



# GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: Post Graduate

Branch: Rubber Technology

Course / Subject Code:ME01088011

Course / Subject Name : Mixing of Rubber

w. e. f. Academic Year:	2024-25
Semester:	1 <sup>st</sup> Semester
Category of the Course:	PCC

## Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes
01	Identify the Changes in material during Mixing
02	Calculate the mixing energy
03	Solve the problems related to save power, energy and environment.
04	Analyze the viscoelastic behavior of different elastomers.

## Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
L	T	PR		C	Theory		Tutorial / Practical	
			ESE (E)		PA / CA (M)	PA/CA (I)	ESE (V)	
03	00	02	04	70	30	20	30	150

## Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	<b>Overview of Mixing of Rubber:</b> Unit Processes, Interpretation of Mixing Process, Compaction as a part of the Mechanism in incorporating Carbon Black into an Elastomer.	04	10
2.	<b>Polymerization and Molecular Architecture:</b> Natural Rubber & Synthetic Rubbers.	04	05
3.	<b>Mill Processibility:</b> Interpretation of Mill Processibility, Science of Mill Processibility.	03	05
4.	<b>Viscoelasticity and Fracture:</b> Introduction to Viscoelasticity, Viscoelasticity for Characterization, Viscoelastic Behavior of Rubber in an Internal Mixer, Mechanism of Fracture of Gum rubber.	04	10



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5.	<b>Linear Viscoelasticity:</b> Linear Viscoelasticity and mixing of rubber, Relaxation time and its distribution, Linear viscoelasticity as a conceptual background for the mixing of rubber.	04	10
6.	<b>Viscoelastic Characterization of Rubber Compounds:</b> Viscoelastic Properties of Compounds, Strain and Strain-rate Amplification, Unique Characteristics of Compounds.	04	10
7.	<b>Application of Characterization Methods for a Specific Problem:</b> Effect of Fillers and Rubber Structures on Tensile behavior of filled, Unvulcanised compounds of Cis 1,4-Polybutadiene.	04	10
8.	<b>Reinforcing Fillers &amp; Liquid Additives:</b> Reinforcing Fillers- Mixing case of fillers, structure of aggregate and agglomerate. Liquid Additives- The Energy Aspects of Mixing Rubber: Energy Balance- Experiment, Experimental Program.	04	05
9.	<b>Proposed Model of a Mixing Mechanism:</b> Changes in material during mixing, Mechanical actions, Material-machine interaction, Macroscopic versus microscopic deformation	03	10
10.	<b>Model of Material Behavior in the Internal Mixer:</b> 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.	04	10
11.	<b>Nano and Molecular Scale of Mixing:</b> Chemical Reactions during Mixing, Optimum state of the elastomer for mixing, Improvements in rotor design.	04	05
12.	<b>Post-Mixing Processes:</b> Causes of non-uniformity in feeding, Material behavior, flow Mechanism etc.	03	10
<b>Total</b>		<b>45</b>	<b>100</b>



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## 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

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

## References/Suggested Learning Resources:

### (a) Books:

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

### (b) Open source software and website:

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

## Suggested Course Practical List: If any

Practical based on above topics.

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