NEW SYLLABUS

POLYMER ENGINEERING AND TECHNOLOGY

POLYMER ENGINEERING AND TECHNOLOGY

Proposed Revised Syllabus

The Bachelor of Technology is now a four year program, after 12th.

The structure consists of subjects common to all branches, and includes basic sciences, engineering and some humanities and management components.

In this document, the structure of the syllabus, divided into 8 semesters, is followed by the detailed syllabus for special subjects

Polymer Technology domain.

Syllabus Structure B. Tech. First Year

Semester I								
Subjects	**Credits**	**Hrs/Week**			**Marks for various Exams**			
		L	**T**	**P**	**C. A.**	**M.S.**	**E. S.**	**Total**
Physical Chemistry-I	3	2	1	0	10	15	25	50
Analytical Chemistry	3	2	1	0	10	15	25	50
Applied Mathematics-I	4	3	1	0	20	30	50	100
Applied Physics-I	4	3	1	0	20	30	50	100
Physical and Analytical Chemistry Lab	2	0	0	4	25	-	25	50
Engineering Graphics	4	2	0	6	50	-	50	100
Communication Skills	2	0	0	4	50	-	-	50
TOTAL:	22	12	4	14	-	-	-	500

Semester II								
Subjects	**Credits**	**Hrs/week**			**Marks for various Exams**			
		L	**T**	**P**	**C. A.**	**M.S.**	**E. S.**	**Total**
Physical Chemistry-II	3	2	1	0	10	15	25	50
Organic Chemistry	4	3	1	0	20	30	50	100
Process Calculations	4	3	1	0	20	30	50	100
Applied Mathematics-II	4	3	1	0	20	30	50	100
Applied Physics-II	3	2	1	0	10	15	25	50
Physics Laboratory	2	0	0	4	25	-	25	50
Organic Chemistry Laboratory	2	0	0	4	25	-	25	50
Total	22	13	5	8	-	-	-	500

Syllabus Structure B. Tech. Second Year

Semester III									
Course Code	**Subjects**	**Credits**	**Hrs /week**			**Marks for various Exams**			
			L	**T**	**P**	**C. A.**	**M.S.**	**E.S.**	**Total**
PST 1301	Spl 1: Polymer Science & Technology	4	3	1	0	20	30	50	100
PST 1302	Spl 2: Polymer Chemistry & Technology	4	3	1	0	20	30	50	100
	Material Technology	3	2	1	0	10	15	25	50
CHT1133	Chemistry and Applications of Colorants	4	3	1	0	20	30	50	100
CHT1124	Industrial Inorganic Chemistry	4	3	1	0	20	30	50	100
PSP 1301	Pr1:Raw Material Analysis for Resins and Polymers	2	0	0	4	25	-	25	50
MAP1201	Computer Application Lab	2	0	0	4	25	-	25	50
	Total	23	14	5	8	-	-	-	550

Semester IV									
Course Code	**Subjects**	**Credits**	**Hrs/week**			**Marks for various Exams**			
			L	**T**	**P**	**C. A.**	**M.S.**	**E. S.**	**Total**
GET1116	Engineering Mechanics & Strength of Materials	4	3	1	0	20	30	50	100
PYT1202	Color Physics and Color Harmony	3	2	1	0	10	15	25	50
CET 1105	Transport Phenomena	4	3	1	0	20	30	50	100
GET1105	Electrical Engineering and Electronics	3	2	1	0	10	15	25	50
PST1403	Spl3 : High Polymer Chemistry	4	3	1	0	20	30	50	100
GEP1106	Electrical Engineering and Electronics Lab	2	0	0	4	25	-	25	50
PYP1203	Pr 2: Color Physics Lab	2	0	0	4	25	-	25	50
	Total	22	13	5	8	-	-	-	500

Syllabus Structure B. Tech. Third Year

Semester V									
Course 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
CET1201	Chemical Reaction Engineering	3	2	1	0	10	15	25	50
PST1504	Spl 4: Technology of Thermoplastic Polymers (Common)	4	3	1	0	20	30	50	100
PST1505	Spl 5 Technology of Thermoset Polymers (Common)	4	3	1	0	20	30	50	100
PET1506	Spl 6: Additives for Polymers	4	3	1	0	20	30	50	100
PSP1503	Pr3 : Synthesis & Characterization of Resins & Polymers Lab	4	0	0	8	50	-	50	100
PSP1504	Pr4 : Analysis and characterization of Resins and polymers Lab	2	0	0	4	25	-	25	50
	Total	24	13	5	12	-	-	-	550

Semester VI									
Course Code	**Subjects**	**Credits**	**Hrs/week**			**Marks for various Exams**			
			L	**T**	**P**	**C. A.**	**M.S.**	**E. S.**	**Total**
PET1607	Spl7 :Compounding and Polymer Processing	4	3	1	0	20	30	50	100
PET1608	Spl 8: Design and Fabrication of Molds	3	2	1	0	10	15	25	50
HUT1103	Industrial Psychology and Human Resource Management	3	2	1	0	10	15	25	50
HUT1104	Industrial Management – I	3	2	1	0	10	15	25	50
PST1609	Spl 9: Elective-I Structure property Relationship (Common)	3	2	1	0	10	15	25	50
HUT1106	Environmental Science and Technology	3	2	1	0	10	15	25	50
PEP1605	Pr 5: Mold Designing Lab	4	0	0	8	50	-	50	100
PEP1606	Pr 6: Identification of Resins and Polymers Lab	2	0	0	4	25	-	25	50
PEP1607	Pr 7: Processing of Polymers Lab	2	0	0	4	25	-	25	50
	Total	27	13	6	16	-	-	-	550

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 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									
Course Code	**Subjects**	**Credits**	**Hrs/week**			**Marks for various Exams**			
			L	**T**	**P**	**C. A.**	**M.S.**	**E. S.**	**Total**
CET1703	Chemical Process Control	3	2	1	0	10	15	25	50
PST1710	Spl 10: Environment Health and Safety of polymers and coating (Common)	4	3	1	0	20	30	50	100
PST1711	Spl 11: Evaluation and Testing of polymers and coatings (Common)	3	2	1	0	10	15	25	50
PET1712	Spl12:Elective II Technology of Plastic Packaging	3	2	1	0	10	15	25	50
HUT1105	Industrial Management – II	3	2	1	0	10	15	25	50
MAT1106	Design and Analysis of Experiments	3	2	1	0	10	15	25	50
CEP1714	Chem. Eng. Laboratory	2	0	0	4	25	-	25	50
PSP1708	Seminar	2	0	0	4	-	-	50	50
PSP1709	Project I	2	0	0	8	-	-	50	50
PSP1710	In Plant Training	3							50
	Total	28	13	6	16	-	-	-	550

Semester VIII									
Course 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
PET1813	Spl 13: Technology of Elastomers	3	2	1	0	10	15	25	50
PST1814	Spl 14: Nano materials and their applications (Common)	3	2	1	0	10	15	25	50
PET1815	Spl 15 Composites and Post Polymer Processing	4	3	1	0	20	30	50	100
PET1816	Spl 16: Elective III Speciality polymers	3	2	1	0	10	15	25	50
HUT1107	Value Education	3	2	1	0	10	15	25	50
PSP1811	Project II	6	0	0	8	-	-	150	150
PEP1812	Pr 8: Advanced characterization of Polymers and Composites Lab	4	0	0	8	50	-	50	100
	Total	29	11	5	16	-	-	-	600

Semester V

	Course Code: SPL4	Course Title: : Technology of Thermoplastic Polymers (100 marks)	Credits = 4		
			L	T	P
	Semester: V	Total contact hours: 60	3	1	0
List of Prerequisite Courses					
	Polymer science and Technology, Polymer chemistry and Technology Raw material Analysis of resins and polymers, Resins and polymer analysis.				
List of Courses where this course will be prerequisite					
	Compounding and Polymer Processing Project, Environment Health and Safety of Polymers and Coating, Evolution and testing of Polymers and Coatings, Technology of Plastic Packaging.				
Description of relevance of this course in the B. Tech. Program					
To give understanding of industrial manufacturing processes, properties and applications, processing of various types of thermoplastic polymers. Knowledge of subject will help student to carry out research and development in the areas of polymer blends polymer nanocomposites, coating formulation development. Fiber reinforce 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.					

	Course Contents	Reqd. Hours
1	Industrial Manufacturing processes, properties and applications processing environmental concerns of various types of polymers polyolefin like LDPE HDPE etc	5
2	Polypropylene and copolymer of PP Plastomers	5
3	Copolymer of polyolefin 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	Polyamides- Nylon 6, Nylon 6,6, Nylon 11etc, 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

List of Text Books/ Reference Books

1. Plastics Materials, 7th Edition by John Brydson, Elsevier 1999.
2. Text book of polymer Science by Billmeyer, John Wiley and Sons 1984.
3. Principles of Polymer Science, by Bahadur and Sastry, Narosa Publishing House2002.
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. Handbook of Thermoplastics, Second Edition Olagoke Olabisi by CRC Press 2015.
8. Thermoplastic Materials by Ibeh, Christopher C, Taylor Francis Inc 2013.
9. Introduction to Polymer Science and Technology by H. S. Kaufman and J. J.Falcetta, Wiley – Interscience Publication, 1977.
10. Handbook of Polyethylene, A. J. Peacock, Marcel Dakker Inc, 2000 .
11. PVC Technology, A. S. Athalye and Prakash Trivedi, Multi-Tech Publishing Co,1994.
12. Engineering Thermoplastics Polycarbonates Polyacetals Cellulose Esters, L.Bottenbruch, Hanser Publishers, 1996.
13. Polymer and Resins; Their Chemistry and Chemical Engg, Brage Golding,D.VanNostrand Company Inc, 1959.
14. Structures of Cellulose, Atlla, American Chemical society, 2003.
15. Styrene Based Plastics and their Modifications, Ellis Harwood, 1991.

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

1	To study industrial manufacturing process advantages disadvantages, process parameters of the thermoplastics polymers and environmental concerns of their products	
2	To give understanding of properties like physical mechanical thermal rheological etc	
3	To make aware of practical applications of thermoplastics in real world and structure properties and relationship.	
4	To study basic processing methods related to of the thermoplastics polymers.	
5	To make aware of different grades of commodity and engineering plastics manufacturer suppliers of them in the market.	

	Course Code: PST1505	Course Title: : Technology of Thermosets (100 marks)	Credits = 4		
			L	T	P
	Semester: V	Total contact hours: 60	3	1	0
List of Prerequisite Courses					
	Polymer Chemistry and Technology Raw material Analysis of resins and polymers, Resins and Polymer Analysis.				
List of Courses where this course will be prerequisite					
	Compounding and Polymer Processing Project, Environment Health and Safety of Polymers and Coating, Evolution and testing of Polymers and Coatings, Technology of Plastic Packaging.				
Description of relevance of this course in the B. Tech. Program					
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. Various thermosetting polymers.					
	Course Contents		**Reqd. hours**		
1	Alkyd resins Basic components like polyfunctional alcohols, poly-basic acids, vegetable oils/fatty acids. Different types of drying oils: drying, semi-drying and non-drying with examples. Influence of all these components in the synthesis and properties of the final alkyds obtained. Modification of alkyds: modifications with rosin, maleic anhydride, acrylics, vinyls, imides, etc.		5		
2	Polyesters Resins – unsaturated polyesters resins: Raw material: poly-basic acids, polyfunctional glycols. Curing of resins through unsaturation of the resin/polymer backbone. Curing systems, catalysts and accelerators. Molding compositions, fibre and film forming compositions		5		
3	Phenolics. Basic Components of the polymer. Different kinds of phenols to aldehyde on the nature and the property of the polymer. Theory of resinification and effect of pH on the reaction mechanism and the reaction product. Curing of Phenolics.		5		
4	Modification of Phenolics such as oil soluble and oil reactive. Phenolic moulding compounds ingredients, compounding and applications		5		
5	Polyurethanes – Theromoplastic and Thermoset: Basic components diisocyanates and diols, different diisocyanates and diols used Reactions of isocyanates with various other functional groups synthesis of polymers polyurethane foams, polyester and polyether foams.		5		
6	Processes like one-shot process, Polyether pre-polymers, Quasi-pre-polymer polyether foams, etc. Flexible foams Polyurethanes in Coatings Polyisocyanates IPN using polyurethanes-acrylic blends.		5		

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	Silicon resin compounding, Processing and applications. Silicone modified resins	5
10	Thermosetting acrylics: Synthesis of acrylic polymers and co-polymers, different techniques.	5
11	Structure property relationship application of thermosetting acrylics, like anaerobic adhesives, laminating resins, etc	5
12	Miscellaneous thermosetting polymers	5

List of Text Books/ Reference Books

1. Text book of Polymer Science by Billmeyer, John Wiley ans Sons 1984.
2. Encyclopedia of Polymer Science and Technology, Johan Wiley and Sons, Inc 1965.
3. Alkyd Resin by Martins C. R, Reinhold Publishing corporations 1961.
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. Polyester Resin by Lawrence J. R, Reinhold Publishing corporations 1960.
7. Polymer and Resins; Their Chemistry and Chemical Engg, Brage Golding, D.Van Nostrand Company Inc, 1959.
8. Phenolic Resin chemistry by Megson, N.J.L, Butterworths scientific publication 1958.
9. Phenolic Resin by Whitehouse A.A.K, 2nd edition 1967.
10. Phenolic Resins by A. Knop and L. A. Pilato, Springer verlag 1985.
11. Polyurethane & synthetic resin by Robinson, R.S and Weeks, C.A.
12. Polyurethane Technology by Bruins P. f, Interscience publishers 1969.
13. Acrylic & other synthetic resins by S. D Tylmen and F. A. Peyton, J. B. Lippincott Co. 1946.
14. Silicones by R. N. Meals and F. M. Lewis, Reinhold Publishing corporations 1959.
15. Silicones by Ranney, M. W, Noyes Data co. 1977.
16. Silicones and their uses by McGregor R. B, McGraw hill book co. 1954.
17. Thermosetting Polymers by Jean-Pierre Pascault, Henry Sautereau, Jacques Verdu, Roberto J. J. Williams, CRC Press, 2002.
18. Chemistry and Technology of Epoxy Resins by Eliss Brayn ,Springer Nethelands,1993

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

1	Ability to understand basic concepts of resins	
2	Student should able to understand curing systems of Various resins	
3	Student should able to understand structure properties and relationships of resins	
4	Ability to understands about raw materials used in industry	
5	Ability to understand modification chemistry of Resin	

	Course Code: PST150	Course Title: : Additives for Polymers(100 marks)	Credits = 4		
			L	T	P
	Semester: V	Total contact hours: 60	3	1	0
List of Prerequisite Courses					
	Polymer Chemistry and Technology Raw material Analysis of resins and polymers, Resins and Polymer Analysis.				
List of Courses where this course will be prerequisite					
	Compounding and Polymer Processing Project, Environment Health and Safety of Polymers and Coating, Evolution and testing of Polymers and Coatings, Technology of Plastic Packaging.				
Description of relevance of this course in the B. Tech. 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	5
2	Fillers, mechanical properties due to fillers	2
3	UV stabilizers, Resistance to Heat Stabilizers	5
4	Flame Retardants	5
5	Conductivity, Antistatic and conductive Polymers	5
6	Curing & Curing agents	5
7	Coupling agents and Compatibilization agents	5
8	Plasticizer	5
9	Blowing Agents	5
10	Processing and modifier aid	5
11	Lubricants Mould Release Agents, Antislip and Antiblocking additives	5
12	Appearance Colorants Pigments Dyes Special Effects, Appearance Black and White Pigmentation	5
13	Additives for rubber and recycling, mixing, compounding, Health and Safety	5

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…..)

1	Ability to identify and choose various pigments and additives for a particular application	
2	Understanding of basic ideas, properties, dosage, techniques of dispersion for wide variety of pigments (organic and inorganic)	
3	Ability to understand the mechanism of color formation and effect of various factors on shade and hue of pigment.	
4	Should be able to perform manufacturing and synthesis of various pigments	
5	Ability to decide the dosage and selection criteria for various types of additives.	
6	Ability to identify and choose various pigments and additives for a particular application	

	Course Code: PSP1503	Course Title: : Synthesis and Characterization of Resins and Polymers (100 marks)	Credits = 4		
			L	T	P
	Semester: V	Total contact hours: 2x4hr/Week	0	0	8
List of Prerequisite Courses					
	Polymer science and Technology, Polymer chemistry and Technology, Technology of Thermoset, Technology of Thermoplastics, Raw material Analysis of resins and polymers, Resins and polymer analysis.				
List of Courses where this course will be prerequisite					
	Compounding and Polymer Processing Project, Environment Health and Safety of Polymers and Coating, Evolution and testing of Polymers and Coatings, Structure Property Relationship. Paint Processing, Paint Technology.				

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 development, 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, resole and to analyze free formaline, free phenol content, %solids, curing characteristics 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 in situ polymerization	
9	To study kinetics of free radical polymerization	
10	To synthesis superabsorbent, 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	

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, New York, 1961 3. Polymer Science by Gowarikar V.R, John Wiley and Sons 1986. 4. Encyclopedia of Polymer Science and Engineering, Johan Wiley and Sons, Inc 1988 5. Experimental Plastics A practical course for students by C.A.Redfran, Interscience Bublisher Inc.NY 1971 6. Polymer Synthesis and Characterization by Stanley R. Sandler, Wolf Karo, Jo-Anne Bonesteel and Eli M. Pearce, Academic Press 1998. 7. Advances in Polymeric Science by Shishir Sinha, OP Pandey, Vinay Kumar and Parmod Kumar. Studium Press (India) Pvt. Ltd. 2011. 8. Polymer Synthesis and Characterization Edited by Florian Paulus, Dirk Steinhilber, Tobias Becherer. Polymer Analysis by Barbara H. Stuart, John Wiley & Sons, 2002.		
Course Outcomes (students will be able to…..)		
1	Do laboratory scale experiment for synthesis of polymers like PS PMMA polyacrylamide Epoxy Polyesters nanocomposites, etc.	
2	Design and conduct experiments for synthesis of Resins and polymers and understand the practical problems related to the experiment.	
3	Analyze and characterize polymers by finding yield melting point epoxy value acid value % solid etc.	
4	Interpret data, process parameters within realistic constraints of the experiment.	
5	Communicate effectively in team work and understanding of professional and ethical responsibility.	

	Course Code: PSP1504	Course Title: : Analysis and characterization of Resins and Polymers Lab **(50 marks)**	Credits = 4		
			L	**T**	**P**
	Semester: V	**Total contact hours: 1x4hr/Week**	**0**	**0**	**8**
List of Prerequisite Courses					
	Analytical Chemistry Lab, Polymer science and Technology, Polymer chemistry and Technology, Technology of Thermoset, Technology of Thermoplastics, Raw material Analysis of resins and polymers, Resins and polymer analysis.				
List of Courses where this course will be prerequisite					
	Experimental Project, Research and Development in the area of Polymer Synthesis, analysis and characterization				
Description of relevance of this course in the B. Tech. Program					
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.					

	Course Contents	**Reqd**
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 Polyolefins	
8	Determine the chlorine content of the chlorinated polymers	

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, New York, 1961 3. Testing of Paints by S.Patil, Current Awareness Service Publisher, 1993. 4. Polymer Analysis by Barbara H. Stuart, John Wiley & Sons, 2002. 5. 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…..)		
1	Do laboratory scale experiment for synthesis of polymers like PS PMMA polyacrylamide Epoxy Polyesters nanocomposites .etc	
2	Design and conduct experimentsfor synthesis of Resins and polymers and understand the practical problems related to the experiment	
3	Analyze and characterize polymers by finding yield melting point epoxy value acid value % solid etc	
4	Interpret data, process parameters within realistic constraints of the experiment	
5	Communicate effectively in team work and understanding of professional and ethical responsibility	

Semester VI

	Course Code: PET1607	**Course Title:** Compounding and Polymer Processing **(100 marks)**	**Credits = 4**		
			L	**T**	**P**
	Semester: VI	**Total contact hours: 60**	**3**	**1**	**0**
List of Prerequisite Courses					
	Polymer science and Technology, Polymer chemistry and Technology Raw material Analysis of resins and polymers, Resins and polymer analysis.				
List of Courses where this course will be prerequisite					
	Compounding and Polymer Processing Project, Environment Health and Safety of Polymers and Coating, Evolution and testing of Polymers and Coatings, Technology of Plastic Packaging.				
Description of relevance of this course in the B. Tech. 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) , Compatibilizers (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 multilayred 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
	Blow molding, Compression molding	5
	Injection stretch blow molding, Resin transfer molding, Gas and water assisted injection molding and other three dimensional molding.	5
9	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…..)

1	Able to Process the polymers by various techniques	
2	Able to Formulate the master batches and Process it	
3	Can Formulate the batch for any processing with proper quantity of each and every ingredient such as fillers and additives etc.	
4	The temperature during processing, screw dimensions, the rate of addition as well as concentration of addition of filler etc. the knowledge of such small details of processing is	
5	The knowledge about the trouble shooting during the processing is given hence student can handle any emergency.	
6	Ability to understand the degradation/stabilization of polymers and to analyses the respective case studies	

	Course Code: PET 1608	Course Title: : Design and Fabrication of Molds**(50 marks)**	Credits = 3		
			L	**T**	**P**
	Semester: VI	**Total contact hours: 45**	**2**	**1**	**0**

List of Prerequisite Courses	
	Engineering Graphics, Technology of Thermoplastics, Technology of Thermosets, Strength of Materials, Compounding and Processing of Polymers
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. hours**
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

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…..)		
1	Ability to understand the processing techniques	
2	Ability to design a mold for a product	
3	Ability to understand the importance of mold in product development.	

	Course Code: PST 1609	Course Title: : Structure property Relationship **(50 marks)**	Credits = 3		
			L	**T**	**P**
	Semester: VI	**Total contact hours: 45**	**2**	**1**	**0**
List of Prerequisite Courses					
	Polymer Science & Technology, Polymer Chemistry & Technology, Technology of Thermoplastics, Technology of Thermosets				
List of Courses where this course will be prerequisite					
	Project, Seminar, Speciality Polymers, Additives in Polymer				
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…..)

1	Ability to understand the general structural features of polymers	
2	Ability to understand the Configuration and conformation and structure properties of polymers and Molecular mass heterogeneity and structure properties	
3	Ability to understand the thermodynamics and factors affecting dissolution	
4	Ability to understand the polymer chain flexibility and thermal properties of polymers.	
5	Ability to understand the intermolecular orders and the crystallinity properties	
6	Ability to understand the degradation/stabilization of polymers and to analyses the respective case studies	

	Course Code: PEP1605	Course Title: : Mold Designing Lab **(100 marks)**	Credits = 4		
			L	**T**	**P**
	Semester: VI	**Total contact hours: 2x4hr/Week**	**0**	**0**	**8**

List of Prerequisite Courses

	Polymer science and Technology, Polymer chemistry and Technology, Technology of Thermoset, Technology of Thermoplastics, Raw material Analysis of resins and polymers, Resins and polymer analysis.	

List of Courses where this course will be prerequisite

	Compounding and Polymer Processing Project, Environment Health and Safety of Polymers and Coating ,Evolution and testing of Polymers and Coatings, Structure Property relationship, Paint Processing, Paint Technology.	

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	**2x4hr/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…..)		
1	Ability to understand the processing techniques	
2	Ability to design a mold for a product	
3	Ability to understand the importance of mold in product development.	

	Course Code: PEP1606	**Course Title: :** Identification of Resins and Polymers Lab**(100 marks)**	**Credits = 4**		
			L	**T**	**P**
	Semester: VI	**Total contact hours: 1x4hr/Week**	**0**	**0**	**8**
List of Prerequisite Courses					
	Polymer science and Technology, Polymer chemistry and Technology, Technology of Thermoset, Technology of Thermoplastics, Raw material Analysis of resins and polymers, Resins and polymer analysis.				
List of Courses where this course will be prerequisite					
	Compounding and Polymer Processing Project, Environment Health and Safety of Polymers and Coating ,Evolution and testing of Polymers and Coatings, Structure Property relationship.Paint Processing, Paint Technology.				
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…..)		
1	Able to identify unknown polymer sample in any given form.	
2	Student gets knowledge of thermal characterization, solubility technique, correlation of solubility and structure of polymers, flammable or inflammable nature of various polymers.	
3	In case of unknown sample by applying the above knowledge they can identified the sample.	
4	The knowledge about the temperature effect on polymers, its solubility helps the student to segregate the polymers for various application depending upon its properties.	
5	The knowledge of commodity polymers, engineering plastic and special purpose polymers is gets clear with such identification.	

	Course Code: PEP 1607	Course Title: Pr 7: Processing of Polymers Lab(50 marks)	Credits = 2		
			L	T	P
	Semester: VI	Total contact hours: 1x4hr/Week	0	0	4
List of Prerequisite Courses					
	Compounding and Polymer Processing, Polymer chemistry and Technology, Technology of Thermoset, Technology of Thermoplastics,				
List of Courses where this course will be prerequisite					
	Polymer fabrication, Polymer composite,Evolution and testing of Polymers and Coatings, Structure Property relationship.				

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

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
6. Encyclopedia of Polymer Science and Technology, Johan Wiley and Sons, Inc 1965.
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…..)

1	Ability to use, know polymer processing and compounding techniques, skills and modern engineering tools like twin screw extruder injection molding etc.so as to be easily adaptable to polymer industry	
2	Design and conduct experiments for processing of Resins and polymers and understand the practical problems related to the experiment.	
3	Ability to analyze and interpret data, process parameters like temperature, pressure within realistic constraints of the experiment	
4	Know casting thermoforming corona discharge etcand modern engineering tools so as to be easily adaptable to polymer industry	
5	Communicate effectively in team work and understanding of professional and ethical responsibility.	

Semester VII

Syllabus: Instrumentation and Process Control

	Course Code: PST 1710	**Course Title: : Environment Health and Safety of Polymers and Coating (100 marks)**	**Credits**	
			T	**P**
	Semester: VII	**Total contact hours: 60**	**1**	**0**
List of Prerequisite Courses				
	Polymer chemistry and Technology, Surface coating Chemistry, Plastic Material, High Polymer Chemistry, Paint Technology			
List of Courses where this course will be prerequisite				
	Synthesis of Polymer and resins at laboratory scale and at industrial level. For recycling industry, plastic waste management			
Description of relevance of this course in the B. Tech. Program				
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.				
	Course Contents			**Reqd**
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 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

List of Text Books/ Reference Books

1. Plastics Materials by *J.A. Brydson*, Butterworth-Heinemann, 1999 - Technology & Engineering - 920 pages
2. Handbook of Industrial Chemistry: Organic Chemicals by Mohammad Farhat Ali, Ph.D., Bassam M. El Ali, Ph.D., James G. Speight, Ph.D. McGraw-Hill Education: 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…..)

1	Understand basics of environmental and safety issues in chemical industry.	
2	Understand safety in handling monomer and resins	
3	Impact of final product of polymer and coating on environment after use and its waste management.	
4	Identify, formulate and know Polymer & Resins	
5	Understand safety rule and regulation for polymer and resins. Manufacturing process and application impact and health hazards study of polymer and resins.	

	Course Code: PST1711	**Course Title:** Evaluation and Testing of Polymers and Coating **(100 marks)**	**Credits = 4**		
			L	**T**	**P**
	Semester: VII	**Total contact hours: 45**	**3**	**1**	**0**
List of Prerequisite Courses					
	Polymer Chemistry and Technology Raw material Analysis of resins and polymers, Resins and Polymer Analysis.				
List of Courses where this course will be prerequisite					
	Compounding and Polymer Processing Project ,Environment Health and Safety of Polymers and Coating ,Evolution and testing of Polymers and Coatings, Technology of Plastic Packaging.				
Description of relevance of this course in the B. Tech. Program					
To understand the various testing methods used for testing mechanical, thermal, rheological properties of polymers. The principle on which the testing methods are based. It will help us to understand use of testing method to analyze the properties and applications of the polymer					
	Course Contents		**Reqdh ours**		
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		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		5		
5	Analytical instruments in paints technology, UV, IR, GCMS,X-Ray Diffraction, LCMS MS, Microscopy		5		
6	Partical size analysis of pigments, Accelerated weathering of paints Evaluation and testing of Synthetic Enamel, Primer, Emulsion paint, Intermediate Coat		5		

7	NVM,Viscosity,WPL, Grind, Hinding, Drying Time, Scratch Hardness, Impact Test, Flexibility, Gloss Dry Film Thickness, Acid Alkali, and water Resistance, Adhesion As per IS101, Corrosion Resistance By Salt Spray And Humidity Cabinet, Accelerated Exposure of Paints In QUV And Atlas Apparatus	5
8	% Solids, Scrub Resistance, Stain Resistance ,Rheology of Paint system	5
9	Colour Matching of Synthetic Enamel, Plastic Emulsion Paint And Distemper	5

List of Text Books/ Reference Books

1. Plastics Materials by *J.A. Brydson*, Butterworth-Heinemann, 1999 - Technology & Engineering - 920 pages
2. Handbook of Industrial Chemistry: Organic Chemicals by Mohammad Farhat Ali, Ph.D., Bassam M. El Ali, Ph.D., James G. Speight, Ph.D. McGraw-Hill Education: 2005.
3. SPI Plastics Engineering Handbook of the Society of the Plastics Industry, Inc. by Berins, Michael L., 1991.
4. Handbook of Plastics Analysis, H. Lobo and J. V. Bonilla, Marcel Dekker, 2003.
5. Handbook of polymer Testing Roger Brown, Marcel Dekker Inc, 1999.
6. Instrumental Methods by Dyer.
7. Developments in Polymer Characterization 1-5 by J. V. Dawkins

	Course Outcomes (students will be able to…..)	
1	Able to understand the significance and can suggest the techniques which are used for anaylsis of Polymers such as NMR	
2	Students gets knowledge about various properties of polymers such as mechanical, electrical etc. hence they can suggest the various polymer depending upon specific	

3	The significance of rheology is well understood by student and correlation of rheology and temperature is understood hence student can apply this knowledge	
4	Student gets theoretically knowledgeable about FTIR, NMR etc hence in case of any hand on experiment with such equipment they can apply this knowledge.	
5	Student gets idea theoretically about how to identify any unknown sample.	

PET 1712 Elective II Technology of Plastic Packaging50 marks

	Course Code: PET 1712	**Course Title: :** Technology of Plastic Packaging**(50 marks)**	**Credits = 3**		
			L	**T**	**P**
	Semester: VII	**Total contact hours: 45**	**2**	**1**	**0**
List of Prerequisite Courses					
	.Technology of Thermoplastics, Additives in Polymers, Compounding and Processing of Polymer				
List of Courses where this course will be prerequisite					
	Seminar, Project, Speciality Polymers, Research and developmentof 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…..)		
1	Able to identify unknown polymer sample in any given form.	
2	Student gets knowledge of thermal characterization, solubility technique, correlation of solubility and structure of polymers, flammable or inflammable nature of various polymers.	
3	In case of unknown sample by applying the above knowledge they can identified the sample.	
4	The knowledge about the temperature effect on polymers, its solubility helps the student to segregate the polymers for various application depending upon its properties.	
5	The knowledge of commodity polymers, engineering plastic and special purpose polymers is gets clear with such identification.	

SEMESTER VIII

PET 1813Technology of Elastomers(polymer) 50 marks Contact hr45hr

	Course Code: PET 1813	**Course Title: :** Technology of Elastomers **50 marks)**	**Credits = 3**		
			L	**T**	**P**
	Semester: VIII	**Total contact hours: 45**	**2**	**1**	**0**
List of Prerequisite Courses					
	. Technology of Thermoplastics, Additives in Polymers, Compounding and Processing of Polymer				
List of Courses where this course will be prerequisite					
	Compounding and Polymer Processing Project, Environment Health and Safety of Polymers and Coating ,Evolution and testing of Polymers and Coatings, Technology of Plastic Packaging.				
Description of relevance of this course in the B. Tech. 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. 7. Elastomers and Components by V Coveney, Woodhead Publishing 2006. 8. Elastomers and Rubber Compounding Materials by I. Franta, Elsevier (December 3, 2012)		
Course Outcomes (students will be able to…..)		
1	Ability to understand the elastomer and various types of it.	
2	Ability to understand in detail about the elastomers and there physical, chemical properties, uses, applications and lubricants and various rheology modifiers	
3	Ability to understand the Impact modifiers, classification of Fillers	
4	Ability to understand the Reinforcements and their treatments & use in plastics	
5	Student should be able to understand in detail about the Flame retardants, antistats, nucleating agents, blowing agents	

	Course Code: PST1814	Course Title: Nanomaterial and their applications (50 marks)	Credits = 4		
			L	T	P
	Semester: VIII	Total contact hours: 45	3	1	0
List of Prerequisite Courses					
	Polymer science and Technology, Polymer chemistry and Technology, Technology of Thermoset polymers, Analysis of resins and polymers, Environment Health and Safety of Polymers and Coating, Evaluation and testing of Polymers and Coatings.				
List of Courses where this course will be prerequisite					
	Paint Technology II, Environment Health and Safety of Polymers and Coating,Evaluation and testing of Polymers and Coatings.				
Description of relevance of this course in the B. Tech. Program					
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					

	Course Contents	Reqd. hours
1	Definition, Classification of nanomaterial and its unique properties.	5
2	Synthesis, properties and applications of Carbonnanotubes.	6
3	Synthesis, properties and applications fulleneres.	6
4	Synthesis, properties and applications inorganic nanomaterials like titanium dioxide, zinc oxide etc.	6
5	Synthesis, properties and applications of nanoparticles of gold, silver cellulosics etc.	6
6	Dendrimers, Nanoclaysand its differnt treatment.	6
7	Polymernanocomposites and its processing properties,applications and charecterization	5
8	Nanocoatings,safety regulatins of nanomaterials.	5

List of Text Books/ Reference Books

1. Structural Nanocomposites: Perspectives for Future Applications (Engineering Materials) Hardcover – Import, 16 Dec 2013 by 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.
5. Polymeric Nanomaterials by Challa S. S. R. Kumar, Wiley 2011.
6. Encyclopedia of Polymeric Nanomaterials by Kobayashi**,** Shiro, Müllen, Klaus, Springer-Verlag Berlin Heidelberg, 2015.

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

1. Able to understand the significance of nanosize.
2. Able to synthesized various nanomaterials and nanocomposites
3. Able to take care of safety measurements and to deal with any emergency when working with nanoparticles
4. Able to judge the property variation with differentiation of particle size of any filler, pigment etc. in polymer composite, coating etc.
5. Gets aware about new and emerging technology in Polymer and Coating industry such as carbon nanotubes and anticorrosive coating with the use of same.

	Course Code: PET1815	Course Title: : Composites and Post Polymer Processing (100 marks)	Credits = 4		
			L	T	P
	Semester: VIII	Total contact hours: 60	3	1	0

List of Prerequisite Courses		
	Polymer science and Technology, Polymer chemistry and Technology Compounding and Polymer Processing Additives for Polymers	

List of Courses where this course will be prerequisite		
	Composite manufacturing Industry, Printing Industry, Decoration of Plastics. Environment Health and Safety of Polymers and Coating ,Evolution and testing of Polymers and Coatings, Technology of Plastic Packaging.	

Description of relevance of this course in the B. Tech. 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. hour
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…..)		
1	Understand basics of fiber reinforce composites reinforcement manufacturing of its constituents like like glass fibers carbon fibers etc	
2	Understand properties of polymer Composites, Mechanics their structure properties and relation as well as to analyze and interpret data	
3	To make aware of practical applications of Composite in real world and recycling of composite and their impact on environment, engineering community and society.	
4	Identify, formulate and know practical applications of Polymer Composites	
5	Understand Joining, Welding, decoration and coating of plastic substrate, so as to be easily adaptable to polymer industry, coating industry, Composite industry.	

	Course Code: PET 1813	**Course Title: :** 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, Technology of Thermosets, Polymer Science and Technology, Polymer Chemistry and Technology, Compounding and Processing of Polymer, Structure property and Relationship of Polymers				
List of Courses where this course will be prerequisite					
	Project, 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. hour**
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…..)		
1	Able to learn manufacturing properties of specialty of polymers	
2	Able to learn Processing of specialty of polymers	
3	Able to learn trade names suppliers of the polymers	
4	Able to learn smart applications of polymers	

	Course Code: PEP1808	Course Title: : Advanced Characterization of Polymers and Composite(100 marks)	Credits = 4		
			L	T	P
	Semester: VIII	Total contact hours: 2x4hr/Week	0	0	8

	List of Prerequisite Courses	
	Evolution and testing of Polymers and Coatings, Analytical Chemistry and Technology, Technology of Thermoset, Technology of Thermoplastics	

	List of Courses where this course will be prerequisite	
	Polymer blends, Polymer Nanocomposites , Structure Property Relationship, Polymer Processing,	

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. 8. 9.Plastics Materials, 7th Edition by John Brydson, Elsevier 1999		
Course Outcomes (students will be able to…..)		
1	Ability to useselect analytical and physical testing equipment and modern engineering tools necessary for characterization of polymers like DSC Molecular Weight IR.etc	
2	Ability to analyze and interpret data and characterize additives and polymers within realistic constraints of the experiment	
3	Recording appropriate data like tensile strength impact strength glass transition etcand presenting these in a concise and scientifically meaningful way	
4	To characterize material using XRD GPC DSC optical microscopy	
5	To understand and do calculations observations formulations involved , team work and understanding practical problems related to the experiment	