Benvenuto, Mark Anthony. Industrial Inorganic Chemistry; de Gruyter (2015)
3	Swaddle, T. W. Inorganic Chemistry – An Industrial and Environmental Perspective; 1st Ed.; Academic Press (1997)
4	House, James, E. Inorganic Chemistry; 3rd Ed.; Academic Press, Inc. (2019)

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

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

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

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

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

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

List of Prerequisite Courses

Standard XII Chemistry Laboratory Course

List of Courses where this course will be prerequisite

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

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

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

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	Experiments based on chemical reaction kinetics, phase equilibria and electrolyte systems, surface and interfacial phenomena such as surface tension and CMC measurements	4hrs/session X 15 sessions
	Total	**60**

List of Text Books/ Reference Books

1	Practical physical Chemistry – B. Viswanthan and P. S. Raghavan
2	Practical physical Chemistry- Alexander Findlay

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

CO1	identify and determine physicochemical parameters using simple tools (K3)
CO2	interpretation of data and drawing scientific conclusions, dryers, etc (K4)

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

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	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	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; − No Contribution

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

Semester II

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

List of Prerequisite Courses

Standard XII Chemistry

List of Courses where this course will be prerequisite

Physical and Analytical Chemistry Laboratory (CHP 1343), other Chemistry Courses

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

The course introduces the students to key concepts of chemical analysis – sampling, selection of analytical method and data analysis. It presents basic techniques like spectroscopy and chromatography. The students should be able to select an appropriate analytical technique and apply it in accordance with its strengths and limitations.

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	Introduction to Chemical Analysis, Terminology (technique/method/procedure /protocol), Broad classification of analytical techniques, Good Laboratory Practices (GLP)	5
2	Sampling: Basics and procedures, preparation of laboratory samples Criteria for selecting analytical methods – accuracy, precision, sensitivity, selectivity, and detection limit Calibration and validation	8
3	Data Analysis: Errors – Systematic and random errors, statistical treatment of experimental results (F, Q and t tests, rejection of data, and confidence intervals), least square method, correlation coefficients	6
4	Spectroscopic Methods: General principle, instrumentation and applications of - UV-visible spectroscopy - Fluorescence spectroscopy	8
5	Electrochemical Methods: General principles, instrumentation and applications of – Conductometry, Potentiometry, Coulometry, Voltammetry	8
6	Chromatographic Methods: General principle, instrumentation and applications of - Gas chromatography (GC), High-performance liquid chromatography (HPLC), Ion-exchange chromatography, Size-exclusion chromatography	10
	Total	**45**

List of Textbooks/Reference Books

1	Modern Analytical Chemistry by David Harvey, McGraw-Hill, 1999.
2	Quantitative Analysis by R. A. Day and A. L. Underwood, Prentice Hall of India, 2001.
3	Instrumental Methods of Analysis by H. H. Willard, L. L. Merritt, J. A. Dean and F. A. Settle, Wadsworth Publishing, USA
4	Fundamentals of Analytical Chemistry by D. A. Skoog, D. M. West, F. James Holler and S. R. Crouch, Cengage Learning, 2014
5	Principles of Instrumental Analysis by D. A. Skoog, F. James Holler and S. R. Crouch, Cengage Learning, 2007

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	Explain the principles of chromatographic methods (K2)

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

List of Prerequisite Courses

Standard XII Chemistry, Physical Chemistry - I (CHT1341)

List of Courses where this course will be prerequisite

Other Chemistry and Applied Chemistry courses

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

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

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	Introduction – concept of reaction rates and order, experimental methods in kinetic studies, differential and integral methods to formulate rate equations of zero, first and second order reactions Experimental methods of kinetic studies	3
2	Kinetics and reaction mechanism – rate determining step, steady state approximation Complex reactions- parallel, consecutive and reversible reactions Mechanism of thermal, photochemical chain reactions, polymerization reactions Fast reactions – experimental techniques	6
3	Homogenous catalysis – homogeneous acid / base catalysis (specific and general acid catalysis), enzyme catalysis (Michalis-Menten kinetics)	4
4	Reactions at interface – Adsorption isotherms, kinetics of surface reactions- Hishelwood and Rideal models of surface reactions	4
5	Theories of reaction rates - Theory of unimolecular reactions, collision theory and transition state theory, Effect of temperature, Solvent effects on reaction rates	6
6	Surface and interfacial Chemistry – introduction, surface tension and surface free energy, methods of determining surface and interfacial tensions	10
7	Thermodynamics of surfaces – surface excess, Gibbs adsorption equation, curved surfaces- bubbles, droplets and foams, Kelvin, Young Laplace and Thomson equations, homogeneous nucleation	4
8	Liquid-liquid and solid-liquid interfaces – contact angle, wetting and spreading, adhesion and cohesion, contact angle measurements and hysteresis	4
9	Surfactants: Types, adsorption at surfaces and interfaces, surfactant aggregates, factors affecting aggregation phenomena, applications of surfactants and mixed surfactant systems	4
10	Colloids: preparation, stability, characterization, surface charges and electrical double layer Emulsions: Thermodynamics and stability of emulsions, microemulsions and foams, HLB values	5
	Total	**45**

List of Textbooks/Reference Books

1	Physical Chemistry (11th edition) by P. W. Atkins, J. de Paula and J. Keeler, Oxford University Press, 2017.
2	Chemical Kinetics (3rd edition) by Keith J. Laidler, New York : Harper & Row, 1987.
3	Introduction to Colloid and Surface Chemistry (4th edition) by Duncan Shaw, Butterworth-Heinemann 2013.
4	Surfaces, Interfaces, and Colloids: Principles and Applications (2nd edition) by Drew Myers, John Wiley & Sons, Inc., 1999
5	Surfactants and Interfacial Phenomena (4th edition) by M. J. Rosen, John Wiley & Sons, Inc., 2012

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

CO1	comprehend fundamental knowledge in chemical kinetics with basics of order, molecularity and temperature effect (K2)
CO2	examine kinetics for complex, fast as well as surface reactions and comprehend different theories in kinetics (K4)
CO3	comprehend fundamental knowledge and thermodynamics in surface and interfacial chemistry

	(K3)
CO4	evaluate the behavior of surface-active agents and disperse systems based on the knowledge of interfacial phenomena (K4)

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

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K2	3	2	1	2	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	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
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; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

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

List of Prerequisite Courses

Organic Chemistry - I (CHT1137)

List of Courses where this course will be prerequisite

Other Chemistry and Applied Chemistry courses

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

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

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	Nitro and amino arenes Reactions, basicity of aminoarenes, diazotisation reactions	5
2	Aromatic nucleophilic substitution reactions Addition, elimination mechanism; elimination – addition mechanism (benzyne), Sandmeyer reaction	5
3	Pericyclic Reactions Symmetry of molecular orbitals, frontier orbitals of ethylene, 1,3-butadiene, 1,3,5-hexatriene and allyl system, classification of pericyclic reactions; Woodward-Hoffmann correlation diagrams, FMO and PMO approaches; electrocyclic reaction -conrotatory and disrotatory motions of 4n, 4n+2 and allyl systems; cycloaddition -antara facial and suprafacial addition, 4n and 4n+2 systems, 2+2 addition of ketenes, 1,3 dipolar cycloadditions and cheleotropic reactions; sigmatropic rearrangements - suprafacial and antarafacial shifts of hydrohen, sigmatropic shifts involving carbon moieties, 3,3- and 5,5- sigmatropic rearrangements, Claisen, Cope and Aza-Cope rearrangements, ene reaction.	13
4	Heteroaromatic compounds IUPAC nomenclature, structures and common names, comparison with benzenoid compounds, reactivity and synthesis – pyrroles, furans, thiophenes and pyridines	10
5	Named Organic reactions Perkin reaction (Mauvine synthesis-dyes), Fischer indole synthesis, (dyes), Jacobson Corey epoxide synthesis (Pharmaceutical), Ziegler Natta polymerisation (polymer), Multicomponent reactions, Mailard reaction (foods), Strecker amino acid synthesis (Pharmaceuticals & Food), Wittig reactions, Prilezhaev reaction	12
	Total	**45**

List of Textbooks/Reference Books

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

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

CO1	Explain the aromatic chemistry and interpret the outcome of general transformations (K3)
CO2	appreciate and visualize the reactions involving radicals such as cyclizations, pericyclic reactions in synthesis (K3)
CO3	understand the importance of heterocycles, learn the properties and synthetic routes, interpret IUPAC of compounds and decipher outcomes of various transformations involving heterocycles (K3)
CO4	apply the knowledge obtained through the course to predict the outcome of reactions and devise solutions to unknown problems (K3)

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

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

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

List of Prerequisite Courses

Standard XII Physics, Applied Physics – I, Physics Laboratory

List of Courses where this course will be prerequisite

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

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

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

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

List of Textbooks/Reference Books

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

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

CO1	do simple quantum mechanics calculations (K3)
CO2	define various terms related to properties of materials such as, permeability, polarization, etc (K2)
CO3	state some of the basic laws related to quantum mechanics as well as magnetic and dielectric properties of materials (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	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
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; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

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

List of Prerequisite Courses

HSC Standard Mathematics, Applied Mathematics – I (MAT1101)

List of Courses where this course will be prerequisite

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

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

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

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

	Total	**60**
List of Textbooks/ Reference books		
1	Kreyszig, E.; Advanced Engineering Mathematics; 10th ed.; Wiley Global Education (2010) (Officially Prescribed)	
2	Iyengar, S. R. K.; Jain, R. K. Advanced Engineering Mathematics; 4th ed.; Alpha Science (2014)	
3	Jain, M. K.; Iyengar, S. R. K.; Jain, R. K. Numerical Methods for Scientific and Engineering Computation; 4th Ed.; New Age International (P) Ltd. (2004)	
4	Boyce, W. E.; DiPrima R. C. Elementary Differential Equations; 10th ed.; John Wiley & Sons (2012)	
5	Brown, J. W.; Churchill, R. V. Fourier Series and Boundary Value Problems; 8th ed.; McGraw-Hill Higher Education (2011)	
Course Outcomes (Students will be able to…..)		
CO1	solve system of linear algebraic equations (K3)	
CO2	do numerical integrations of functions (K3)	
CO3	solve higher order ODE by analytical methods (K4)	
CO4	solve initial value problems using numerical methods (K3)	
CO5	apply Fourier series and Laplace transform techniques to solve ODE and PDE (K3)	

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

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

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

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

	Course Code:	Course Title:	Credits = 4		
	CET1507	Process Calculations	L	T	P
	Semester: II	Total Contact Hours: 60	2	2	0

List of Prerequisite Courses

Standard XII Mathematics, Chemistry, Physics

List of Courses where this course will be prerequisite

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

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

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

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	Introduction to chemical process calculations, Overview of single- and multistage operations, Concept of process flow sheets	2
2	Revision of Units and Dimensions, Dimensional analysis of equations, Mathematical techniques	4
3	Mole concept, Composition relationship, Types of flow rates	2
4	Material balance in non-reacting systems: Application to single- and multistage processes	8
5	Stoichiometry	2
6	Material balance in reacting systems: Application to single- and multistage processes	6
7	Behavior of gases and vapors	4
8	Introduction to Psychrometry, Humidity and air-conditioning calculations.	6
9	Calculation of X-Y diagrams based on Raoult's law.	2
10	Applications of material balances to multiphase systems	6
11	Basic concepts of types of energy and calculations	2
12	Application of energy balance to non-reacting systems	6
13	Application of energy balance to reacting systems	6
14	Fuels and combustion	4
	Total	**60**

List of Text Books/ Reference Books

1	Elementary Principles of Chemical Processes, Felder, R.M. and Rousseau
2	Chemical Process Principles, Hougen O.A., Watson K. M.
3	Basic Principles and Calculations in Chemical Engineering, Himmelblau,
4	Stoichiometry, Bhatt B.I. and Vora S.M.

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

CO1	convert units of simple quantities from one set of units to another set of units (K2)
CO2	calculate quantities and /or compositions, energy usages, etc. in various processes and process equipment such as reactors, filters, dryers, etc. (K3)
CO3	apply material balances in multiphase systems (K3)
CO4	apply energy balance to various systems (K3)

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

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

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

List of Prerequisite Courses

Applied Physics - I

List of Courses where this course will be prerequisite

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

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

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

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

List of Text Books/ Reference Books

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

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

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

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

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	2	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; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: HUP1101	Course Title: Communication Skills	Credits = 2		
			L	T	P
	Semester: II	Total Contact Hours: 45	0	0	4

List of Prerequisite Courses

Standard XII English

List of Courses where this course will be prerequisite

All

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	5
2	The writing skills should emphasize technical report writing, scientific paper writing, letter drafting, etc.	12
3	The oral communication skills should emphasize presentation skills.	5
4	Use of audio-visual facilities like powerpoint, LCD. for making effective oral presentation	12
5	Group Discussions	11
	Total	**45**

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	3	2	3	3
CO2	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
Course	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

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

List of Prerequisite Courses

Standard XII 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, 4thedition 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	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
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; − No Contribution

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

Semester III

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

List of Prerequisite Courses

Standard XII Biology

List of Courses where this course will be prerequisite

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

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

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

	Course Contents (Topics and Subtopics)	Required Hours
1	Overview of basics of Human Anatomy and Physiology, the terminologies used etc. Definitions of Anatomy, Physiology, Histology, Biochemistry, Homoeostasis, Health, Disease, Toxicity, Safety, Genotoxicity, etc. Systems that make the human body, the rationale behind introducing the subject to the technology students of Pharma, foods, Polymers, Surface coatings, Oils, Textiles, Dyes	7
2	Overview of the cell functioning as a whole unit and its organelles with their functions and its applications to technology. An overview of normal cell division, cell death by apoptosis, necrosis , Cancerous growth, metabolites/ energy production , cellular secretions, different types of cells, cell repair, biomarkers, etc.	8
3	Overview of Biomaterials: Biodegradable, Biocompatible and their technological applications	5
4	Practical applications: design some simple experiments to evaluate toxicity using cellular experiments, organisms, animals etc. OECD guidelines. Concept of Safety studies and industrial relevance. (oral, dermal, inhalation)	5
5	Toxicity evaluation in terms of mortality, Genotoxicity, hypersensitivity (allergy), biocompatibility as per various international guidelines namely, ICH, OECD, ISO to name a few.	10
6	Toxicity evaluation in terms of mortality, Genotoxicity, hypersensitivity (allergy), biocompatibility as per various international guidelines namely, ICH, OECD, ISO to name a few.	5
7	Irritation potential evaluation of Lubricants, surfactants, excipients, etc.	5
	Total	**45**

List of Textbooks/Reference Books

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

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

CO1	understand and explain the basic concepts and terminologies of Biology (K2)
CO2	Appreciate interdisciplinary nature of biology and will be able to design and execute simple experiments (K3)
CO3	understand about the concept of toxicity/safety and its relevance to technology and its applications in everyday life (K2)

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

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

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

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

List of Prerequisite Courses

None

List of Courses where this course will be Prerequisite

Material Technology, Strength of Materials, 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 Thermodynamics:** First Law of Thermodynamics, Steady-flow energy equation, Second Law of Thermodynamics	3
2	**Properties of Steam and Boilers:** Steam formation, Types of steam, Steam Properties – Enthalpy, Simple numerical for finding enthalpy and dryness fraction Steam Boilers: Classification, Working principle of Cochran, Babcock & Wilcox, etc. boilers	6
3	**I. C. Engines:** Classification, Working of 2-stroke, 4-stroke C.I. and S.I. Engines with P-V diagrams, Definitions and simple numerical for determining indicated power, Brake power, Mechanical efficiency, Indicated thermal efficiency, and Brake thermal efficiency	6
4	**Prime Movers:** Classification of Prime movers, Working principle of steam, gas and water turbines, Concept of impulse and reaction steam turbines	4
5	**Compressors:** Classification of compressors, Reciprocating compressors, Single-stage and multistage compressors, P-V diagram, Rotary compressors, Fan, Blower & Compressors, Centrifugal and axial compressors, Application of compressors	4
6	**Pumps:** Classification of pumps, Reciprocating pumps, Centrifugal pumps, Axial pumps, Gear pumps, Maintenance of pumps	4
7	**Refrigeration:** COP of refrigerator and heat pumps, Classification of refrigerants, Nomenclature, Properties desired by refrigerants, Vapour compression refrigeration cycle, Methods of increasing COP of VCRS, Vapour absorption refrigeration systems	5
8	**Renewable Energy:** Role and importance of nonconventional and alternate energy sources such as solar, wind, ocean, bio-mass and geothermal	4
9	**Transmission of Power:** Introduction to various drives such as belt, rope, chain and gear drives, Introduction to mechanical elements such as keys, couplings and bearings in power transmission (No numericals)	5
10	**Properties and Applications of Engineering Materials:** Metals –ferrous, cast-iron, tool steels and stainless steels and non-ferrous aluminium, brass, bronze Polymers – Thermoplastic and thermosetting polymers Ceramics – Glass, optical fibre, glass, cermets Composites – fibre-reinforced composites, metal-matrix composites	4
	Total	**45**

List of Text Books/ Reference Books

1	Nag, P. K. Engineering Thermodynamics; 5th Ed.; McGraw Hill Education (2013)
2	Morse, Frederick T. Power Plant Engineering; 3rd Ed.; Van Nostrand Reinhold Inc. (1953)
3	Ballaney, P. L. Thermal Engineering: Engineering Thermodynamics & Energy Conversion Techniques; 5th Ed.; Khanna Publishers (1966)
4	Lal, J. Hydraulic Machines Including Fluidics; 6th Ed.; Metropolitan Book Co. Pvt. Ltd. (2016)
5	Twidell, John; Weir, Tony. Renewable Energy Resources; 3rd Ed.; Routledge (2015)
6	Rai, G. D. Non-conventional Energy Sources; Khanna (1988)
7	Arora, C. P. Refrigeration and Air Conditioning; 4th Ed.; McGraw Hill (2021)
8	Rattan, S. S. Theory of Machines; 5th Ed.; McGraw Hill (2019)

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

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

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	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	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
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; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: PST1301	Course Title: Spl 1 -Polymer Science & Technology	Credits = 4		
			L	T	P
	Semester: III	Total Contact Hours: 60	3	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 (PSP1301), Analysis & Characterization of Resin and Polymers (PSP1504), Technology of Thermoset (PST1506), Technology of Thermoset Polymers (PST1504)

Description of relevance of this course in the B. Tech. (Surface coating 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	5
3	Natural Polymers: Chemical & Physical structure, properties, source, important chemical modifications, applications of polymers such as Lignin, starch, rosin, shellac, latexes etc.	5
	Ethyl Cellulose Methyl Cellulose Nitro cellulose Cellulose acetates etc.	5
	Vegetable oils and gums, proteins etc.	5
4	Manufacturing Chemistry, properties applications of raw material for synthetic polymers like Ethylene, propylene, butadiene, vinyl chloride, vinylidene dichloride, styrene etc.	5
	Polyols like ethylene glycol propylene ethylene glycol and their modification etc	5
	Acrylic monomers like acrylic acid, acrylonitrile, methacrylic acid, methacrylates, acrylamide etc	5
	Azelic acid sabacic acid aminododacnoic acid etc	5
	Phenol modified phenols Formaldehyde Epiclorohydrine Bisphenol A melamanine isocynates etc	5
5	Storage Handling Hazards of monomers	5
6	Evaluation of raw materials and reactants for synthesis & manufacturing of resins and polymers.	5
	Total	**60**

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)

		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	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

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

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

List of Prerequisite Courses

Structural Mechanics, Applied Physics, Applied Chemistry

List of Courses where this course will be prerequisite

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

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

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

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	Engineering Materials: Classification, Fundamentals of Engineering properties of materials, Phase diagrams, Study of ferrous and nonferrous materials	12
2	Composite and smart materials	03
3	Structure-Property Relationship: Subatomic to macroscopic level, Modification and control of material properties	10
4	Theory of Failure of Materials: Fracture, creep and fatigue	08
5	Corrosion Engineering: Electrochemical principles, different types of corrosion, Polarization, Mechanisms of corrosion control and prevention, Preventive coatings. Corrosion behavior of industrial materials	08
6.	Criteria for selection of materials in Chemical Process industry	04
	Total	**45**

List of Textbooks

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

List of Additional Reading Material/Reference Books

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

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

CO1	resolve the issues related to mechanical failure (K3)
CO2	troubleshoot corrosion-related industrial problems (K3)
CO3	learn from incidences (LFI) (K2)

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

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

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

Course Code: CHT1133	Course Title: Chemistry and applications of coloroants	Credits = 4		
		L	T	P
Semester: III	Total contact hours: 60	3	1	0

List of Prerequisite Courses

HSC (Science), Organic Chemistry

List of Courses where this course will be prerequisite

Technology of Textile Dyeing, Additives for polymers (PET 1507), Additives for Coatings (SCT 1509) Compounding and polymer Processing (PET1607) Analysis of Paints (SCP1812) Synthesis, processing and characterization of colorants (SCP1608), Experimental Dyeing, Theory of Textile Coloration

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

Students will understand the chemistry behind the colorants.

They will be able to explain the its applications in various field according to the chemistry involved..

Sr. No.	Course Contents (Topics and subtopics)	Reqd. hours
1	Introduction of Pigments ,Colour Index Generic Names of Pigments, Colour Constitution Number ,Polymorphism, Properties required in a pigment and extender, Pigment dispersion basics Classification of inorganic and organic pigments with examples, additive and substractivecolour mixing. Definitions of pigment, extenders, dyes, pigment dyestuffs, toner and lakes	5
2	Theory of color formation in organic compounds, effect of auxiliary groups on the shade and hue of the pigment (Bathochromic and hyper chromic shift) Practices and requirement of Pigments	5
3	Inorganic pigments such as titanium dioxide, zinc oxide, carbon black, chromate pigments, molybdate orange, chrome green. General methods of processing and synthesis of inorganic pigments: Crushing and grinding, vaporization, co precipitation, filtration, drying, flushing, calcinations/roasting, vapour phase oxidation etc. Raw materials for organic pigments: A brief study of coal tar distillation and the role of distillation products in the manufacture of synthetic dyes: bases and precipitants used in the colour striking, toners and	5
4	Ultramarine blue, iron blue, cadmium red, pearlescent and other effect pigments Ceramic pigments, metal flake pigments, extenders	5
5	Organic pigments such as Antraquinone, Benzimidazolonedioxazines, Diazo lakes	5
6	Litholrubones, Monoazo lakes, Napthol AS lakes, Napthol AS, Perylenes, Phthalocyanines, Quinacridones effect pigments	5
7	Pigments for Plastics, Textiles, Paints, Resins,PrintingInk,Cosmetics, Rubbers,Special Application fields.	5
8	Spectral properties of colorants, Jablonski diagram, classification of dyes a application/constitution, empirical treatment of colour and constitution	5
9	Azo dyes: Diazotisation and coupling reactions, azoic colours, acid dyes, mono azo dye; diasazo, nitro, diphenylamine and anthraquinone dyes; acid mordant dyes, azo metal complex dyes, direct dyes	5
10	Basic dyes: Diphenylmethane and triphenylmethane dyes and heterocyclic analogues thereof, triphenodioxazine dyes. Disperse dyes: azo, anthraquinone, dinitrophenylamine, methine dyes; properties in relation to constitution	5

11	Vat dyes: Indigoid, anthraquinonoid and polycyclic quinonoid dyes; solubilised vat dyes. Sulphur dyes and sulphurised vat dyes	5
12	Reactive dyes: Chlorotriazine and other halo heterocyclic compounds, vinyl sulphone based dyes, high fixation, highly substantive, neutral fixing bifunctional reactive dyes.	5
	Total	60

List of Text Books/ Reference Books

1	Color Chemistry, 3rd Edition, Heinrich Zollinger, Wiley – VCH 2003
2	Colorants and Auxiliaries: Colorants v. 1: Organic Chemistry and Application Properties,
3	The Chemistry of Synthetic dyes, K. Venkataraman, Academic Press (1 January 1971)
4	Industrial Inorganic Pigments, Gunter Buxbaum, Wiley-VCH; 1 edition (March 11, 2005)
5.	Industrial Organic Pigments: Production, Properties, Applications, 3rd, Completely Revised
6.	Application Properties of Pigments By A.Karnik, First Edition Thane1999

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

CO1	Understand fundamental knowledge on basics of chemistry involved in the colorants. (K2)
CO2	Describe the types of pigments and their applications (K2)
CO3	Compare the physical properties of Pigments and dyes to differentiate them (K4)
CO4	Illustrate synthetic methods used for azo dyes and their properties. (K3)
CO5	Identify types of dyes on the basis of application, properties and functional groups. (K2)

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

POs		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
K level		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K5	K4	K3
CO1	K2	3	2	2	3	2	2	3	3	2	1	2	3	3	2	3
CO2	K2	2	1	3	2	2	2	2	2	2	2	2	2	3	2	3
CO3	K4	3	3	2	3	3	3	3	2	1	2	2	3	2	2	2
CO4	K3	3	2	2	3	3	2	3	1	2	2	2	3	3	3	3
CO5	K2	2	2	3	2	2	2	3	2	2	1	3	3	3	2	3
Course	K4	3	2	3	3	3	2	3	2	2	2	2	3	3	2	3

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

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

	Course Code: PYT1203	Course Title: Colour Physics & Colour Harmony	Credits = 3		
			L	T	P
	Semester: III	Total contact hours: 45	2	1	0

List of Prerequisite Courses

H. S. C. Science

List of Courses where this coursewill be prerequisite

Chemistry and Application of Colorants

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

This subject will be useful for understanding choice of material for dyeing and printing for specific requirement of color or shade.

	Course contents(topics/subtopics)	Required hrs
1	**Introduction:** Colour as a concept, its definition, geometric and chromatic	3
2	**Radiation and illumination:** SPD, CT andCCT; Sources and illuminants; Need for artificial sources – various ways of producing light and different artificial sources; efficacy and colour rendering properties of sources.	6
3	**Interaction of radiation with matter** : gloss and diffused reflectance, travel, flip and flop colour,polar diagrams; absorption of light in sample-various transitions in dye molecule, Beer – Lambert law and its verification, deviation from Beer – Lambert law, Additivity of absorbances, mixture analysis, various instruments used for the purpose; absorbance and scattering in the sample –	8
4	**Perception of colour** in **eye \ brain**: various colour coding processes at retina and beyond it, colour constancy, colour theories, anomalous colour visions, metamerism	6
5	**Colour specification**: Additive-substractive mixing, Grassmann's law,1931 and1964CIE system-XYZ and L*a*b*colour spaces, colour difference formulae, Munsell colour order system	8
6	**Recipe match prediction**: Single constant Kubelka – Munk theory of colourant formulation and recepie prediction; Modern computerised methods of colour matching	6
7	**Colour Harmony**: Definition, colour associations, colour harmony theories; colour contrasts-successive and simultaneous contrast, contrast of proportion, intensity, value, hue etc.(Itten's contrasts);colour wheel and various colour schemes, dominant, subdominant and accent colours; visual weight and balance in colour schemes	8
	Total	45

List of Text Books/ Reference Books

1	Colour Physics for Industry, R. McDonald, West Yorkshire, 1997.
2	Color: A Multidisciplinary Approach; Zollinger Heinrich Zurich, Verlag Helvetica Chemica Acta. 1999
3	The Colour Science of Dyes and Pigments, R. McLaren Bristol, Adam Hilger Ltd., 1983
4	Industrial Colour Technology, Johnson R. M., Sartzman M, American Chemical Society, Washington D.C., 1971.
5	Coloring of Plastics: Fundamentals by Robert A. Charvat John Wiley & Sons, 11-Mar-
6	Coloring of plastics: theory and practice by M.Ahmad Van Nostrand Reinhold, 1979

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

CO1	Understand the colour perception and the effect of various parameters on it. (K2)
CO2	Understand various visual and colour processes in human beings. (K2)

CO3	Understand various systems to specify uniquely a colour stimulus and use them to do so. (K3)
CO4	Use knowledge of such colour systems to predict recipe (K3)
CO5	Understand various colour harmony theories and the use of colour wheel. (K3)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)																
POs		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
K level		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K5	K4	K3
CO1	**K2**	2	1	1	1	1	1	1	2	2	2	2	2	2	2	3
CO2	K2	2	1	1	1	1	1	1	2	2	2	2	3	2	2	2
CO3	K3	3	2	2	2	2	2	2	3	2	3	2	2	3	3	2
CO4	K3	3	2	2	2	2	2	2	3	3	3	2	3	2	3	3
CO5	K3	3	2	1	1	1	2	2	3	2	2	3	3	3	3	2
Course	K3	3	2	2	1	2	2	2	3	2	2	2	3	2	3	2

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: PSP 1301	**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 (CHT 1341), Physical Chemistry II (CHT1342), Analytical Chemistry (CHT 1401), Applied Mathematics- I (MAT1101)					
List of Courses where this course will be prerequisite					
	Technology of Thermoplastic Polymers (PST1504) Technology of Thermoset Polymers (PST1506) Synthesis & Characterization of Resins & Polymers Lab (PSP1503) Analysis and characterization of Resins and polymers Lab (PSP1504)				
	Description of 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 Daniel flow-point 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 purity of functional raw materials (K3)
CO4	Manage to separate various solvents from their mixture (K5)
CO5	Design experiment to determine 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; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: PSP 1204 **By Physics Dept.**	**Course Title: Colour Physics Lab(By Physics)**	**Credits = 2**		
			L	**T**	**P**
	Semester: III	**Total contact hours: 60 hrs**	**0**	**0**	**4**
List of Prerequisite Courses					
	Inorganic Chemistry Organic Chemistry Engineering, Mathamatics, Engineering Physics				
List of Courses where this course will be prerequisite					
	Colour Physics and Color Harmony Lab, Additives for Polymers, (PET1507), Additives for Coatings(SCT 1509), Synthesis, processing and characterization of colorants (SCP 1608), Technology of Textile Dyeing, Technology of Textile Printing, Technology of Garment Manufacturing. & Processing				
Description of relevance of this course in the B. Tech./B. Pharm. Program					
Students will be trained to determine various parameters related to colour physics which are applicable in different fields.					
	Course contents(topics/subtopics)		**Required hrs**		
1	Determination of unknown concentration of a dye in solution by Dubosque colorimeter.		**1x4hr/week**		
2	Verification of B-L law (dependence of absorbance on concentration) by spectrophotometer.				
3	Mixture analysis using spectrophotometer.				
4	Determination of gloss of various samples using gloss meter				
5	Determination of color of various textile samples in terms of Lovibond primaries and chromaticity co-ordinates using Lovibond tintometer				
6	Specification of color of a textile sample in terms of ‘Lab’ at using color computer.				
7	Finding color differences (ΔE) between set of samples vis a vis dye solution concentration				
8	Finding color differences (ΔE) between set of samples vis a vis time of exposure.				
9	Determination of colors of samples in terms of Munsell color system using Munsell Color Tree				
10	Recipe prediction and matching of colored samples using CCM.				
Course Outcomes (students will be able to.....)					
CO1	Evaluate and estimate about various colour specifying systems and schemes of quantification of colour. (K5)				
CO2	Use instrument such as gloss meter, color spectrophotometers (K3)				
CO3	Measure the intensity of the transmitted light and correlate it with concept of chromophore and colour (K4)				
CO4	Use instruments to uniquely specify a colour in terms of nos. (K3)				
CO5	Recognize about various concepts of colour mixing, sources etc. (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	K5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
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	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO5	K2	3	2	1	2	1	3	3	3	3	3	3	1	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; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

Semester IV

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

List of Prerequisite Courses

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

List of Courses where this course will be Prerequisite

Material Technology, Strength of Materials, Environment Science and Technology

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

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

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

	Recycling of waste – value addition Testing of Materials and its relevance	
	Total	**45**

List of Text Books/ Reference Books

1	Thadani, B. N. Engineering Mechanics; Asia Publishing House (1966)
2	Popov, Egor P. Introduction to Mechanics of Solids; Macdonald (1968)
3	Beer. Mechanics of Materials; 7th Ed.; Mc Graw Hill India (2016)
4	Dadhe, V. G.; Jamdar, M. G.; Walavlkar, Y. N. Fundamentals of Applied Mechanics; Sarita Prakashan (1989)
5	Timoshenko, S.; Young, D. H.; Rao, J. V.; Pati, Sukumar. Engineering Mechanics; 5th Ed.; McGraw Hill Education (2017)
6	Singer, Ferdinand L.; Pytel, Andrew. Strength of Materials; 4th Ed.; Harper Colins Publishers (2012)
7	Kaw, Autar K. Mechanics of Composite Materials; 2nd Ed.; CRC Press (2006)
8	Shetty, M. S.; Concrete Technology: Theory and Practice; S. Chand & Co. Ltd. (2005)

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

CO1	quantify the actions and able to find reactions by applying conditions of equilibrium, find out the Centroid and Moment of Inertia for various cross sections used in engineering structures and for plane areas and be able to draw the Shear Force and Bending Moment diagram for different types of beams under simple and complex loading (K3)
CO2	calculate the forces, reactions, stresses, strains in components of the bodies of a complex engineering structure (K3)
CO3	find out the Bending Stresses at different positions and Shear Stress distribution across the cross section at various points and calculate the Slope and Deflection at different points under simple and complex loading (K3)
CO4	explain various materials used in various applications in engineering. Cement composite – Concrete, Chemicals used to alter the properties of concrete (K2)

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

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

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

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

List of Prerequisite Courses

XIIth Standard Physics and Mathematics

List of Courses where this course will be prerequisite

This is a basic course required in special subjects that deal with flow 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, Fluid moving machinery such as pumps	10
3	Particle Dynamics, Flow through fixed and fluidized Beds	4
4	Equations of Continuity and Motion in laminar flows and its applicationsfor simple Couette flow and Poiseuille flow applications	6
5	Heat conduction, Convective heat transfer and concept of heat transfer coefficient	4
6	Design and Constructional Aspects of Exchangers: Types of flows – Concurrent, counter-current and cross flows, Log mean temperature difference, Double-pipe and Shell and tube heat exchangers Introduction to other heat exchangers like, PHE, finned tube heat exchangers, graphite block, etc.	10
7	Heat transfer aspects in agitated tanks, Condensers, Reboilers and evaporators	6
8	Fundamentals of Mass Transfer: Molecular diffusion in fluids, concept 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	calculate friction factor, pressure drop, power (K3)
CO2	calculate flow and power required for pumps(K3)
CO3	calculate heat transfer coefficients and do basicsizing of double pipe and shell and tube heat exchangers (K3)
CO4	calculate mass transfer coefficients and estimate mass transfer rates in simple situations (K3)

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

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

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

	Course Code: GET1105	Course Title: Electrical Engineering and Electronics	Credits = 3		
			L	T	P
	Semester: IV	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

Standard XII Physics and Mathematics courses

List of Courses where this course will be prerequisite

Various Technology Courses and Professional Career

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

In this course, students will get an insight to the importance of Electrical Energy in Chemical Plants. The students will understand basics of electricity alongside basic knowledge about Transformer and selection of different types of drives for a given application process. They will get basic knowledge of electronic devices and their applications in Power supplies, amplifiers and other circuits.

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	Basic Laws: Kirchoff's current and voltage law, Simple series and parallel connections, star and delta transformation. Mesh and nodal analysis, Basic elements R, L and C. Concept of self and mutual inductance	6
2	Network theorems: super position, Thevenin's theorems	3
3	A.C. Fundamentals: Equations of alternating voltages and currents, cycle, frequency. Time period, amplitude, peak value average value, R.M.S. value, A.C. through resistance, inductance and capacitance, simple RL, RC and RLC circuits. Resonance in series RLC circuits, Power, power factor, series and parallel circuits	5
4	Three Phase systems: Star and delta connections, relationship between line and phase voltages and currents, Power in three phase circuits	5
5	Transformer: Introduction, principle of operation, e.m.f. equation, phasor diagrams. Ideal transformer, transformer on no load, Transformer under load, Transformer losses, efficiency, regulation	5
6	Introduction to dc and ac drives	5
7	Diodes and rectifiers: P-N junction diode characteristics, Zener diode, Half wave and full wave rectifiers, their waveforms, brief introduction to filters	4
8	Bi-polar junction transistor: Current components. Modes of operation, Input and output characteristics, Regions of operation, Transistor as an amplifier, classification of amplifiers	6
9	Introduction to Uni junction transistor, Characteristics, UJT relaxation oscillator	3
10	Silicon controlled rectifier, controlled rectification, characteristics, methods of turning-on. Applications	3
	Total	**45**

List of Textbooks/Reference Books

1	Electrical Engineering Fundamentals by Vincent Deltoro
2	Electronic devices and circuits by Boylstead, Nashelsky
3	Electrical Machines by Nagrath, Kothari
4	Electrical Machines by P.S. Bhimbra
5	Electrical Technology by B. L. Theraja, A.K.Therajavol I,II,IV
6	Thyristors and their applications by M. Ramamurthy
7	Power Electronics by P.S. Bhimbra

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

CO1	Explain the basic concepts of D.C circuits. Solve basic electrical circuit problems (K3)
CO2	Explain the basic concepts of single phase and three phase AC supply and circuits (K2)
CO3	Explain the basic concepts of transformers & motors used as various industrial drives (K2)
CO4	Explain 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	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	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
Course	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: PST 1303	Course Title: Spl 2- Polymer Chemistry & Technology	Credits = 4		
			L	T	P
	Semester: IV	Total Contact Hours: 60	3	1	0

List of Prerequisite Courses

HSC (Science)

List of Courses where this course will be Prerequisite

High Polymer Chemistry (PST1404), Structure Property Relationship (PST1609), Compounding and Polymer Processing (PET1607), Technology of Thermoplastics (PST1504), Technology of Thermosets (PST1506).

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, Poly dispersity 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 &kinitics 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
Curse	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: PST1404	Course Title: Spl 3-High Polymer Chemistry	Credits = 3		
			L	T	P
	Semester: IV	Total contact hours: 45	3	0	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 mechanisms of free radical and ionic polymerization. To make aware of polymemer synthesis via CRP,ROP GTP etc, They will learn about catalyst used in polymers synthesis like ziegglar-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	3
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	4
4	Interfacial polymerization, Melt polycondensation, Solution polycondensation.	5
5	Advanced polymer synthesis and mechanisms , Ring opening metathesis polymerization (ROMP), ring forming polymers,	3
6	Group transfer Polymerization ,Photopolymerization ,Mini-dispersion polymerization,	5
7	Cyclopolymerisation, Oxidative polymerization, Dispersion polymerization ,Metal catalyzed olefin polymerization	4
8	Introduction to Ziegglar natta catalyst its Mechanism with examples of different systems,Effect of catalyst, co- catalyst their ratio, types of metals used their form & pendent groups	3
9	Supported unsupported catalysts, soluble insoluble system, efficiency& rate affecting factors like catalyst/ co catalyst, effect on molecular weight/ MWD & effect on tacticity	3
10	Introduction to Metallocene catalysts with examples of different systems	3

11	Hyperbranched polymers, Dendrimers, Interpenetrating Networks	4
12	Microbial synthesis of polymers, Template polymerization	3
	Total	45

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, Bill Meyer, 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 – 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	Comparison of various monomers and their selection based on achieving required properties (K4)
CO3	Describe and Design advanced techniques of polymerization (K5)
CO4	Distinguish about various catalyst used in polymers synthesis like ziegglar-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)

		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	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
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; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: PET1507	Course Title: Spl 4- Additives for Polymers	Credits = 3		
			L	T	P
	Semester: IV	Total contact hours: 45	2	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	3
4	Flame Retardants	3
5	Conductivity, Antistatic and conductive Polymers	3
6	Curing & Curing agents	3
7	Coupling agents and Compatibilization agents	5
8	Plasticizer	5
9	Blowing Agents	5
10	Processing and modifier aid	3
11	Lubricants Mould Release Agents, Antislip and Antiblocking additives	3
12	Appearance Colorants Pigments Dyes Special Effects, Appearance Black and White Pigmentation	3
13	Additives for rubber and recycling, mixing, compounding, Health and Safety	3
	Total	**45**

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	Describe the importance of various additives such as flame retardant, plasticizer, blowing agents, processing and modifier aid, UV stabilizer etc (K3)
CO3	Use proper dosage of additives based on their requirements and chemistries (K3)
CO4	Distinguish between the various additive chemistries (K4)
CO5	Solve the problems during processing, end application by selecting proper additives, their dosage, combination based on requirement (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	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; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: GEP1106	Course Title: Electrical Engineering and Electronics Laboratory	Credits = 2		
			L	T	P
	Semester: IV	Total Contact Hours: 45	0	0	4

List of Prerequisite Courses

Standard XII Physics and Mathematics courses

List of Courses where this course will be prerequisite

Various Technology Courses and Professional Career

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

In this course, students will get an insight to the importance of Electrical Energy in Chemical Plants. The students will understand basics of electricity alongside basic knowledge about Transformer and selection of different types of drives for a given application process. They will get basic knowledge of electronic devices and their applications in Power supplies, amplifiers and other circuits.

	Course Contents (Topics and Subtopics)	Required Hours
	Suitable no of experiments out of the following will be conducted -	
1	Superposition Theorem	5
2	Thevenin's Theorem	5
3	Series RL circuit	5
4	Resonance in Series RLC circuit	5
5	H.W. and F.W. Rectifiers	4
6	Cathode Ray Oscilloscope	5
7	Input and output characteristic of npn transistor in CE mode	2
8	Load Test on Transformer	2
9	Three phase star connection	2
10	Three phase delta connection	2
11	Study of UJT relaxation oscillator	2
12	Design of UJT relaxation oscillator	2
13	Load Test on 3 phase induction motor	2
14	Study of Thermocouple	2
	Total	**45**

List of Textbooks/Reference Books

1	Electrical Engineering Fundamentals by Vincent Deltoro
2	Electronic devices and circuits by Boylstead, Nashelsky
3	Electrical Machines by Nagrath, Kothari
4	Electrical Machines by P.S. Bhimbra
5	Electrical Technology by B. L. Theraja, A.K.Therajavol I,II,IV
6	Thyristors and their applications by M. Ramamurthy
7	Power Electronics by P.S. Bhimbra

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

CO1	Explain concepts of basic working of D.C circuits (K2)
CO2	Explain the basic applications of single phase and three phase AC supply and circuits (K2)
CO3	Explain the working and utility of transformers and motors used as various industrial drives (K2)
CO4	Apply the basic principles in electronic devices and circuits (K3)

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

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K2	3	2	1	2	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
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; − No Contribution

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

	Course Code: MAP 1201	Course Title: Computer Application Lab	Credits = 2		
			L	T	P
	Semester: IV	Total Contact Hours: 60	0	0	4

List of Prerequisite Courses

HSC Standard Mathematics, Applied Mathematics – I

List of Courses where this course will be prerequisite

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

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

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

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

List of Textbooks/ Reference Books

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

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

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

Mapping of Course Outcomes (Cos) with Programme Outcomes (Pos)															
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	2	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	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; – No Contribution

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

Semester V

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

List of Prerequisite Courses

Process Calculations, 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. Programme

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

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	Distillation: Fundamentals of flash-, batch- and continuous distillation, Distillation columns internals, Steam and azeotropic distillation	12 – 15
2	Liquid-Liquid Extraction: Solvent selection, Construction of ternary diagrams, Staged calculations, Types of extraction equipment	6
3	Crystallization: Phase diagram (temp/solubility relationship), Evapo-rative and cooling crystallization, Introduction to different types of crystallizers	5
4	Filtration: Mechanism of filtration, Basic equation, Constant volume, Constant pressure filtration, Rate expressions with cake and filter cloth resistances, Compressible and incompressible cakes, Introduction to various types of filters	5
5	Drying: Drying mechanism, Drying rate curves, Estimation of drying time, ypes of dryers	5
6	Introduction to Other Aspects of Unit Operations: Content will be aimed towards understanding practical and safety aspects of unit operations and/or introducing other separation processes like: adsorption/ion exchange, membrane processes and gas absorption, etc.	9 – 6
7	Industrial Case Studies: Interactive discussion with experienced professionals from industry or equipment vendors with emphasis on applicability, importance and challenges of different unit operations	3
	Total	**45**

List of Text Books/ Reference Books

1	Richardson, J.F., Coulson, J.M., Harker, J.H., Backhurst, J.R., 2002. Chemical engineering: Particle technology and separation processes. Butterworth-Heinemann, Woburn, MA.
2	Seader, J.D., Henley, E.J., 2005. Separation Process Principles, 2 ed. Wiley, Hoboken, N.J.
3	Svarovsky, L., 2000. Solid-Liquid Separation. Butterworth-Heinemann, Woburn, MA.
4	McCabe, W., Smith, J., Harriott, P., 2004. Unit Operations of Chemical Engineering, 7 ed. McGraw-Hill Science/Engineering/Math, Boston.
5	Green, D., Perry, R., 2007. Perry's Chemical Engineers' Handbook, Eighth Edition, 8 ed. McGraw-Hill Professional, Edinburgh.
6	Dutta, B.K., 2007. Principles of Mass Transfer and Separation Process. Prentice-Hall of India Pvt. Ltd, New Delhi.

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

CO1	perform basic sizing of continuous and batch distillation columns (K3)
CO2	analyze filtration data and select systems based on requirements, estimate filtration area for given requirements, understand filter aids and their usage (K4)
CO3	describe few industrial crystallization, filtration and drying equipment (K2)
CO4	describe the need and importance of other separation processes like adsorption, ion exchange and membrane (K2)
CO5	Apply the concept of unit operation in chemical industries (K3)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	2	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
CO4	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO5	K3	3	3	2	2	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; – No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

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

List of Prerequisite Courses

Physical Chemistry – I 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

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

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

List of Textbooks

1 Elements of Chemical Reaction Engineering – H. Scott Fogler

List of Additional Reading Material / Reference Books

1 Heterogeneous Reactions, Vol.I and II –L.K. Doraiswamy, M.M.Sharma

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

CO1	describe and apply the principles of various types of reactors (K3)
CO2	calculate rates of reactions based on given reaction scheme (K3)
CO3	design various components of reactors used in industrial practice (K3)
CO4	compare various reactors and select an appropriate reactor for a given situation (K4)

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

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	2	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	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; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: PST1504	Course Title: Spl 5-Technology of Thermoplastic Polymers	Credits = 4		
			L	T	P
	Semester: V	Total Contact Hours: 60	3	1	0

List of Prerequisite Courses

Polymer science and Technology (PST1301), Polymer chemistry and Technology (PST1303), Raw material Analysis of resins and polymers (PSP1301), High Polymer Chemistry (PST 1404)

List of Courses where this course will be Prerequisite

Compounding and Polymer Processing (PET1607), 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. (Surface coating Tech.) Programme

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 ofpolymers polyolefins like LDPE HDPE etc.	5
2	Polypropylene and copolymer of PP Plastomers	5
3	Copolymer of polyolefines like EVA LLDPE EAA etc.	5
4	Polystyrene, HIPS, SAN	5
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	5
7	Polycarbonates, Polyacetals	5
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	5
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		**60**

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)
CO3	Discuss the practical applications of thermoplastics in real world and structure properties and relationship. (K2)
CO4	Describe the basic processing methods related to of the thermoplastics polymers. (K2)
CO5	Distinguish between different grades of commodity and engineering plastics manufacturer suppliers of them in the market. (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	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
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; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: PST1506	Course Title: Spl 6- Technology of Thermoset Polymers	Credits = 3		
			L	T	P
	Semester: V	Total Contact Hours: 45	3	0	0

List of Prerequisite Courses

Polymer science and Technology (PST1301), Polymer chemistry and Technology (PST1303), Raw material Analysis of resins and polymers (PSP1301), High Polymer Chemistry (PST 1404)

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. (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	3
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.	3
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.	3
6	Processes like one-shot process, Polyether pre-polymers, Quasi- pre-polymer polyether foams, etc. Flexible foams Polyurethanesin Coatings Polyisocyanates IPN using polyurethanes-acrylicblends.	3
7	Silicones Theromoplastic and Thermoset; Preparation of intermediates, Grignard's method, directs method, olefin addition method, sodium condensation method, rearrangement of organochlorosilanes.	5
8	Nature and effect of Si-H, Si-O, Si-Si, and Si-C bond. Silicone fluids, resins, elastomers.	5
9	Compounding, Processing and applications of Silicone resins. Modified silicone	5

	resins.	
10	Thermosetting acrylics: Synthesis of acrylic polymers and co- polymers, different techniques. Structure property relationship application of thermosetting acrylics, like anaerobicadhesives, laminating resins, etc	5
11	Miscellaneous thermosetting polymers.	5
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; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: PET 1609	Course Title: Spl 7- Design and Fabrication of Molds	Credits = 3		
			L	T	P
	Semester: V	Total contact hours: 45	2	1	0

List of Prerequisite Courses

Engineering Graphics, Technology of Thermoplastics (PST 1504), Technology of Thermosets (PST1506), Strength of Materials

List of Courses where this course will be prerequisite

Packaging plastics and its application, Research and Development of New Product

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

The course gives insight into designing of molds. The thought process behind developing a mold. It improves the ability to think about proper product design.

	Course Contents	Reqd. hrs
1	Compression moulds: Positive, semi-positive and flash mould with horizontal and vertical flash, arrangement of loading shoes, simple two plate and three plate moulds, split moulds.	5
2	Transfer moulds: Principles of internal pot, auxiliary ram and separated pot mould, calculation of number of cavities.	5
3	Injection moulds : Two plate and three plates types, injection, venting, runner and gets, calculation of number of cavities, hot runner mould	10
4	Extrusion dies: extrusion of simple shapes tubing, cable covering and sheeting dies.	10
5	Mould fabrication: steels for molding tools and their treatment include processes used for mould fabrication, finishing processes.	5
6	Heating system for plates and moulds, measurement and control of temperature of moulds and dies, simple blow mould	5
7	Introduction to computer aided design and software design aspects for moulds and dies	5

Course Outcome (Students will able too…)

CO1	Compare different processing technique and their molds (K4)
CO2	Interpret importance of mold during processing (K3)
CO3	Propose a design and draw the design based on product requirement (K5)
CO4	Design a mold for various processing technique(K5)
CO5	Assemble different mold geometries based on requirements and processing (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	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	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; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: MAT 1106	Course Title: Design and Analysis of Experiments	Credits = 4		
			L	T	P
	Semester: V	Total Contact Hours: 60	3	1	0

List of Prerequisite Courses

HSC Standard Mathematics, Applied Mathematics – I, Engineering Application of Computers (MAP1201)

List of Courses where this course will be prerequisite

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

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

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
	Module I (Statistical Theory of Design of Experiments)	
1	**Fundamental Principles of Classical Design of Experiments:** Strategy of Experimentation, Typical applications of experimental design, Basic principles, Guidelines for designing experiments	2
2	**Review of Probability and Basic Statistical Inference:** Concepts of random variable, Probability, Density function cumulative distribution function, Sample and population, Measure of central tendency, Mean, median and mode, Measures of variability, Concept of confidence level, Statistical Distributions: Normal, Log Normal & Weibull distributions, Hypothesis testing	4
3	**Experiments with a Single Factor: Analysis of Variance -** Fixed effect model and Random effect model, Model adequacy checking, Contrasts, Orthogonal contrasts, Regression Models and ANOVA, Violation of normality assumption: Kruskal-Wallis test Randomized block designs, Latin square designs, Balanced incomplete block designs	8
4	**Factorial Designs:** Definition, Estimating model parameters, Fitting response curves and surfaces	4
	Module II (Data Analysis using Software (R/Python))	
5	The 2^k Factorial design, Blocking and confounding in the 2^k Factorial design, Focus of 2^2 and 2^3 designs, Blocking and confounding in the 2k Factorial Design	8
6	Plackett Burman methods, Central Composite Design (CCD)	4
7	Descriptive Statistics, Probability Distribution and Testing of Hypothesis using R	6
8	Regression techniques, Diagnostic checks, ANOVA using R and implementation of contrasts	6
9	Construction of Balanced Incomplete Block Designs and data analysis using R	6
10	Analysis of factorial designs using R, Understanding output and interpretation	6
11	Factorial designs, Data analysis and interpretation.	6
	Total	**60**

List of Textbooks/ Reference Books

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

Course Outcomes (Students will be able to…..)	
CO1	Explain the basic principles of design of experiments (K2)
CO2	perform statistical analysis of single experiments and do post hoc analysis (K3)
CO3	conduct experiment and analyse the data using statistical methods (K4)
CO4	choose an appropriate design given the research problem (K5)
CO5	perform statistical analysis of different designs using R and interpret the results (K5)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K2	3	2	1	2	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	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; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: PSP1503	Course Title: Pr 3- Synthesis and Characterization of Resins and Polymers Common	Credits = 4		
			L	T	P
	Semester: V	Total contact hours: 120 hrs	0	0	8

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	2x4hr/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 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 by 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	PSO1	PSO2
		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; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: PSP1504	Course Title Pr4- 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	

List of Text Books/ Reference Books

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)

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	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; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

Semester VI

	Course Code: PET1607	Course Title: Spl 8- Compounding and 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 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), Technology of Plastic Packaging (PET1712).

Description of 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	Polymer Compounding and Requirements Fundamentals of Compounding and processing Essentials of Compounding like Ingredients, Formulation, Morphology, Temperature, Polymer Melt, Processing requirements	5
2	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
3	Blenders, Internal Mixers - Single Screw Extruders - Twin Screw Extruders - Intermeshing Twin Screw Extruders - Reciprocating Screws - Reactive Compounding - Farrel Continuous Mixer, Batch mixers.	5
4	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
5	Reactive compounding, Phase Morphology Variations in Processing Operations, High performance compounding, Various Feeding processes.	5
6	Classification and Discussion of Melting Mechanisms, Devolatilization Equipment	5
7	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	5
8	Molding: Injection molding,	5

9	Blow molding, Compression molding	5
10	Injection stretch blow molding, Resin transfer molding, Gas and water assisted injection molding and other three dimensional molding.	5
11	One-dimensional process is like Coating and Adhesives.	5

List of Text Books/ Reference Books	
1	Encyclopedia of Polymer Science and Technology, Johan Wiley and Sons, Inc 1988.
2	Polymer processing by Mckelvey, J.M, John wiley & sons inc 1962.
3	Polymer processing fundamentals by T. A. Osswald, Munich hanser publishers 1998.
4	Polymer reaction engineering by K. H. Reichert and W. Heiseler, VCH publishers, 1989
5	Plastics Compounding by David Burton Todd, Hanser Publishers 1998.
6	Principles of Polymer Processing, 2nd Edition by Zehev Tadmor, Costas G. Gogos, John Wiley & Sons, Inc., 2006.
7	Fundamentals of Modern Manufacturing: Materials, Processes, and Systems by Mikell P. Groover, 2009.
8	Polymer Extrusion by Chris Rauwendaal, Carl Hanser Verlag GmbH & Co; 3rd Revised edition edition (1 August 1994).
9	Polymer Processing: Principles and Design, 2nd Edition by Donald G. Baird, Dimitris I. Collias, Wiley-Interscience, 2014.
10	Polymer Processing and Characterization by Sabu Thomas, Deepalekshmi Ponnamma, Ajesh K. Zachariah. Apple Academic Press 2012.

Course Outcomes (students will be able to…..)	
CO1	Process the polymers by various technique and able to solve the problems observed during processing. Ability to understand the degradation/stabilization of polymers and to analyses the respective case studies (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 (K5)
CO4	Formulate the batch for any processing with proper quantity of each and every ingredient such as fillers and additives etc. (K5)
CO5	Design, formulate as well as process the polymer/ polymer blends/ polymer composite in future by getting minute details of processing (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	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	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; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: PST 1712	Course Title: Spl 9- Environment Health and Safety of Polymers and Coating	Credits = 4		
			L	T	P
	Semester: VI	Total Contact Hours: 60	3	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-HillEducation: 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)

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	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
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; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: PST 1609	Course Title: Spl 10- Structure property Relationship	Credits = 3		
			L	T	P
	Semester: VI	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	Descibe 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)

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	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
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; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

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

List of Prerequisite Courses

None

List of Courses where this course will be prerequisite

Technology Courses in the forthcoming semesters

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

This course equips students with human resource management skills to be able to function effectively in their professional careers.

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

List of Textbooks/Reference Books

1	Innovation and Entrepreneurship, Peter Drucker
2	Essentials of organizational Behaviour, Srephen Robbins

3	Organizational Behaviour, Luthans
4	Select HBR cases and articles for review
5	Innovation and Entrepreneurship, Peter Drucker
Course Outcomes (Students will be able to…..)	
CO1	explain the fundamental concepts of industrial psychology and human resource management (K2)
CO2	analyze practical solutions (K4)
CO3	provide applicable solutions (K3)

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

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K2	3	2	1	2	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	K3	3	3	2	2	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; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: HUT1106	Course Title: Environmental Science and Technology	Credits = 3		
			L	T	P
	Semester: VI	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

Various Technology Courses in previous semesters

List of Courses where this course will be prerequisite

Various Technology Courses in the forthcoming semesters

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

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

	Course Contents (Topics and Subtopics)	Required Hours
1	Introduction to all prevailing international standards of Health, Safety, and Environment (HSE); Environmental laws and regulations; Standards (air quality, noise, water), ISO14000+	3
2	Environmental impact assessment, Life cycle assessment (LCA)	3
3	Pollution prevention in chemical manufacturing, effluent valorization	2
4	Air pollution; Air pollutants: sources (specific pollutants), effects, and dispersion modelling, air pollution, air quality, pollutants minimisation and control, fugitive emissions (source and control), Noise pollution	4
5	Wastewater treatment; Groundwater and surface water pollution, removal of specific water contaminants; Solid waste; Hazardous waste	4
6	Inherent safety; Major disasters (e.g. Flixborough, UK; Bhopal, India; Seveso, Italy; Pasadena, Texas; Texas City, Texas; Jacksonville, Florida; Port Wentworth, Georgia)	5
7	Toxicology; Industrial hygiene	2
8	Source models; Toxic release and dispersion models	5
9	Fires and explosions; Concepts to prevent fires and explosions	3
10	Chemical reactivity	2
11	Reliefs and reliefs sizing; Hazard identification; Risk assessment	4
12	Safety procedures and designs	4
13	Some case histories	4
	Total	**45**

List of Textbooks/Reference Books

1	Environmental Studies by R. Rajagopalan, Oxford University Press.
2	Essentials of Environmental Studies by Kurian Joseph & Nagendran, Pearson
3	Education Renewable Energy by Godfrey Boyle, Oxford Publications
4	Perspective of Environmental Studies, by Kaushik and Kaushik, New Age
5	International Environmental Studies by. Anandita Basak, Pearson Education
6	Textbook of Environmental Studies by Dave and Katewa, Cengage Learning
7	Environmental Studies by Benny Joseph, Tata McGraw Hill
8	Textbook of Environmental studies by Erach Books Bharucha, University Press.

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

CO1	calculate BOD / COD for a given composition of effluent stream, Estimation of bio Kinetics.
CO2	calculate adiabatic lapse rate and determine conditions for suitability of atmospheric dispersion, effective stack height, chimney design.
CO3	calculate concentrative of pollutant at any point in the neighbourhood of emission given atmospheric conditions like wind, dispersion, environmental factors, etc.
CO4	calculate size/time/power required for primary clarifier, secondary treatment, tertiary

	treatment, sizing of different types of Biological treatments etc
CO5	identify hazards in a given process and assess the same and provide solutions for operating safely.

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	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
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; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: PSP1712	Course Title: Seminar	Credits = 3		
			L	T	P
	Semester: VI	Total Contact Hours: 60	0	0	6

List of Prerequisite Courses

Polymer science and Technology (PST 1301), Polymer chemistry and Technology (PST 1303), Additives for Polymers (PET1507), Environment Health and Safety of Polymers and Coating (PST1712), Evaluation and testing of Polymers and Coatings(PST1711), Structure Property relationship(PST1609), Compounding and polymer Processing (PET1607)

List of Courses where this course will be prerequisite

Project I (PSP1714), Project II (PSP1811)

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

Course objectives

1. Develop a systematic thinking about a topic related to food technology
2. Develop skills for presenting a topic in food science effectively

	Course Contents (Topics and Subtopics)	Required Hours
1	Each Student will conduct literature survey, collect full papers, reviews, book chapters etc. and prepare presentation and written review report on the given seminar topic. Oral presentation & written report of the seminar will be evaluated.	60
	Total	**60**

List of Textbooks/Reference Books

1	Principles of Polymer Science, by Bahadur and Sastry, Narosa Publishing House 2002.
2	Text book of polymer Science, Billmeyer, John Wiley ans Sons 1984.
3	Additives for plastic handbook by John Murphy, Elsevier advance technology 1996.
4	Polymer processing by Mckelvey, J.M, John wiley & sons inc 1962.
5	Polymer processing fundamentals by T. A. Osswald, Munich hanser publishers 1998.
6	A Practical Course in Polymer Chemistry S. H. Pinner, Borough Polytechnic, London, Pergamon Press, he., New York, 1961
7	Various research papers, review papers, patents, thesis, dissertations related to the topic

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

CO1	Develop a protocol for literature survey about a certain topic (K4)
CO2	Evaluate the literatures and interpret the scientific content (K5)
CO3	Apply the concept of Polymer Engineering and related technology on a selected topic (K3)
CO4	Develop skills for presenting a scientific topic in Polymer Engineering and Technology(K6)
CO5	Develop skills for writing a scientific document (K6)

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

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

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: PEP1608	Course Title: Pr 5- Mold Designing 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 1303), Technology of Thermoset (PST 1506), Technology of Thermoplastics (PST 1504), 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 , Evalution and testing of Polymers and Coatings (PST1711)

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

This course gives a hands on experience in mold designing.

	Course Contents	Reqd. hours
1	Compressor Mould Design	1x4hr/Week
2	Transfer Mould Design	
3	Injection Mould Design	
4	Extrusion Die Design	
5	Blow Mould Design	

List of Text Books/ Reference Books

1	Plastic mould engineering handbook by Du Boi's and I. Pribble.
2	Plastic moulds and Dies Laszlo Sors.
3	Injection moulds design by Pye, 2nd ed. George godwin 1978.
4	Compression and transfer moulding of plastics by J. Butler.
5	Extrusion dies design by M. V. Joshi.

6	Plastic engineering data book by Glanvill.
7	Injection moulds and molding a practical manual by Dym, J. B. Van nostrand reinhold co. 1979.
8	Injection mould design fundamentals by A. B. Glanvill and E. N. Denton, Industrial press ins 1965.
Course Outcomes (students will be able to…..)	
CO1	Propose a design and draw the design based on product requirement (K5)
CO2	Compare various mold designing based on product and process (K4)
CO3	Design a mold for various processing technique(K5)
CO4	Propose a design and draw the design based on product requirement (K5)
CO5	Interpret importance of mold during processing (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+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	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
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; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, 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	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	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
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; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: PSP1712	**Course Title: Seminar**	**Credits = 2**		
			L	**T**	**P**
	Semester: VI	**Total contact hours: 60**	**0**	**1**	**4**
List of Prerequisite Courses					
	None				

List of Courses where this course will be Prerequisite	
	Project I (**PSP1714**), Project II (**PSP1075**)
Description of relevance of this course in the B. Tech. (Polymer Eng. And Tech.) Programme	
Course objectives 3. Develop systematic thinking and documenting it effectively on a contemporary topic related to polymer engineering and technology 4. Develop skills for presenting a topic in polymer engineering and technology effectively	

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	Students will be required to prepare a critical review of selected topics in polymer engineering and technology and submit it in the form of a standard typed report. Typically, the report should contain and will be evaluated based on the following points: (i) Introduction: 2 pages maximum, (ii) Exhaustive review of the literature (including tables and figures): 10 – 12 pages: 50% weightage (iii) Critical analysis of the literature and comments on the analysis (including tables and figures): 10 – 12 pages: 50% weightage. The critical analysis of the literature should include the following points: • Are the papers technically correct? • Whether the assumptions reasonable and logical? • Are the methods used in the literature appropriate? • Are there any internal contradictions, and are there any loopholes in the observations? If so, please explain. • Critical analysis of papers should also contain a quantitative comparison of observations, results, and conclusions amongst the various papers. Each student will also be required to make an oral presentation of the review. Weightage would be 40% for the presentation and 60% for the report. Additional details and requirements are given to the students every year by the coordinator of this activity.	**60**
	Total	**60**

Course Outcomes (Students will be able to…..)	
CO1	Develop a protocol for a literature survey about a certain topic (K4)
CO2	Evaluate the literature and interpret the scientific content (K5)
CO3	Apply the concept of food technology to a selected topic (K3)
CO4	Develop skills for presenting a scientific topic in polymer engineering and technology (K6)
CO5	Develop skills for writing a scientific document (K6)

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

CO1	K4	3	3	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	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO4	K6	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO5	K6	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Course	K6	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; – No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

Semester VII

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

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

List of Courses where this course will be prerequisite

Chemical Engineering Laboratory, Projects

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

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

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

List of Text Books/ Reference Books

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

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

1	Specify the required instrumentation and control elements for a particular process (K3)
2	Develop input-output transfer function models for dynamics of processes (K4)
3	Characterize the dynamics and stability of processes based on mathematical analysis (K5)
4	Design and tune process controllers (K6)
5	Specify the required instrumentation and control elements for a particular process (K3)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	2	2	3	3	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	K6	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
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; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: PST1711	Course Title: Spl 11- Evaluation and testing of polymer and coatings	Credits = 3		
			L	T	P
	Semester: VII	Total Contact Hours: 45	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)

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)

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	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

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; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: PET 1712	**Course Title: Spl 12-Technology of Plastic Packaging**	**Credits = 3**		
			L	**T**	**P**
	Semester: VII	**Total contact hours: 45**	**2**	**1**	**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) Speciality 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 definations,Plastics-performance all wrapped up, ASTM terminology, , Indian scenario, Selection criteria for flexible packing materials		**10**		
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	10
6	Adhesion Adhesives and Heat sealing	5
7	Applications of packaging in Food, Pharma, Polymer industries.	5

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)

		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	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
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; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

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

List of Prerequisite Courses

None

List of Courses where this course will be prerequisite

None

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

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

	Course Contents (Topics and Subtopics)	**Required Hours**
1	Greiner's Model of Organization Life Cycle Organic and mechanistic structures	3
2	Marketing Management Introduction, Porter's value chain, Porter's five forces, Porter's generic strategies	7
3	Introduction to the 4Ps of Marketing Product, Price, Place, Promotion	11
4	Production and Operations Management Concept of productivity, World class manufacturing, Business process reengineering, Kanban, JIT, Poka Yoke system, Maintenance practices	10

5	Quality Management The concept of quality, Quality control ,acceptance sampling and SQC Deing's 14 points, TQM, Insights into ISO-9000, ISO -14000,ISO-50000	6
6	Financial Management Accounting system, Balance-sheet evaluation, Fund-flow analysis, Financial ratios an insight, Costing	15
7	Materials Management Value analysis, Purchasing and vendor development, Warehousing and inventory control methods	4
8	Maintenance Management Classifications, Equipment and plant reliability and availability, Management of shut downs and turnarounds	4
	Total	**60**

List of Textbooks/Reference Books

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

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

CO1	explain the fundamental concepts of Marketing management and the various aspects therein (K2)
CO2	describe the fundamental concepts of Finance and analyse the balance sheet (K4)
CO3	explain various productivity techniques that when combined with engineering knowledge can be applied successfully in the industry (K2)

CO4	study real life practical problems, constraints and will be able to think in terms of various alternative solutions (K3)

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

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO2	K4	3	3	2	3	2	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	K3	3	3	2	2	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; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code:	Course Title:	Credits = 2		
	CEP1714	Chemical Engineering Laboratory	L	T	P
	Semester: VII	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 in this and the last semester

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

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

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

List of Text Books/ Reference Books

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

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

CO1	Learn how to experimentally verify various theoretical principles (K3)
CO2	Visualize practical implementation of chemical engineering equipment (K4)
CO3	Develop experimental skills (K4)

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

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO2	K4	3	3	2	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
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; − No Contribution

	Course Code: PEP 1607	Course Title: Pr 7- Processing of Polymers Lab	Credits = 2		
			L	T	P
	Semester: VII	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 understanding 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 polymerslike 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 resinetc	

List of Text Books/ Reference Books

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

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. Extrusion of Polymers: Theory and Practice by C.Chung, Hanser Publications,2000
5. Polymer Extrusion5th Edition by Chris Rauwendaal Hanser Publishers 2006
6. SPE Injection molding and Extrusion by Chris Rauwendaal Hanser Publications,2000
7. Encyclopedia of Polymer Science and Engineering, Johan Wiley and Sons, Inc 1988.
8. Handbook of Thermoplastics, Second Edition Olagoke Olabisi by CRC Press
9. 2015
10. Thermoplastic Materials by Ibeh, Christopher C, Taylor Francis Inc 2013
11. Plastics Materials, 7th Edition by John Brydson, Elsevier 1999
12. Chemistry and Technology of Epoxy Resins by Eliss Brayn ,Springer Nethelands,1993
13. Polymer Processing: Principles and Design 1st Edition by Donald G. Baird (Author), Dimitris I. Collias (Author)
14. Phenolic Resins chemistry, Applications, Standardization, Safety and Ecology by L.Knop,Springer-Verlag Berlin Heidelberg 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 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	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	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
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; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: PSP1714	Course Title: Project -I	Credits = 2		
			L	T	P
	Semester: VII	Total contact hours: 60	0	1	4

List of Prerequisite Courses

	Seminar (**PSP1712) and all the courses up to Semester VI**

List of Courses where this course will be Prerequisite

	Project II (**PSP1075)**

Description of the relevance of this course in the B. Tech. (Polymer Eng. and Tech.) Programme

1. Develop skills to execute & solve ideas on new products/processes in polymer engineering and technology for possible commercialization
2. Develop skills for presenting research work effectively

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	-Teachers will communicate various research project topics to all the students based on interest and facilities available, and relevance to the area of polymer engineering and technology. - Each student, based on his/her interest and merit, selects the research topic and is allotted a supervisor. -The literature search will have to be submitted in the form of a standard typed report - Review of literature, formulation of the research project, hypothesis, objectives, methodology, possible expected outcomes, planning for experimentation, experimental trials, data generation, and analysis. Every student will be orally examined. The student will be assessed based on the progress made during the semester. There would be (i) submission of report and (ii) PowerPoint presentation. The PowerPoint will be presented to a panel of faculty members/examiners, and they will also evaluate the submitted report. There will be a weightage of 60% for the report submission and 40% for the presentation. Additional details may be given to the students from time to time by the coordinator.	**60**
	Total	**60**

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	3	3	3	3
CO3	K5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	K6	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO5	K6	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Course	K6	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

Semester VIII

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

List of Prerequisite Courses

Material and Energy Balance Calculations, Equip Design and Drawing I, Energy Engineering, Industrial Engineering Chemistry

List of Courses where this course will be prerequisite

Home Papers I and II

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

This course is required for the future professional career.

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	Introduction to the green field projects and global nature of the projects Impact of currency fluctuations on Project justification and cash flows Concepts of 'Quality by Design' including typical design deliverables Understanding constructability, operability and maintainability during all stages of project execution Meaning of Project Engineering, various stages of project implementation	6
2	Relationship between price of a product and project cost and cost of production, EV Analysis. Elements of cost of production, monitoring of the same in a plant Meaning of Administrative expenses, sales expenses, etc. Introduction to various components of project cost and their estimation Introduction to concept of inflation, location index and their use in estimating plant and machinery cost Various cost indices	8
4	Project financing, debt:equity ratio, promoters, contributors, shareholders contribution, source of finance, time value of money Concept of interest, time value of money, selection of various alternative equipment or system based on this concept, Indian norms, EMI calculations Depreciation concept, Indian norms and their utility in estimate of working results of project. Working capital concept and its relevance to project	7
5	Estimate of working results of proposed project. Capacity utilization, Gross profit, operating profit, profit before tax, Corporate tax, dividend, Net cash accruals. Project evaluation: Cumulative cash flow analysis Break-Even analysis, incremental analysis, various ratios analysis, Discounted cash flow analysis	7
6	Process Selection, Site Selection, Feasibility Report	4
7	Project: Conception to Commissioning: milestones, Project execution as conglomeration of technical and nontechnical activities, contractual details. Contract: Meaning, contents, Types of contract. Lump- sum Turnkey (LSTK),Eng, Procurement and Construction(EPC),Eng, Procurement and Construction Management (EPCM).Mergers and Acquisitions	6
8	Reading of balance sheets and evaluation of techno-commercial project reports	3
9	PERT, CPM, Bar-charts and network diagrams	4
	Total	**45**

List of Text Books/ Reference Books	
1	Chemical Project Economics,MahajaniV.V.andMokashi SM.
2	Plant Designand Economics for Chemical Engineers,Peters M.S.,TimmerhausK.D.
3	Process Plant and Equipment Cost Estimation, Kharbanda O.P.
Course Outcomes (students will be able to…..)	
CO1	calculate working capital requirement for a given project (K3)
CO2	calculate cost of equipment used in a plant total project cost (K3)
CO3	calculate cash-flow from a given project (K3)
CO4	select a site for the project from given alternatives (K4)
CO5	list out various milestones related to project concept to commissioning (K2)

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

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO2	K3	3	3	2	2	2	3	3	3	3	3	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	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; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: PET1815	Course Title: Spl 13- Composites and Post Polymer Processing	Credits = 4		
			L	T	P
	Semester: VIII	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	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, aramidefibers,natural fibers etc	5
4	Thermoset and thermoplastic matrix,Fillers and Other Additives , Recycling and	5
5	Incorporation of Fibers into Matrix- Prepregs,Sheet-Molding Compounds,DMC	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. Encyclopedia of Polymer Science and Engineering, Johan Wiley and Sons, Inc1988.
5. Joining of Plastics By K.W. Allen Smithers Rapra Publishing 1988
6. Plastics finishing and decoration by Donatas Satas,Van Nostrand Inc, 1986
7. Decoration and Assembly of Plastic PartsBy Edward A. Muccio, ASM International 1999.
8. Designing with Plastics and Composites: A Handbook By Donald Rosato Springer Science & Business Media 2014
9. Composite Polymeric Material, R. P. Sheldon, Applied SciencePublishers,1982.
10. Composites: Design Guide, Industrial Press Inc, 1987.
11. Composite Material Handbook, M. M. Schwartz, McGraw-Hill company, 1984

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

CO1	Apply the concept of fiber reinforce composites, practice the reinforcement manufacturing of its constituents like 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)

		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	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
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; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: PET 1813	Course Title: Spl 14- 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 elatomers, different processeses 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 applicationsUse 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)

		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	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO3	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
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
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; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: PST1814	Course Title: Spl 15 - Nanomaterials and their Applications	Credits = 4		
			L	T	P
	Semester: VIII	Total Contact Hours: 45	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 nanosize. 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.	5
2	Synthesis, properties and applications of Carbon nanotubes.	6
3	Synthesis, properties and applications fulleneres.	6
4	Synthesis, properties and applications in organic nanomaterials like titanium dioxide, zinc oxide etc.	6
5	Synthesis, properties and applications of nanoparticles of gold, silver cellulosics etc.	6
6	Dendrimers, Nanoclay sand its differnt treatment.	6
7	Polymer nanocomposites and its processing properties, application sand charecterization.	5
8	Nanocoatings,safety regulations of nanomaterials.	5
	Total	**45**

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 nanosize. (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 same.(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	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	2	3	2	3	3	3	3	3	3	2	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; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: PET 1816	Course Title: Spl 16- Specialty Polymers 50 marks)	Credits = 3		
			L	T	P
	Semester: VIII	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	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	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
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; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: PSP1075	Course Title: Project –II	Credits = 4		
			L	T	P
	Semester: VIII	Total contact hours: 120	0	0	8

List of Prerequisite Courses

Project I (**PSP1714**)

List of Courses where this course will be Prerequisite

None

Description of the relevance of this course in the B. Tech. (Polymer Eng. and Tech.) Programme

1. Develop skills to execute & solve ideas on new product/process in polymer engineering and technology for possible commercialization
2. Develop skills for presenting research outcomes effectively

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	Work done in Semester VII (Project I) will be studied in detail by extrapolating further. The topic of the research with defined objectives and hypotheses should be explored by scientifically planned rational experiments. Students should have actual experimental data collected on the chosen research topic. Should be able to address relevant matters such as quality assurance, packaging, costing, plant layout, and regulatory as well as marketing aspects of the product(s) developed.	**80**
2	Every student will be orally examined. The student will be assessed based on (i) submission of report and (ii) Presentation and Viva-voce. The student will present his/her work to a panel of faculty members/examiners, and they will also evaluate the submitted report. Final report of Project -II would be given a weightage of 50 marks. There will be a viva-voce after the presentation. The weightage for the viva-voce would be 50 marks. Additional details may be given to the students from time to time by the coordinator.	**40**
	Total	**120**

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 the experimental data critically 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+S	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	3	3	3	2	3	3
CO3	K5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	K6	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO5	K6	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Course	K6	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: PEP1812	Course Title: Pr 8- Advanced Characterization of Polymers and Composite Lab	Credits = 4		
			L	T	P
	Semester: VIII	Total contact hours: 120 hrs	0	0	8

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	2x4hr/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, % elongatioin	
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	Electrospining 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	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	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; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain