



GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3142607

Semester – IV

Subject Name: Rubber Rheology

Type of course: Professional Core 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 | 0 | 2 | 4 | 70 | 30 | 30 | 20 | 150 |

Content:

| Sr. No. | Content | Total Hrs |
|---------|---|--------------|
| 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. | 06 |
| 2 | Rheological Models & Fluids : Power law fluid Model, Eyring Model, Bingham Plastic fluid model, Ellis fluid model , Eyring-Powel model , Reiner-Philipoff model , Meter model | 07 |
| 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. | 07 |
| 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. | 07 |
| 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. | 07 |
| 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, Capillary Rheometers, Compression Rheometers, Stress Relaxation Instrument. | 07 |



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|---|--|----|
| 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. | 07 |
| 8 | 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. | 06 |

Suggested Specification table with Marks (Theory):

| 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:

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

Course Outcomes:

After learning this course students will be able to:

| Sr. No. | CO statement | Marks % weightage |
|---------|--|-------------------|
| CO-1 | Apply the rheological model in the fluid flow operation | 15 |
| CO-2 | Compare the velocity distribution in laminar flow and turbulent flow | 15 |
| CO-3 | Calculate the flow rate and velocity distribution for different fluids | 20 |
| CO-4 | Analyse the performance of individual components of different rheometers | 20 |
| CO-5 | Implement the various sale forecasting methods on real life problems | 15 |
| CO-6 | Identify the different variable influencing the Rheology | 15 |



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List of Experiments:

Tutorials/Presentation/Practicalsbased on above topics.

Major Equipment:

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/>