

# GUJARAT TECHNOLOGICAL UNIVERSITY

## RUBBER TECHNOLOGY (40)

PHYSICS OF RUBBER ELASTICITY (PHRE)

SUBJECT CODE: 2724008

SEMESTER: II

**Type of course:** (Major Elective-III) (M.E.Rubber Technology)

**Prerequisite:** NA

**Rationale:** NA

### Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P		Theory Marks		Practical Marks				
			ESE (E)	PA (M)	ESE (V)		PA (I)			
					ESE	OEP	PA	RP		
3	2#	0	4	70	30	30	0	10	10	150

### Content:

Sr.No	Course Content	Total Hrs	% Weigh tage
<b>1.</b>	<b>General Physical Properties of Rubber:</b> Chemical constitution of rubbers, Early theories of Rubber Elasticity, The Kinetic theory of Elasticity, Cross-Linking and Vulcanisation: network theory, The glass-rubber transition, Crystallization in raw rubber, Crystallization in the stretched state, Photoelastic Properties of Rubbers etc.	<b>7</b>	<b>15</b>
<b>2.</b>	<b>Internal Energy and Entropy Changes on Deformation:</b> Stress-temperature relations, Thermodynamic analysis, Application to experimental data, Interpretation of thermoplastic data, Thermal effects of extension.	<b>8</b>	<b>10</b>
<b>3.</b>	<b>The Elasticity of Long-Chain Molecules:</b> Statistical Properties of Long-chain molecules, Statistical form of Long-chain molecule, The randomly jointed chain, Properties of Gaussian functions, The distribution of r-values, Equivalent random chain. The entropy of a single chain, the tension on a chain.	<b>7</b>	<b>15</b>
<b>4.</b>	<b>The Elasticity of a Molecular Network:</b> The nature of the problem, Detailed development of the theory, Significance of theoretical conclusions, The principal stresses, Significance of single elastic constant, The elastic properties of a swollen rubber, Development of	<b>8</b>	<b>15</b>

	the theory by James and Guth, Network imperfections : 'loose end' corrections.		
<b>5.</b>	<b>Experimental Examination of The statistical Theory:</b> Introduction, Particular stress-strain relations, Experimental examination of stress-strain relations, Derivations from theory: Mooney equation, Non-Gaussian Chain Statistics and Network Theory, Thermodynamic Analysis of Gaussian Network etc.	<b>8</b>	<b>15</b>
<b>6.</b>	<b>Swelling Phenomena:</b> Introduction, General Thermodynamic Principles, Significance of thermodynamic quantities, Statistical treatment of Swelling, The Swelling of Cross-linked polymers, Relation between swelling and modulus, The Cohesive-energy density, The dependence of swelling on strain, Swelling under torsional strain , etc.	<b>8</b>	<b>15</b>
<b>7.</b>	<b>Cross linking and Modulus:</b> Introduction, The experiments of Moore and Watson and of Mullins, Effect of entanglements etc.	<b>8</b>	<b>15</b>

**Reference Books:**

- The Physics of Rubber Elasticity by L.R.G.Treloar.
- Viscoelastic Properties of Polymers by John D.Ferry

**Course Outcome:**

After learning the course the students should be able to:

- Understand the Chemical constitution of rubbers.
- Learn the Kinetic theory of Elasticity.
- Understand the Stress-temperature relations.
- Identify the Statistical Properties of Long-chain molecules of Rubber.
- Learn about the elastic properties of a swollen rubber.
- Establish the relation between swelling and modulus.
- Identify the effect of entanglements.

**Major Equipments:**

Mixing Mill, Press, Tensile Testing Machine etc.

**List of Open Source Software/learning website:**

- <http://www.crcpress.com>
- [www.citycollegiate.com](http://www.citycollegiate.com)
- [WWW.rubberchemtechnol.org/doi/abs/10.5254/1.3546653](http://WWW.rubberchemtechnol.org/doi/abs/10.5254/1.3546653)

**Review Presentation (RP):** The concerned faculty member shall provide the list of peer reviewed Journals and Tier-I and Tier-II Conferences relating to the subject (or relating to the area of thesis for seminar) to the students in the beginning of the semester. The same list will be uploaded on GTU website during the first two weeks of the start of the semester. Every student or a group of students shall critically study 2 papers, integrate the details and make presentation in the last two weeks of the semester. The GTU marks entry portal will allow entry of marks only after uploading of the best 3 presentations. A unique id number will be generated only after uploading the presentations. Thereafter the entry of marks will be allowed. The best 3 presentations of each college will be uploaded on GTU website