GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering

Level: PG

Branch: Rubber Technology

Subject Code ME02088011

Subject Name: Rubber Blends

w. e. f. Academic Year:	2024-25
Semester:	2
Category of the Course:	PCC

Prerequisite:	Students have basic knowledge of different types of rubbers, its structure and properties
Rationale:	Rubber-rubber blends represent a cornerstone in the development of advanced elastomeric materials, offering a pathway to tailor properties for specific industrial applications. The rationale for studying these topics stems from the critical need to enhance the performance, sustainability, and applicability of rubber materials across diverse sectors. This comprehensive framework encompasses the morphology, preparation, analytical methods, and modifications of rubber blends to meet the evolving demands of industries such as automotive, construction, and consumer goods. Understanding the morphology and characterization methods of rubber blends is essential to optimize their physical and mechanical properties. The preparation and study of multiphase elastomers and miscible blends enable the design of materials with superior properties, including improved elasticity, resistance to environmental factors, and processability. These blends provide a foundation for innovations in product performance and durability.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes
C01	Explain and interpret the analytical methods used for blend characterization.
C02	Demonstrate the ability to analyze and predict the processing behavior of rubber blends.
C03	Identify and investigate the root causes of poor physical properties in blends, and categorize possible solutions.
C04	Assess the effectiveness of modification strategies for different rubber grades.
C05	Design and implement methods to improve the morphology and properties of rubber blends.

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	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.	**Rubber-Rubber blends:** Introduction, morphology, analytical methods for blend characterization, preparation of rubber blends and properties of rubber blends, multiphase elastomers, miscible blends.	7	15
2.	**NR/NBR Blends:** Introduction, NR/BR41, NR/Krynac 34.50 Blends, Improving the Morphology and Properties of NR/NBR Blends with NR/PMMA Graft Copolymers, Improving the Morphology and Properties of NR/NBR Blends with Polychloroprene as the Compatibilizing Agent, NR/NBR Blends – Compounding for Food Contact Applications	8	15
3.	**Novel Natural Rubber/Ethylene Propylene Copolymer (EPM) Blends:** Introduction, Dynamic Vulcanization, Selection of Dynamic Cure System, Dynamic Vulcanization of NR/EPM Blends, The Sandwich Mix Cycle, Processing Behavior, Vulcanization of DV Blends, Resistance to Environmental Damage.	8	20
4.	**Natural Rubber/ENR-25 Blends:** Introduction, Designed Experiments, Plasticizer Investigations, Cure Systems, Dynamic: Static Modulus Ratios, Tri-Blends, Improving Resistance to Low Temperature Crystallization in NR/ENR-25 Blends.	7	15
5.	**NR/EPDM Blends:** Solutions to the Basic Problems of Poor Physical Properties of NR/EPDM Blends, Approaches to Improving NR/EPDM Blend Properties, Mixing Procedures, Effect of EPDM Modification on Crosslink Density, Effect of EPDM Modification on Phase Morphology, Interaction of Modified EPDM and Carbon Black, Physical Properties, High Temperature Curing Effects, Modification of Different EPDM Grades, Compounding	7	15

	NR/EPDM Blends for Light-Coloured Applications NR/EPDM Blends for Extruded Profile Weather-strip.		
6.	**Blends of carboxylated elastomers with other polymers:** Blends of carboxylated and regular NBR, blends of carboxylated NBR with polybutadiene, with epichlorohydrin rubber, with pvc, with regular NBR and pvc, with chlorosulfonated polyethylene, with chlorobutyl rubber, with polychloroprene, with modified natural rubber, with polyacrylic rubber, with polyolefins, blends of carboxylated elastomers with polyamides, blends of carboxylated EPDM with polyethylene terephthalate.	8	20
	Total	**45**	**100**

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. Blends of Natural Rubber Novel Techniques for Blending with Specialty Polymers Edited by Andrew .J Tinker and Kevin P. Jones; Publisher: CHAPMAN & HALL
2. Handbook of Elastomers edited by Ani1 K. Bhowmick and Howard l. Stephens

(b) List of Open Source Software/learning website:

- **http://www.sciencedirect.com/**
- **http://rri.nsf.ac.lk/**
- **http://www.scirp.org/**

- **Suggested Course Practical List: If any**
  Practical based on above topics.

- **Suggested Project List:**
  1. Characterization of Morphology in Rubber Blends
  2. Preparation and Property Optimization of NR/NBR Blends
  3. Development of Food-Grade NR/NBR Blends
  4. Enhancement of Low-Temperature Crystallization Resistance in NR/ENR-25 Blends

5. Crosslink Density and Phase Morphology in NR/EPDM Blends
6. Blends of Carboxylated NBR with Polybutadiene and Epichlorohydrin Rubber
7. Blends of Carboxylated Elastomers with Modified Natural Rubber
8. Carboxylated Elastomers Blended with Polyolefins and PET
9. Compatibility Studies of Carboxylated EPDM Blends with Engineering Polymers
10. Performance Analysis of Carboxylated Elastomer/Polyamide Blends

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