GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3132602
Semester – III
Subject Name: Rubber Technology

Type of course: Professional Core Course

Prerequisite:

Rationale:

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	4	5	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	**Natural Polymers:** Natural polymers like Rubber, Lignin, humus, coal, kerogen, asphltens, shellac, amber, Tall oil-derived polymers, Polysaccharides like Cellulose, Regenerated cellulose, derivatives of cellulose, starch, derivatives of starch, other Polysaccharides, Proteins like Amino acids, polypeptides and Proteins, Protein structure, synthesis of polypeptides and proteins, wool, silk, collagen, and regenerated protein, Nucleic acids , its structure and Nucleic acids synthesis.	08
2	**Chemical Composition of Rubbers:** Chemical Composition of the Rubber & Polymer Molecule, Monomeric Ingredients in the Final Polymer Composition.	07
3	**Chain Orientation of Rubbers & Polymers:** Concept of chain orientation, Orientation in amorphous and crystalline Polymers, Uniaxial and biaxial orientation, practical significance, orientation process, properties of oriented polymers.	07
4	**Morphology and order in crystalline Rubbers & Polymers.** Introduction, Configuration involving an asymmetric carbon atom, Structural requirements for crystallinity, The amorphous state, Crystallinity, Polymer Morphology (Glass Transition temperature) (Tg), Thermal transition in polymers, Physical Properties and Morphology of polymers, Other factors affecting crystallisability, Effect of Crystallinity on the properties of polymers, Property-Molecular Weight Relationships, Molecular Weight Distribution, Interchain and intrachain forces, Crystalline-Amorphous Structures, Transitions.	07
5	**Monomers for the production of Rubbers:** Butadiene (1,3-butadiene),production of Butadiene from n-Butenes, production of Butadiene from n-Butane, production of Butadiene by steam Cracking of Naphtha Petroleum Fraction, production of Butadiene from Ethyl Alcohol, Reppe Process, production of Butadiene from acetaldehyde, production of Styrene by Dehydrogenation of Ethylbenzene, production of Styrene by Oxidation of Ethylbenzene, Acrylonitrile ,production of Acrylonitrile by reaction between Acetylene and Hydrogen Cyanide, production of Acrylonitrile by reaction between ethylene Oxide and Hydrogen Cyanide, production of Acrylonitrile by reaction between Propylene and Ammonia in the presence of Oxygen, production of Acrylonitrile by reaction between Propylene and Nitric Oxide,	10

	Isoprene(2-methyl-1-,3-Butadiene), production of Isoprene by the Propylene Dimer Process, production of Isoprene by Dehydrogenation of Isopentane and /or 2- Methyl Butenes, production of Isoprene by the Isobutene Formaldehyde process, production of Isoprene by the acetone-acetylene Process, Chloroprene(2-Chloro-1,3-Butadiene), production of Chloroprene from Acetylene, production of Chloroprene from Butadiene, Ethylene, Propylene, Isobutene(Isobutylene) Acrylic Monomers, Vinyl Chloride, Vinyl Acetate.	
6	**Polymer sorbents & Porous structure of Polymers:** Sorption & Adsorption, Porosity & Methods of its Estimation: Calculation of specific surface area of sorbent, calculation of total pore volume of sorbent, Methods of Forming porous Structure of polymers, porous structure of polymers, classification of polymer sorbents, Mechanism of Sorption of Low-Molecular substances by polymers.	**07**
7	**Polymer Degradation** Introduction, Types of degradation, thermal degradation, mechanical degradation, degradation by ultra sonic waves, photo-degradation, degradation by high-energy radiation, oxidative degradation, hydrolytic degradation. Ozone oxidation degradation, Oxidative degradation of saturated polymers, oxidation of phenol formaldehyde, Antioxidants Etc.	**08**

Suggested Specification table with Marks (Theory): (For BE only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	**10**	**20**	**10**	**10**	**10**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

- Polymer Chemistry An Introduction by Malcom P. Stevens
- Text Book of Polymer Science, Third Edition by Fred W. Billmeyer, JR
- Introductory Polymer Science By S. K. Bashin & Rekha Mann
- Synthetic Rubbers, their Chemistry and Technology, by D. C. Blackley
- Polymer Latices Science and Technology, Second Edition: Volume- 3 Applications of Latices, by D. C. Blackley
- Polymer Structure, Properties and Applications by Rudolph D. Deamin.
- Physical Chemistry of Polymers by A. Tager

Course Outcomes:

After learning this course students will be able to:

Sr. No.	CO statement	Marks % weightage
CO-1	Learn the Characteristics of natural polymers	15

CO-2	Understand Importance of Structure & Synthesis of Polymers	20
CO-3	Identify the importance of monomeric ingredients in Rubbers	20
CO-4	Evaluate the specific features of Polymer Sorbents	10
CO-5	Calculate the molecular mass and molecular weight of different rubbers	20
CO-6	Correlate the mechanism of different types of Rubber degradation.	15

List of Experiments:

Tutorials/Presentation/Practicals based on above topics.

Major Equipment:

Muffle Furnace, Smoke Point Apparatus, Oven, Heating mantle, Hot Plate, Weighing balance.

List of Open Source Software/learning website:

- www.vosflips.com/recycling/natural-rubber-cultivation-process/
- www.sciencedirect.com/science/article/pii/S0032386100008533
- www.researchgate.net/.../0141-3910_Polymer_Degradation_and_Stabilit.
- www.rubberchemtechnol.org/doi/pdf/10.5254/1.3538460
- www.bioe.psu.edu/labs/yang.../Richard%202010%20Soft%20Matter.