GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: Under Graduate

Branch: Rubber Technology

Subject Code : BE04026031

Subject Name : Textile & Metal Reinforcement of Elastomers

w. e. f. Academic Year:	2024-25
Semester:	4
Category of the Course:	PCC-06

Prerequisite:	None
Rationale:	This course provides comprehensive knowledge on textile materials and their applications in rubber composites, focusing on fiber classification, yarn production, and textile properties essential for industrial use. It covers various textile reinforcements such as Rayon, Nylon, and Aramid, along with their fabric constructions and treatments. The course also explores rubber-to-textile and rubber-to-metal adhesion systems, bonding mechanisms, and testing methods. Advanced topics include short-fiber reinforced composites, metal surface treatments, and adhesion challenges like corrosion and staining. Emphasis is placed on practical bonding techniques, such as dipping, coating, and wet blast preparation, to ensure durable, high-performance rubber-based assemblies.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes
01	Classify textile materials, fiber structures, and yarn properties for industrial use.
02	Analyze production and properties of textile reinforcements.
03	Evaluate adhesion mechanisms and bonding methods for textile, rubber, and metals.
04	Apply short-fiber reinforcement and surface treatments in rubber products.
05	Design and assess rubber-to-metal bonding systems and processes.

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	TH		ESE (E)	PA (M)	PA/ (I)	TW/ SL (I)	ESE (V)	
45	0	30	45	120	04	70	30	20	30	50	200

- ***Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.***

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, PA = Progressive Assessment, ESE = End-Semester Examination

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	General Introduction: Classification of Textiles, Textile terms & Definitions, Fiber Properties, Fiber Morphology, Property requirements of yarns for industrial uses, Production of textile yarns & cords, Textile & rubber composites, Production & properties of textile.	06	10
2	Textile Reinforcements: Types, Production methods and properties of fibers: Rayon, Nylon, Polyester, Aramid, Glass Cord and fabric constructions: Production of single end reinforcements, Fabric production, non-woven fabrics, The design of woven fabric, Pré-treatment and surface modification of cords.	06	10
3	Rubber-to-textile adhesion systems: Introduction, Basic principles of adhesion, Method of achieving adhesion between textile and rubber, Mechanisms of physical and chemical adhesion, Surface energy, interfacial compatibility Adhesion test methods: Peel strength, H-pull, lap shear Dipping techniques and bonding agents: Dipping, plasma, UV, and chemical bonding techniques Coating of textiles with rubber compounds, Latex proofing, Coating of steel cords, etc.	06	10
4	Rubber-Fiber/Short-Fiber Composites: Fiber handling & compounding with Rubber, Properties & examples of application, Short-Fiber Composite concepts, Applications in rubber of santoweb short-fibers, Enhancement of rubber properties via short kevlar aramid fibers, Extrusion of short fiber reinforced rubber, Fibrous magnesium silicate as a high volume & high modulus reinforcing filler in rubber composites.	06	20
5	Surface Treatment for Metal: Aluminum, Copper, Steel, Polymers, Corona discharge, Acid etching, Plasma treatment & other methods.	06	10
6	Adhesion, Corrosion and Staining: Adhesion to metals, Corrosion of, and adhesion to metals, Staining.	05	10
7	Rubber to Metal Bonding: Elements of rubber to metal system, Mechanical and chemical treatment, Application methods of rubber to metal bonding agent, Metal cleaning,	05	10

	Surface treatment, Rubber to metal assemblies, Materials, Manufacturing methods, Moulding, Insert moulding, Adhesives, Testing, Problem solving in rubber to metal bonding.		
8	Wet blast preparation and the subsequent phosphating process and related equipment: Purpose, Operation, Comparison, Advantages and Other benefits.	05	10
	Total		**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
12	12	16	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. Textile Reinforcement of Elastomers, edited by William C. Wake & David B. Wootton; Applied Science Publishers
2. Rubber Engineering by Indian Rubber Institute
3. Polymer Latices Science and Technology, Second Edition: Volume-3: Applications of Latices, by D. C. Blackley
4. Handbook of Elastomers: New Developments & Technology, Edited by Anil K. Bhowmick & Howard L. Stephens
5. Proceedings the 8th Scandinavian Rubber Conference. (June 10-12, 1985, Copenhagen, Denmark)
6. Proceedings for RAPRA Technology Ltd.

(b) Open source software and website:

- http://www.iom3.org/events/rubber-reinforcement
- https://core.ac.uk/download/pdf/16670851.pdf
- https://www.mdpi.com/2073-4360/16/24/3478

Suggested Course Practical List: If any

Practical based on above topics.

List of Laboratory/Learning Resources Required:

Suggested Project List:

1. Analysis of Yarn Property Requirements for Rubber-Based Applications.
2. Production and Testing of Woven vs. Non-Woven Textile Structures
3. Surface Modification of Fabric Cords for Enhanced Rubber Bonding.
4. Effect of Plasma and UV Treatment on Textile-Rubber Bond Strength.
5. Study of Interfacial Compatibility in Rubber-Textile Adhesion.
6. Comparison of Santoweb and Conventional Fibers in Reinforced Rubber.
7. Study on Acid Etching vs. Plasma Treatment of Metal Surfaces.
8. Investigation of Corrosion Inhibition in Rubber-Metal Interfaces.
9. Comparative Study of Insert Molding vs. Adhesive Bonding Techniques.
10. Optimization of Surface Treatment Parameters for Enhanced Bonding.
11. Study on Wet Blast Surface Preparation and Its Impact on Phosphating.
12. Surface Roughness Analysis Before and After Wet Blast Treatment.
13. Rubber-to-Metal Bond Strength Evaluation Using H-Pull Method.

- **List of suggested activities for Problem Based Learning:**

Sr. No.	Name of the activity	No. of hours	Evaluation Criteria
1.	Online Course	Minimum duration of the course should be 20 h.	Based on assignment submitted and certificate produced.
2.	Virtual Industry Trip	Duration of hours-5h Report preparation- 5h Total -10 h	Based on report submitted. Report should contain manufacturing process, flow chart.
3.	Self-Learning Through Assignment Creation related to subject	Completion of five independent tasks, each designed for a 3-hour engagement. Total = 15h	Based on assignment submitted.
4.	Case Study Analysis related to subject	Duration of data collection -6 h Report preparation – 4h Total- 10 h	Based on Problem identification, depth of analysis, technical insight, application relevance
5.	Technical Article/Video Reviews related to subject	Duration of Review -6h Report preparation -4h Total-10h	Relevance of content, clarity of summary, insights drawn, conceptual understanding
6.	Literature review and Concept Mapping	Duration -6h Report preparation- 4h	Based on selection of a topic, creation of concept map, Accuracy, structure,

		Total-10 h	completeness, clarity and coverage of key concepts
7.	Field Visit to Industrial or Research Setup	Visit- 5h Report preparation-5h Total-10h	Based on report submitted. Report should contain manufacturing process, plant lay out, testing results.
8.	Industry Interaction (Webinar/Interview/Quiz)	Total-10 h	Based on certificate produced for participation in webinar, interview, quiz and based on report submitted. Report should contain key takeaways.
9.	Peer Teaching Video	2 video preparation -10 h	Create a 5–10-minute video explaining a rubber technology concept for peers, incorporating visuals.
10.	DIY Experiments	5 hours including report preparation	Based on report submitted. Report should contain experiments performed which have Creativity, relevance to rubber properties, observation documentation, safety awareness.
11.	Glossary Compilation	Duration -5h	Based on report submitted. Report should contain Accuracy, completeness, formatting, and use of illustrations/examples
12.	Videos focusing on industrial safety topics relevant to the subject	Duration of video = 5h Report preparation = 5h Total = 10h	Based report submitted. Report should contain all safety aspects explaining its importance.
13.	Peer Interaction / Teaching	5 research paper/ Technical Topics = 20 h	Communication skill, clarity of explanation, concept understanding
14.	Visual presentation of technical content through posters, charts, or PowerPoint slides	Duration = 10 h	Based on quality of poster/chart preparation, creativity, accuracy and effectiveness of presentation skills.
15.	Model-making (working or non-working) focused on technical concepts	Duration -15 h	Based on evaluation from inter-department or external experts.

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