GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: Post Graduate

Branch: Rubber Technology

Subject Code : ME02088071

Subject Name: Nano Rubber Composites

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

Prerequisite:	Basic knowledge of rubber technology, its characteristics and knowledge about rubber composites, nano materials.
Rationale:	The study of rubber nanocomposites represents a significant leap in material science, offering innovative solutions to enhance the performance and versatility of rubber in various applications. By incorporating nanofillers such as carbon nanotubes, clay, and polysaccharide nanocrystals, these composites exhibit superior mechanical, thermal, and chemical properties. The manufacturing techniques, including melt compounding and latex compounding, along with interface modification methods, ensure that the rubber matrix and nanofillers interact optimally, enhancing the overall properties of the composites. The exploration of natural rubber green nanocomposites and the aging and degradation behaviors of these materials underscores their potential for sustainable and long-lasting applications. As the field continues to evolve, advances in rubber nanocomposites will open new doors in industries such as tire manufacturing, healthcare, aerospace, and sporting goods, making them indispensable in future technological developments. The ongoing research and innovation in the preparation, characterization, and application of these composites will undoubtedly drive the next generation of rubber-based materials with enhanced performance and environmental benefits.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes
C01	Identify various types of nanofillers.
C02	Explain the properties and behavior of rubber nanocomposites without interface modification.
C03	Describe the characteristics and applications of natural rubber green nanocomposites.
C04	Classify elastomeric nanocomposites and assess the degradation of rubber nanocomposites.
C05	Justify the role of nanofillers in the reinforcement of rubber materials.

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.	**Introduction to Nanocomposites:** Various Nano fillers, Rubber Nanocomposites, Future Outlook, Challenges and Opportunities.	5	10
2.	**Manufacturing Techniques of Rubber Nanocomposites:** Introduction, Melt Compounding, Solution Blending, Latex Compounding.	5	10
3.	**Interface Modification and Characterization:** Introduction, Rubber Nanocomposites Without Interface Modification, Interface Modification by Nonreactive Routes, Interface Modification by Reactive Routes, Characterization of Interface Modification.	5	15
4.	**Natural Rubber Green Nanocomposites:** Introduction, Preparation of Polysaccharide Nano crystals, Processing of Polysaccharide Nanocrystal-Reinforced Rubber Nanocomposites, Morphological Investigation, Swelling Behavior, Dynamic Mechanical Analysis, Tensile Tests, Successive Tensile Tests, Barrier Properties	5	10
5.	**Carbon Nanotube Reinforced Rubber Composites:** Introduction Functionalized Carbon Nanotubes, Elastomeric Nanocomposites.	5	10
6.	**Rubber/Clay Nanocomposites-Preparation, Properties and Applications:** Introduction, Clays and Their Organophilic Modification, Preparation of Rubber/Clay Nanocomposites, Properties of Rubber/Clay	5	10

	Nanocomposites, Applications.		
7.	**Nanofillers In Rubber–Rubber Blends :** Introduction, Types of Nanofillers, Role of Nanofillers in Reinforcement, Methods to Enhance Polymer–Filler Interaction and Reinforcement, Role of Nanofiller as Compatibilizer, Structure Compatibility Concept of NR-Based Latex Blends, Solubility Parameter and Mixing of Latices, Preparation of Nanocomposites, Rubber Blend Nanocomposites Based on Skim NR Latex and Fresh NR Latex: Preparation, Characterization and Mechanical Properties, Advantages of Nanocomposites and Application of Rubber Nanocomposites	5	15
8.	**Aging and Degradation Behavior of Rubber Nanocomposites:** Introduction, Types of Fillers Used in Rubber Nanocomposites, Aging of Rubber Nanocomposites, Degradation of Rubber Nanocomposites**.**	5	10
9.	**Application of Rubber Nanocomposites:** Introduction, Rubber Nanocomposites in Tire Engineering Applications, Rubber Nanocomposite Membranes, Applications of Rubber Nanocomposites in Sporting Goods, Advanced Nanocomposites for Airspace Applications, Nano rubbers in Medicine and Healthcare.	5	10
	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:

Rubber Nanocomposites Preparation, Properties and Applications; edited by Sabu Thomas and Ranimol Stephen.

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

- http://www.crcpress.com
- pt.bme.hu/.../Chapter%20in%20Rubber%20Nanocomposites%20book.pdf
- The American Synthetic Rubber Research Program. Philadelphia

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

Suggested Project List:

1. Exploring the Challenges and Opportunities in Rubber Nanocomposites
2. Comparison of Melt Compounding, Solution Blending, and Latex Compounding in Rubber Nanocomposites
3. Effect of Interface Modification on Rubber Nanocomposite
4. Characterization Techniques for Interface Modification in Rubber Nanocomposites
5. Preparation and Characterization of Polysaccharide Nano Crystals Reinforced Rubber Nanocomposites
6. Fabrication and Characterization of Elastomeric Nanocomposites Reinforced with Functionalized Carbon Nanotubes
7. Role of Nanofillers in Reinforcement of Rubber/Polymer Blends
8. Aging and Degradation Behavior of Carbon Nanotube Reinforced Rubber Nanocomposites
9. Applications of Rubber Nanocomposites in Medicine and Healthcare
10. Development of Rubber Nanocomposite Membranes for Filtration Applications

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