GUJARAT TECHNOLOGICAL UNIVERSITY

RUBBER TECHNOLOGY (26)

VISCOELASTICITY OF ELASTOMERS
SUBJECT CODE: 2142606
B.E. 4th SEMESTER

Type of course: B.E. (Rubber Technology)

Prerequisite: Nil

Rationale: Nil

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	2	0	5	70	20	10	30	0	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightag
1	**Stress and Strain:** Elasticity, Generalized Hook's Law, Moduli of Elasticity, Relation Between Bulk modulus(K) & Young modulus (E), Deviation from perfect elastic behaviour, Plasticity and flow.	6	10
2	**The Elastic Properties of Rubber:** Introduction, Structure of an ideal rubber, entropy - elasticity, elasticity of a network.	6	10
3	**Viscosity:** Introduction, Viscosity and Viscosity Nomenclature, Viscosity Theory, Viscosity Experiments, Polydisperse Polymers, Experimental Procedures, Viscosity Summary.	7	10
4	**Phenomena and molecular mechanism of amorphous polymers:** Viscous flow, Kinetic theory of rubber elasticity, Viscoelasticity, Glassy state & glass transition.	7	15
5	**Non – Newtonian fluid behaviour:** Newton's law, Classification of fluid behaviour, Non-Newtonian fluid behaviour, Time-independent fluid behaviour, Viscoplastic fluid behaviour, Shear-thickening or dilatant fluid behaviour, Time-dependent fluid behaviour, Visco-elastic fluid behaviour, Dimensional considerations for visco-elastic fluids.	7	15
6	**Influence of micro-structure on rheological behaviour:**	7	10
7	**Mechanical Models for Linear Viscoelastic Response:** Maxwell Model, The Voight Element, The Four-Parameter Model, Material Response Time — The Deborah Number, Relaxation and Retardation Spectra, Superposition Principles.	7	15

8	**Glass Transition Temperature:** Introduction, States of aggregation, states of phases, Transition and associated properties, Effect of molecular weight on glass transition temperature, Carothers' equation, heat distortion temperature.	**7**	**15**
	Total Hours	**45**	100%

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks				
R Level	U Level	A Level	N Level	E Level
14	14	14	14	14

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate 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:

1. The Nature and Properties of Engineering Materials by Zbigniew D.Jastrzebski,2nd Edition.
2. Principles of Polymer Engineering by N.G.McCrum,C.P.Bukley and C.B.Bucknall,
3. Textbook of Polymer Science by Fred W.BillMeyer
4. Non-Newtonian Flow and Applied Rheology by R.P.Chhabra & J.F.Richardson,2nd Edition.
5. Polymer Science and Technology by Robert O. Ebewele
6. Polymer Science by V.R. Gowarikar, N.V.Viswanathan & Jayadev Sreedhar

Course Outcome:

After learning the course the students should be able to:

1. Able to learn about Moduli of elasticity.
2. Compare the Relation Between Bulk modulus(K) & Young modulus (E).
3. Know about the Structure of an ideal rubber.
4. Understand the importance of Viscosity for elastomers.
5. Understand the Kinetic theory of rubber elasticity.
6. Learn about the Classification of fluid behaviour.
7. Able to learn about influence of micro-structure on rheological behaviour.
8. Learn and Compare the different Mechanical Models for Linear Viscoelastic Response.
9. Able to understand the importance of Glass Transition Temperature

List of Experiments:

Tutorials/Presentation/Practicals based on above topics

Design based Problems (DP)/Open Ended Problem:

- Stress Strain behaviour of Polymeric Elastomers.
- Evaluation of Rubber Stress-Strain Behavior.
- Classification of Non-Newtonian Fluid.

Major Equipment:

Viscometer, Specific gravity balance, Weighing balance, Hot Plate, Elasticity Test Apparatus etc

List of Open Source Software/learning website:

- http://www.allsealsinc.com/
- http://stbb.nichd.nih.gov/
- http://booksite.elsevier.com/
- http://www.umbc.edu

ACTIVE LEARNING ASSIGNMENTS: 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.