



GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3132606

Subject Name: Numerical methods & Viscoelastic models of Elastomers

Type of course: Basic Science Course

Prerequisite:

Rationale:

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	2	0	5	70	30	0	0	100

Content:

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



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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
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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:

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

Course Outcomes:

Students will be able to

Sr. No.	CO statement	Marks % weightage
CO-1	Learn the moduli of elasticity & importance of viscosity of elastomers	15
CO-2	Compare the Relation Between Bulk modulus (K) & Young modulus (E)	15
CO-3	Interpret the Kinetic theory of rubber elasticity	20
CO-4	Identify the influence of micro-structure on rheological behaviour	20
CO-5	Design & analyze different mechanical models for linear Viscoelastic response.	15



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CO-6	Evaluate the molecular weight and Glass transition temperature of different rubber	15
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List of Experiments:

Tutorials/Presentation/Practicals based on above topics.

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/>