GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering
Level: Post Graduate
Branch: Rubber Technology
Course / Subject Code : **ME01088021**

Course / Subject Name : Modeling & Simulation of Rubber Processing (MSRP)

w. e. f. Academic Year:	2024-25
Semester:	1st Semester
Category of the Course:	PCC

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes
01	Understand the scope of modeling and simulation in Rubber Technology.
02	Demonstrate the ability to form mathematical models for Rubber Equipment.
03	Develop simulations for both batch and continuous process plants.
04	Assess the cost and perform de-bottlenecking analyses in rubber processing.

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:** Design, simulation and optimization: definition and differentiation with examples, applications and scope of modelling and simulation in Rubber Technology.	05	10
2.	**Modelling:** Definition of a model, importance of a model, different types of models, classification, step by step procedure for model development, modelling of	05	10

	Extruder.		
3.	**Artificial Neural Networks (ANN):** Introduction, History of Neural Networks, Structure and Function of Biological neurons, artificial neuron models, Neural Net Architectures: Fully connected networks, Layered networks, acyclic networks, Feed-forward networks, Modular neural networks; Neural Learning: Correlation learning, Competitive learning, Feedback-based weight adaptation; Supervised Learning-single and Multilayer Networks, Unsupervised Learning, Applications.	05	10
4.	**Simulation:** Types and approaches of simulation, modes of simulation: modular, equation oriented and global equation, partitioning, tearing and recycling, system architecture for simulation.	05	10
5.	**Finite Element Analysis (FEA):** Terminology, material laws, FEA models, consideration of special characteristics of rubbers like: large deformations, nonlinear characteristics of load-extension (stress-strain), viscoelastic characteristics and time and temperature dependence, and nearly incompressibility for finite element analysis, boundary conditions and solution.	05	15
6.	**Rubber product simulation:** static and dynamic simulation of rubber products like vehicle mount, tire, O-ring, boot, belt, bumper, dock fender, hose etc.	05	10
7.	**Rubber process simulation:** Simulation of mixing, extrusion, compression molding, and curing process.	05	10
8.	**Simulation of process plants:** Batch Process Simulation, continuous process plant simulation, Cost Analysis and De-Bottlenecking.	05	10
9.	**Software tools:** Introduction to tools like fluent, polyflow, Abaqus, ANSYS, MSC, Moldflow, gmesh, Elmer, etc.	05	15
	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	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. Constitutive models for rubber: proceedings of the First European Conference by Al Dorfmann, Alan Muhr
2. Injection Molding Handbook by Tim A. Osswald, Lih-Sheng Turng, Paul J. Gramann Technology & Engineering by Hanser Verlag, 2008
3. III European Conference on Computational Mechanics: Solids, Structures by C. A. Mota Soares, J. A. C. Martins, H. C. Rodrigues, Jorge A. C. Ambrósio, C. A. B. Pina (b) Open source software and website:

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

List of Laboratory/Learning Resources Required:

- Elmer Software: http://www.csc.fi/english/pages/elmer/index_html
- Elmer Discussion Forum, Bulletin Board for Elmer FEM Users http://www.elmerfem.org/forum/viewforum.php?f=1&sid=3b80753d7ae659698f551f1cd4f6a120
- Artificial Neural Network (ANN) in Scilab: https://atoms.scilab.org/toolboxes/ANN_Toolbox
- Gmsh: a three-dimensional finite element mesh generator with built-in pre- and post-processing facilities http://geuz.org/gmsh/
- ANSYS POLYFLOW CFD Software for Polymer Processing

http://www.ansys.com/Products/Simulation+Technology/Fluid+Dynamics/Specialized+Products/ANSYS+Polyflow

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