



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: Under Graduate

Branch: Rubber Technology

Subject Code : BE04026051

Subject Name : Natural Rubber Science & Technology.

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

Prerequisite:	None
Rationale:	The study of natural rubber and its various modifications is essential for understanding its structure, properties, and wide-ranging applications. Exploring the processing methods and types, including TSR and related materials, provides insight into raw rubber's behavior. Chemical modification and graft copolymerization enhance rubber's performance and introduce functionalities like epoxidation, expanding its use in thermoplastics and advanced engineering. Understanding diffusion phenomena helps explain material interactions, stability, and aging in practical environments. Crystallization at low temperatures and mechanical responses under strain form the basis for structural applications like rubber-steel laminates. Liquid and powdered rubbers offer processing and performance flexibility, while reclaim rubbers contribute to sustainable, cost-effective material use. Together, these topics provide a comprehensive foundation in rubber science, enabling innovation in material design and industrial application.

Course Outcome: After Completion of the Course, Student will able to:

No	Course Outcomes
01	Identify and compare natural rubber grades, explain their key characteristics, and relate crystallization behavior to engineering performance.
02	Apply the principles of diffusion in liquids and solids to evaluate their effects on the behavior and properties of natural rubber.
03	Analyze the differences between liquid and powdered rubber in terms of composition and usage.
04	Evaluate the grafting chemistry and assess the resulting properties of various graft copolymers
05	Design chemically modified natural rubbers using suitable techniques to enhance performance for specific applications.

Teaching and Examination Scheme:

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



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- **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.	Natural Rubber: Introduction, Processing of Latex for Dry Rubber Production, Technically Specified Rubber, Advantages of TSR over conventional grades, Other forms of Natural Rubber, Properties of raw Natural Rubber, Non-rubber substances, Physical properties, Structure of Natural Rubber, Solubility and Swelling, the Status of Natural Rubber, Gutta-parcha, Balata and Related Materials.	06	10
2.	Chemical Modification of Natural Rubber : Introduction, Modification Research, Chemical Reactivity of Natural Rubber, Simple Addition Reactions of the olefinic double bond, Simple substitution reactions of the olefinic double bond, Electro cyclic Reactions, Degradation Reactions, Epoxidation Chemistry, Properties of ENR, Applications of ENR.	06	10
3.	Graft Copolymers from Natural Rubber : Introduction, Thermoplastic Rubber, A method for NR, Grafting Chemistry, Physical Properties of Polystyrene Graft Copolymers, Grafting to other backbones, Graft Chains other than Polystyrene, Alternative Grafting Chemistry, Heveaplus MG & Related Materials.	06	10
4.	Diffusion of Liquids and Solids in Rubber: Introduction, Diffusion Theory, Experimental Methods, Diffusion of Hydrocarbon Liquids and Oils, Blooming of Waxes, Diffusion of Water in Rubber, Practical Relevance.	05	10
5.	Low Temperature Crystallization and Engineering use of Natural Rubber: Crystallization in Natural Rubber, Experimental Techniques, Tensile Strain, Compression, Shear, Force-Deformation behaviour, Environmental Factors, Flexible Rubber-steel Laminates.	06	20
6.	Liquid Rubbers: Introduction, Classes of commercially established Liquid Elastomers, Model studies using Terminally Functional Polybutadiene, Practical considerations affecting the development of Telechelic Polymers as General-purpose Elastomers, Additional Terms in Telechelic Elastomer Research & Development, Counseling Remarks.	05	15
7.	Powdered Rubbers: Introduction, Preparation of powdered rubbers, Partitioning agents, Preparation	06	10



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	of powdered rubber compounds, Mixing, Processing on Open mills, Powdered Mastication principle, Advantages of powdered and particulate rubbers.		
8.	Reclaim Rubbers: Introduction, Different Manufacturing Processes of Reclaim Rubbers, Types of Reclaim Rubbers, Testing and evaluation of Reclaimed Rubber, Properties of Reclaimed Rubber as a compounding ingredient, The advantages of using Reclaimed Rubber, Major uses of Reclaim Rubber, Rubberized Asphalt, Applications, Economics.	05	15
Total			100

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
14	14	14	14	14	14

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. Natural Rubber Science and Technology, by A.D. Roberts
2. Handbook of Rubber Projects, Technology and Product Formulations, by SBP Consultants & Engineers (P) Ltd.
3. Rubber Materials and their components, by J. A. Brydson
4. Rubber Technology : by Maurice Morton

(b) Open source software and website:

- www.sciencedirect.com/science/book/9780857096838
- www.hindawi.com/journals/isrn/2012/168798
- link.springer.com/content/pdf/10.1007/978-1-4613-2205-4_21.pdf

Suggested Course Practical List: If any

Practical based on above topics.

List of Laboratory/Learning Resources Required:



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Suggested Project List:

1. **Physical and Structural Characterization of Raw Natural Rubber.**
2. Extraction and Analysis of Non-Rubber Components from Natural Rubber.
3. Effect of Olefinic Addition Reactions on the Performance of Natural Rubber.
4. Epoxidation of Natural Rubber: Synthesis and Property Evaluation.
5. Development of Thermoplastic Rubber Using Graft Copolymerization Techniques.
6. Water Diffusion Behavior in Filled vs. Unfilled Rubber Samples.
7. Diffusion Study of Hydrocarbon Oils in Natural Rubber at Different Temperatures.
8. Environmental Effects on Mechanical Properties of Crystallized Natural Rubber.
9. Force-Deformation Analysis of Natural Rubber-Steel Laminates.
10. Development of Telechelic Liquid Rubbers and Their Performance Analysis.
11. Comparative Evaluation of Liquid Elastomers for Sealant Applications.
12. Comparison of Mechanical Properties of Powdered vs. Conventional Rubber Compounds.
13. Effect of Reclaim Rubber on Physical and Rheological Properties of Blends.
14. Cost-Benefit Analysis of Reclaimed Rubber in Asphalt and Industrial Applications.
15. Analysis of Wax Blooming in Stored Rubber Compounds.

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	Relevance of content, clarity of summary, insights



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		Total-10h	drawn, conceptual understanding
6.	Peer Teaching Video	2 video preparation -10 h	Create a 5–10-minute video explaining a rubber technology concept for peers, incorporating visuals.
7.	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.
8.	Glossary Compilation	Duration -5h	Based on report submitted. Report should contain Accuracy, completeness, formatting, and use of illustrations/examples
9..	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.
10.	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.