GUJARAT TECHNOLOGICAL UNIVERSITY

RUBBER TECHNOLOGY (26)
RHEOLOGY OF RUBBER
SUBJECT CODE: 2152604
B.E. 5th SEMESTER

Type of course: B. E. Rubber Technology

Prerequisite: NA

Rationale: NA

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)	
					PA	ALA	ESE	OEP		
3	0	3	6	70	20	10	20	10	20	150

Content:

Sr. No	Topics	Teaching Hrs.	Module Weightage
1.	Introduction: Definition of Rheology, Rheological Perspective , The importance of non-linearity, Solids and liquids ,Components of rheological research : Rheometry , Constitutive equations , Complex flows of elastic liquids.	6	10
2.	Rhelogical Models & Fluids : Power law fluid Model, Eyring Model, Bingham Plastic fluid model, Ellis fluid model , Eyring-Powel model , Reiner-Philipoff model , Meter model.	6	10
3.	Velocity Distribution in Laminar Flow: Shell Momentum Balances: Boundary Conditions, Flow of a falling film, Flow through a Circular tube, Flow through an Annulus, Flow between two infinite parallel plates, Adjacent Flow of Two immiscible Fluids.	6	10
4.	Velocity Distribution in Turbulent Flow: Definition of Turbulent flow, difference between laminar & turbulent flow, velocity profile for Newtonian & non Newtonian fluid flow, flow of Viscoelastic fluids, Turbulence Damping.	6	10
5.	Rheology & Boundary conditions studies of Elastomers and their compounds: Stress Tensor and Stress Responses: Stress Tensor: Caudry Laws of Motion, Stress Responses to Flow, Early Investigations of Flow Properties of Elastomer, Shear Flow Instruments for Rheological Characterization of Elastomers :Sandwich Rheometer : Biconical Rheometer, Shearing Disc (Mooney) Rheometer, General Purpose Viscometer, Gallen Kamp, Plunger and Other Viscometers.	6	15
6.	Flow Instruments: Oscillatory &Elongation Flow Instruments : Uniaxial Extension: Bubble Inflation Compression Flow Instruments : Parallel Plate Viscometer, Cup and Bob Viscometer, Differential Plastimeter Quality Control Instrumentation : Rotational Rheometers,	6	15

	Capillary Rheometers, Compression Rheometers, Stress Relaxation Instrument.		
7.	Experimental Studies of Rheological Behavior : Steady Shear Flow: Elongation Flow, Oscillating Flow: Stress Relaxation, Temperature Dependence: Processability, Test & Dependence upon Polymer Structure, Shear Flow Boundary Conditions and Slippage, Flow induced Degradation & Mechanochemistry.	6	10
8.	Rheological Models for Elastomers & compounds and Approaches to Flow Analysis: One Dimensional Rheological Models for Rubber Compounds :Plastic Viscous Model, Plastic Viscoelastic Model, Thixotropic Model, Equation of Motion and Dimensional Analysis of Non-Newtonian Fluids :General, Viscoelastic Fluids, Plastic Fluids, Energy Equation & Non Isothermal Flow :Energy Equation, Dimensional Analysis, Classification of Flows :Internal & External Flow, Hydrodynamic Lubrication Theory.	6	10
9.	Variable influencing the Rheology of Rubbers: Effect of Temperature, Effect of Pressure, Effect of Molecular weight & Molecular structure, effect of entanglement of molecules & molecular motions.	6	10

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	15	15	15	15	-

Reference Books:

1. Rubber Processing, by James L. White
2. Transport Phenomena, by R. Byron Bird, Warren E. Stewart, Edwin N. Lightfoot
3. Rheology of Elastomers by Dr. B.R.Gupta
4. An Introduction to Rheology by H.A.Barnes, J. F. Hutton and K. Walters.
5. Non-Newtonian Flow and Applied Rheology by R.P.Chhabra & J.F.Richardson

Course Outcome:

After learning the course the students should be able to

1. Know about the importance of non-linearity.
2. Learn about different rheological models & fluids.
3. Able to understand the Velocity Distribution in Laminar & Turbulent Flow.
4. Understand the Stress Tensor and Stress Responses.
5. Learn about the Shear Flow Instruments for Rheological Characterization of Elastomers.
6. Compare the different Viscometer.
7. Learn the importance of Rheological Behavior for designing a rubber product.
8. Learn about different types of Rheological Models for Elastomers.
9. Know & study about Variable influencing the Rheology of Rubbers.

List of Experiments:

Tutorials/Presentation/Practicals based on above topics

Design based Problems (DP)/Open Ended Problem:

1. Non Newtonian Fluid Mechanics .

2. Computer modeling of flows of elastic liquids through complex vessels and with forced convection.
3. Rheological behavior of raw natural rubber coagulated by microorganisms
4. Factors That Affect the Rheology of Polymers.

Major Equipments:

Oscillating Rheometer, Mooney Viscometer, Cup & Bob Viscometer etc.

List of Open Source Software/learning website:

- http://www.eolss.net/
- http://www.sciencedirect.com/
- http://www.scielo.br/
- http://www.azom.com/

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.