GUJARAT TECHNOLOGICAL UNIVERSITY

Rubber Technology
SUBJECT NAME: Rubber Technology
SUBJECT CODE: 2132602
B.E. 3RD SEMESTER

Type of course: Core-II (B. E. Rubber Technology)

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)		PA (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	0	4	7	70	20	10	20	10	20	150

L- Lectures; T- Tutorial/Teacher Guided Student Activity; P- Practical; C- Credit; ESE- End Semester Examination; PA- Progressive Assessment; OEP-Open Ended problem; AL-Active learning;

Content:

Sr. No.	Content	Total Hrs	% Weightage
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.	**06**	**10**
2	Cultivation of Natural Rubber: The principal rubber tree: General description, more detailed structure of the mature trunk, The Hevea brasiliensis plantations: Conditions required for the growth of Hevea brasiliensis, Regions of the world where Hevea brasiliensis is found, outline of the history of the Hevea brasiliensis plantations, Propagation of Hevea brasiliensis: Introduction, Propagation by seed, Vegetative propagation.	**06**	**10**
3	Chemical Composition of Rubbers: Chemical Composition of the Rubber & Polymer Molecule, Monomeric Ingredients in the Final Polymer Composition.	**06**	**10**
4	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.	**06**	**10**
5	Chemical & Geometrical Structure of Polymer Molecules. General Remarks on Polymer Microstructure. Microstructures based on Chemical Structure. Microstructures based on Geometrical Structure.	**06**	**10**

6	Morphology and order in crystalline rubbers & polymers. Introduction, Crystalinity & Orientation The Crystalline Structure of Rubber, Strain Crystallizate Rubbers, Glass-Rubber Transition Behaviour, Rubber Properties which change at Tg, Factors which influence Glass Transition in Amorphous Polymers Configuration involving and 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.	**06**	**10**
7	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, 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.	**06**	**10**
8	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, pore radius and DDC, Mercury porosimetry, Specific features of polymer sorbents, Methods of Forming porous Structure of polymers, porous structure of polymers, classification of polymer sorbents, Mechanism of Sorption of Low-Molecular substances by polymers, Ion-Exchange Resins.	**04**	**10**
9	Thermosetting Resins Phenolic and Amino Resins, Unsaturated polyester resins, Epoxy resins and Polyurethanes, silicone rubbers and miscellaneous thermosetting resins.	**04**	**10**
10	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.	**04**	**10**

Reference Books:

1. Polymer Chemistry An Introduction by Malcom P. Stevens
2. Text Book of Polymer Science, Third Edition by Fred W. Billmeyer, JR
3. Introductory Polymer Science By S. K. Bashin & Rekha Mann

4. Synthetic Rubbers, their Chemistry and Technology, by D. C. Blackley
5. Polymer Latices Science and Technology, Second Edition: Volume- 3: Applications of Latices, by D. C. Blackley
6. Polymer Structure, Properties and Applications by Rudolph D. Deamin.
7. Physical Chemistry of Polymers by A. Tager

Course Outcome:

After learning the course the students should be able to:

- Know about the Characteristics of natural polymers.
- Define and distinguish the natural polymers.
- Learn the importance of Proteins & Nucleic Acids.
- Understand the Importance of Structure & Synthesis.
- Understand the structure of the Heveabrasiliensis Tree.
- Define & distinguish the chemical composition of the Rubber & Polymer Molecule.
- Learn the importance of monomeric ingredients in Polymer Composition.
- Learn about Polymer Microstructure.
- Learn the concept of Chain Orientation.
- Learn the Concept of Tg.
- Know about the specific features and classification of polymer sorbents.
- Know about mechanism of different types of degradation.

List of Experiments:

Tutorials/Presentation/Practicals based on above topics.

Major Equipments:

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.**rubber**chemtechnol.org/doi/pdf/10.5254/1.3538460
- www.bioe.psu.edu/labs/yang.../Richard%202010%20Soft%20Matter.pdf

Active learning Assignments (AL) : Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The
Power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU