GUJARAT TECHNOLOGICAL UNIVERSITY

BRANCH NAME: RUBBER TECHNOLOGY
SUBJECT NAME: Mixing of Rubber (MR)

SUBJECT CODE: 3714002
M.E. 1st SEMESTER

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

Prerequisite:

Rationale:

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE(E)	PA (M)	PA (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No	Course Content	Total Hrs	% 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.	05	10
2.	**Polymerisation and Molecular Architecture:** Natural Rubber & Synthetic Rubbers.	06	05
3.	**Mill Processibility:** Interpretation of Mill Processibility, Science of Mill Processibility.	04	05
4.	**Viscoelasticity and Fracture:** Introduction to Viscoelasticity, Viscoelasticity for Characterisation, Viscoelastic Behaviour of Rubber in an Internal Mixer, Mechanism of Fracture of Gum rubber.	05	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.	05	10
6.	**Viscoelastic Characterisation of Rubber Compounds:** Viscoelastic Properties of Compounds, Strain and Strain-rate Amplification, Unique Characteristics of Compounds.	04	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.	04	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.	04	05

9.	**Proposed Model of a Mixing Mechanism:** Changes in material during mixing, Mechanical actions, Material-machine interaction,Macroscopic versus microscopic deformation.	**04**	**10**
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.	**04**	**10**
11.	**Nano and Molecular Scale of Mixing:** Chemical Reactions during Mixing, Optimimum state of the elastomer for mixing, Improvements in rotor design.	**05**	**05**
12.	**Post-Mixing Processes :** Causes of non uniformity in feeding, Material behavior, flow Mechanism etc.	**04**	**10**

Reference Books:

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

Course Outcome:

After learning the course the students should be able to:

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

List of Experiments:

Tutorials/Presentation/Practicals based on above topics.

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**