GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: Under Graduate

Branch: ALL (Except Chemical Engineering and Allied Branches)

Subject Code: BE05000571

Subject Name : Sustainable Polymers: Materials, Safety and Circular Economy

w. e. f. Academic Year:	2024-25
Semester:	5
Category of the Course:	MOPEC-02

Prerequisite:	None
Rationale:	This course provides the knowledge of Polymers — rubber, plastics, fibres, and coatings — are the core materials of every engineering industry, yet most programmes offer little structured exposure to their science, processing, safety, or sustainability, leaving graduates underprepared for industrial realities. This course fills that gap through six purposefully sequenced units covering polymer science fundamentals, rubber and plastics technology, processing defects and troubleshooting, chemical hazard management, and circular economy principles. The inclusion of processing defects and troubleshooting directly addresses a practical industry need — defects such as short shots, sink marks, melt fracture, and porosity cause significant production losses daily. The safety unit ensures students can read SDS documents, select appropriate PPE, and apply engineering controls before entering the workplace. The final unit aligns students with the growing regulatory and sustainability demands of the polymer industry, including India's Plastic Waste Management Rules, REACH, and ZDHC compliance. The course is intentionally designed as a multidisciplinary professional elective, equally relevant to students from rubber, plastics, textile, chemical, and mechanical engineering backgrounds, preparing them to work with polymeric materials knowledgeably, safely, and responsibly.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	Marks % weightage
C01	Classify and explain polymer types, polymerization methods, and key properties relevant to rubber, plastic, and fibre industries.	20
C02	Describe the science, processing, and industrial applications of natural and synthetic rubbers including rubber-fabric composite products.	20
C03	Identify major plastics by properties and processing methods and explain the role of additives in product performance.	20
C04	Analyse common processing defects in rubber and plastics manufacturing and recommend corrective actions using systematic troubleshooting tools.	20
C05	Evaluate chemical hazards, apply safety measures, and assess circular economy strategies and regulatory frameworks governing polymer materials.	20

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Teaching and Examination Scheme:

Teaching/Learning Scheme in hrs/semester					Total Credits	Assessment Pattern and Marks					Total Marks
						Theory		Practical			
L	T	P	PBL*	TH	TH/30	ESE (E)	PA (M)	PA (I)	PBL(I)	ESE (V)	
45	00	00	15	60	2	70	30	30	0	0	130

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

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

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Foundation: Polymer Science Essentials:** Introduction to Polymers, Classification of Polymers, Polymerization — How Polymers Are Made, Key Polymer Properties.	08	15
2.	**Rubber: Science, Technology and Applications:** Natural Rubber, Vulcanization, Rubber Compounding, Synthetic Rubbers — Types and Properties, Rubber Processing Methods, Rubber + Fabric Composite Products.	07	15
3.	**Plastics: Science, Technology and Applications:** Introduction to Plastics, Major Thermoplastics — Properties and Applications, Thermosets and Elastomeric Plastics, Plastic Processing Methods, Plastic Additives.	07	15
4.	**Polymer Processing Defects & Troubleshooting:** Introduction to Defects in Polymer Processing, Defects in Rubber Processing & Moulding, Defects in Plastics Processing, Coating & Moulding, Quality Control Tools & Defect Prevention.	07	15
5.	**Material Safety and Industrial Hazard Management:** Fundamentals of Industrial Hazard and Risk, Chemical Hazards in Rubber Processing, Chemical Hazards in Plastics Processing, Safety Data Sheet (SDS) — Practical Reading, Personal Protective Equipment (PPE), Engineering Controls and Ventilation.	08	20
6.	**Circular Economy, Regulations and Sustainable Polymers:** Linear Economy vs. Circular Economy, Polymer Waste and Recycling, Extended Producer Responsibility (EPR) and Life Cycle Assessment (LCA), Bio-Based and Biodegradable Polymers, Regulatory Framework.	08	20
	Total	45	**100**

Suggested Specification Table with Marks (Theory):

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) Reference Books:

1. Introduction to Polymer Science and Technology by H.R. Billmeyer Jr.
2. Rubber Technology by Maurice Morton
3. Plastics Technology Handbook by Manas Chanda & S.K. Roy
4. Industrial Safety Management by L.M. Deshmukh
5. Circular Economy: A Handbook for Business and Supply Chains by C. Webster & C. MacArthur
6. Bioplastics for Sustainable Development by Luc Avérous (Ed.)

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

- **https://ocw.mit.edu/**
- **https://onlinecourses.nptel.ac.in/e-learning**
- **https://chem.libretexts.org/**

Overall SDG Mapping

The course on Polymer Science, Rubber and Plastics Technology, Processing Defects, Industrial Safety, and Sustainable Polymers supports United Nations **SDG 3, SDG 4, SDG 8, SDG 9, SDG 12, and SDG 13** by promoting scientific knowledge, industrial innovation, safe manufacturing practices, quality improvement, waste reduction, recycling, circular economy concepts, and sustainable polymer technologies. It prepares students to address industrial, environmental, and sustainability challenges in the polymer and rubber industries.

Activities suggested under 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.	Assignments	Completion of five independent tasks, each	Based on assignment submitted.

		designed for a 3-hour engagement. Total = 15h	
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.	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.
7.	Course Seminar	Duration -10h	Based on technical Content & Understanding, Analysis, literature review, Quality of report and presentation.
8.	Mini/ Micro Project	Duration -10h	Based on Technical Analysis, literature review, methodology, innovation/sustainability aspect, Quality of report and presentation.
9.	Complex Problem solving	Duration -5h	Evaluation is based on problem complexity & clarity, analytical approach, design/experimental methodology, use of modern tools, sustainability considerations, innovation, result validation, and feasibility of solution.
10.	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.
11.	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.

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