

# GUJARAT TECHNOLOGICAL UNIVERSITY

## RUBBER ENGINEERING (40)

MIXING OF RUBBERS

SUBJECT CODE: 2714002

SEMESTER: I

**Type of course:** Core-I (M.E.Rubber Technology)

**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)	PA (V)		PA (I)			
					ESE	OEP	PA	RP		
3	2#	2	5	70	30	20	10	10	10	150

**Content:**

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1	Overview of Mixing of Rubber: Unit Processes, Interpretation of Mixing Process, Compaction as a part of the Mechanism in incorporating Carbon Black into an Elastomer.	5	10
2	Polymerisation and Molecular Architecture: Natural Rubber & Synthetic Rubbers.	6	5
3	Mill Processibility: Interpretation of Mill Processibility, Science of Mill Processibility.	4	5
4	Viscoelasticity and Fracture: Introduction to Viscoelasticity, Viscoelasticity for Characterisation, Viscoelastic Behaviour of Rubber in an Internal Mixer, Mechanism of Fracture of Gum rubber.	5	10
5	Linear Viscoelasticity: Linear Viscoelasticity and mixing of rubber, Relaxation time and its distribution, Linear viscoelasticity as a conceptual background for the mixing of rubber.	5	10
6	Viscoelastic Characterisation of Rubber Compounds: Viscoelastic Properties of Compounds, Strain and Strain-rate Amplification, Unique Characteristics of Compounds.	4	10
7	Application of Characterisation Methods for a Specific Problem : Effect of Fillers and Rubber Structures on Tensile behavior of filled, Unvulcanised compounds of Cis 1,4-Polybutadiene.	4	10
8	Reinforcing Fillers & Liquid Additives: Reinforcing Fillers- Mixing case of fillers, structure of aggregate and agglomerate. Liquid Additives- The Energy Aspects of Mixing Rubber: Energy Balance- Experiment, Experimental Programme.	4	5
9	Proposed Model of a Mixing Mechanism: Changes in material during mixing, Mechanical actions, Material-	4	10

	machine interaction, Macroscopic versus microscopic deformation.		
10	Model of Material Behaviour in the Internal Mixer: Material Properties, Pressure profile in the internal mixer, deformation of material between rotor edge and chamber wall, Probability and distribution in mixing, Calculation of Mixing energy.	4	10
11	Nano and Molecular Scale of Mixing: Chemical Reactions during Mixing, Optimum state of the elastomer for mixing, Improvements in rotor design.	5	5
12	Post-Mixing Processes : Causes of non uniformity in feeding, Material behavior, flow Mechanism etc.	4	10

**Reference Books:**

1. The Science & Practice of Rubber Mixing by Nakajima 1<sup>st</sup> Edition 2000.
2. Mixing of Rubbers by Dr. John M.Funt

**Course Outcome:**

After learning the course the students should be able to:

1. Understand the compaction process.
2. Identify the Changes in material during Mixing.
3. Justify the compounding mechanism in depth.
4. Identify the difference between uniform & non uniform mixing.
5. Calculate the mixing energy.
6. Through mechanism able to save power, energy and environment.
7. Develop different models of mixing.
8. Understand the molecular architecture.
9. Understand the viscoelastic behavior of different elastomers.

**List of Experiments:**

Tutorials/Presentation/Practicals based on above topics

**Open Ended Problems:**

1. Methods to characterize Rubber Elastic Behavior for use in Finite Element Analysis.
2. Cooling Impact on rubber mixing.
3. Energy Efficiency in rubber Processing.
4. Natural Rubber as a green commodity

**Major Equipments:**

Mixing Mill, Extruder, Calender Machine, Press etc

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

- Mixing of Rubber By Dr. Gupta
- <http://www.crcpress.com>
- <http://freevideolectures.com/Course/3070/Science-and-Technology-of-Polymers>