GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering

Level: PG

Branch: Rubber Technology

Subject Code: ME02088021

Subject Name: Optimization in Rubber Industries

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

Prerequisite:	Fundamentals of Optimizations and Basic understanding of material science, particularly rubber properties and manufacturing.
Rationale:	The study of optimization and its techniques provides a systematic and mathematical framework for solving problems efficiently and effectively in engineering, science, and industry. In the context of this subject, the rationale focuses on empowering students with the knowledge and tools to address complex challenges, particularly in the rubber industry, where optimization plays a pivotal role in enhancing productivity, quality, and sustainability. This subject integrates mathematical rigor with practical applications to provide students with a comprehensive understanding of optimization techniques. It bridges theoretical concepts with real-world challenges, especially in the rubber industry, fostering innovative problem-solving skills and preparing students for careers in engineering and industrial optimization.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes
C01	Explain the basic concepts of optimization and their significance in problem-solving.
C02	Classify and differentiate between various types of optimization problems based on their characteristics.
C03	Design and analyze single-product batch plants and multiple-product batch plants for optimal performance.
C04	Explain and interpret advanced optimization techniques and their applications in real-world scenarios.
C05	Develop and implement strategies for optimal design and scheduling in complex systems.

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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 Optimization**: Basic concept of optimization, formulation of optimization problems, problem dressing, feasible region, Classification of Optimization Problems: single variable- multivariable problems, optimization without constraints - with constraints, Maximization and minimization problems, convex and concave functions, unimodal-multimodal, single objective-multiobjective optimization.	7	15
2.	**Analytical Optimization Techniques:** Stationary points, Optimization of unconstrained Functions One-dimensional Search, direct substitution, constrained variation, penalty function, Lagrangian Multiplier, Kuhn-Tucker theorem, Simplex Method of Linear Programming, Duals in optimization, Quadratic programming, Geometric Programming	8	15
3.	**Numerical Optimization Techniques:** General principles of numerical search, region elimination techniques, direction of search, final stage in search, direct search, pattern search, acceleration in direct search, gradient methods, the complex method of Box	8	20
4.	**Application of Optimization In Rubber Industries:** Design of product mixes, optimization in mould design, product shape-size design, screw design, optimization in Mixing, Extrusion, Curing.	7	15
5.	**Optimal design and scheduling:** Single product batch plants, Multiple product batch plants, Parallel units and intermediate storage, Sizing in batch plants, Inventories, flow shop and jobshop plants, constraints and formulation of design models for optimization, formulations for discrete sizes.	7	15

6.	**Advanced Optimization Techniques:** Genetic Algorithm, Mematic Algorithm, Simulated Annealing, Differential Evolution, Ant Colony Optimization, Particle Swam Optimization and recent developments, applications for different rubber products.	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. Optimization Theory and Practice by Gordon S.G. Beveridge and Robert S. Schechter, by McGrawHill Publication.
2. Product and Process Design Principles by Warren D Seider, J. D. Seader, Daniel R Lewin, by John Wiley and Sons,Inc.
3. New optimization techniques in engineering by Godfrey C. Onwubolu and B. V. Babu.

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

- **www.iiste.org/Journals/index.php/MTM/article/download/2603/2618**
- **http://www.crcpress.com**
- **http://penerbit.uthm.ed**

Suggested Course Practical List: If any

Practical based on above topics.

- **Suggested Project List:**

1. Analytical Techniques for Product Mix Optimization
2. Application of Simplex and Dual Methods in Mould Design
3. Numerical Optimization of Screw Design for Extrusion Processes
4. Convex and Concave Function Analysis in Rubber Curing
5. Multi objective Optimization in Rubber Product Shape-Size Design
6. Optimization of Mixing Parameters in Rubber Processing
7. Flow and Job Shop Plant Optimization in Rubber Industries
8. Genetic Algorithm for Extrusion Process Optimization
9. Application of Simulated Annealing in Rubber Curing
10. Hybrid Optimization Methods for Rubber Processing
11. Advanced Optimization Techniques for New Rubber Product Development
12. Real-Time Optimization in Rubber Manufacturing

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