GUJARAT TECHNOLOGICAL UNIVERSITY

RUBBER ENGINEERING (40)
MODELLING & SIMULATION OF RUBBER PROCESSING
SUBJECT CODE: 2714007
SEMESTER: I

Type of course: Maths relevant Branch (M.E.Rubber Technology)

Prerequisite: Nil

Rationale: This course provides the knowledge and practice regarding different Foundry processes and their industrial importance. Also focused on efficient design of casting runner, riser and gating system with minimal casting defects and solidification process

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks		Practical Marks				
				ESE (E)	PA (M)	PA (V)		PA (I)		
						ESE	OEP	PA	RP	
3	2	0	4	70	30	30	0	10	10	150

Content:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1	Introduction: Design, simulation and optimization: definition and differentiation with examples, applications and scope of modelling and simulation in Rubber Technology.	5	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 Extruder.	7	10
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.	8	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.	6	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	6	15

	incompressibility for finite element analysis, boundary conditions and solution.		
6	Rubber product simulation: static and dynamic simulation of rubber products like vehicle mount, tyre, O-ring, boot, belt, bumper, dock fender, hose etc.	5	10
7	Rubber process simulation: Simulation of mixing, extrusion, compression moulding, and curing process.	5	10
8	Simulation of process plants: Batch Process Simulation, continuous process plant simulation, Cost Analysis and De-Bottlenecking.	5	10
9	Software tools: Introduction to tools like fluent, polyflow, Abaqus, ANSYS, MSC, Moldflow, gmesh, Elmer, etc.	7	15

Reference 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
3. Technology & Engineering by Hanser Verlag, 2008
4. 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

Course Outcome:
After learning the course the students should be able to:

1. To learn the scope of modelling and simulation in Rubber Technology.
2. Capable of formation of mathematical model for Rubber Equipment.
3. Understand the system architecture for simulation.
4. Justify the special characteristics of rubbers by using FEA method.
5. Capable of design the Static and dynamic simulation of rubber products like vehicle mount, tyre, O-ring, boot, belt, bumper, dock fender, hose etc.
6. To learn the Optimization & Simulation of different rubber processing.
7. Develop the Batch Process & continuous process plant simulation.
8. Learn the Cost Analysis and De-Bottlenecking.
9. Use the different types of software tools according the need & requirement

List of Experiments:

Tutorials/Presentation/Practicals based on above topics

Open Ended Problems:

1. Model for Rubber Curing Process.
2. Extrusion Simulation of Tire Components.
3. 3D Simulation for Rubber Injection Molding

Major Equipments:

Different Softwares

List of Open Source Software/learning website:

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