GUJARAT TECHNOLOGICAL UNIVERSITY

BRANCH NAME: RUBBER TECHNOLOGY
SUBJECT NAME: Modeling & Simulation of Rubber Processing (MSRP)

SUBJECT CODE: 3714007
M.E. 1st SEMESTER

Type of course: Core-I (M.E.Rubber Technology)

Prerequisite:

Rationale:

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)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No	Course Content	Total Hrs	% 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 incompressibility for finite element analysis, boundary conditions and solution.	**6**	**15**
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:

- Constitutive models for rubber: proceedings of the First European Conference by Al Dorfmann, Alan Muhr
- Injection Molding Handbook by Tim A. Osswald, Lih-Sheng Turng, Paul J. Gramann
- Technology & Engineering by Hanser Verlag, 2008
- 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:

- To learn the scope of modelling and simulation in Rubber Technology.
- Capable of formation of mathematical model for Rubber Equipment.
- Understand the system architecture for simulation.
- Justify the special characteristics of rubbers by using FEA method.
- Capable of design the Static and dynamic simulation of rubber products like vehicle mount, tyre, O-ring, boot, belt, bumper, dock fender, hose etc.

- To learn the Optimization & Simulation of different rubber processing.
- Develop the Batch Process & continuous process plant simulation.
- Learn the Cost Analysis and De-Bottlenecking.
- Use the different types of software tools according the need & requirement.

List of Experiments:

Tutorials/Presentation/Practicals based on above topics.

Major Equipment:

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