GUJARAT TECHNOLOGICAL UNIVERSITY

BRANCH NAME: Rubber Technology (26)
SUBJECT NAME: Polymer Kinetics
SUBJECT CODE: 2172602
B.E. Semester-VII

Type of course: (B. E. Rubber Technology)
Prerequisite: NA
Rationale: Na

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		ESE (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	0	3	6	70	20	10	20	10	20	150

Sr. No	Course Content	Total Hrs	% Weightage
1.	**Introduction:** Introduction to Chemical kinetics, Classification of reactions, Variables, affecting rate of reaction, definitions of reaction rates.	4	10
2.	**Kinetics of homogenous reactions**: Concentration dependent term of rate equation, single, multiple, elements & non-elementary reactions, molecules Hg & order of reaction, rate constant, representation of reaction rate, kinetic model & its testing, temp. dependent term of rate equation from Arrhenius law, thermodynamics, collision theory, transition state theory, compression of theories, activation energy, searching mechanism, predictability of reaction rate	6	10
3.	**Molecular weight & size:** Introduction, Molecular Weights of polymers, Number Average & Weight Average Molecular Weights, Methods of determination of Molecular Weights of polymers, Polydispersity & Molecular weight distribution in polymers, Size of polymer molecules. Determination of Reactive Molecular Mass, End group analysis, Osmotic pressure, Light Scattering, Ultracentrifuge methods, Viscosity method, molecular weight and degree of polymerization, Molecular weight distribution in polymers, Practical significance of polymer molecular weight, size of polymer molecules.	6	10
4.	**Reactors**:	6	10

	Interpretation of batch reactor data constant & variable volume batch reactor, CSTR, irreversible 1st and 2nd order reactions, Integral & differential method of analysis, search for a rate equation.		
5.	**Kinetics of heterogeneous reactions:** Introduction to heterogeneous reaction, kinetics rate equation for heterogeneous reactions, contacting patterns, illustrations of fluid particles & fluid-fluid reactions solid & catalyzed reaction.	**5**	**10**
6.	**Kinetics of Polymerization:** Introduction, free radical, cationic, Anionic, chain Polymerization kinetics, Kinetics of condensation reactions.	**5**	**10**
7.	**Co-Polymerization**: Kinetics of free radical polymer & ionic Co-polymerization, Co-poly condensation.	**5**	**10**
8.	**The Chemical Modification of Rubbers & Polymers** : Introduction, Esterification, Etherification & Hydrolysis of Polymers, The Hydrogenation Of Polymers, Dehydrogenation, Elimination & Halogenations Reactions in Polymers, Other Addition Reactions to Double Bonds, Oxidation Reaction of Polymers, Functionalisation of Polymers, Miscellaneous Chemical Reactions of Polymers, Block & Graft Copolymerization.	**5**	**10**
9.	**Diffusivity, Solubility & Permeability in Rubber & Polymer Systems**: Diffusivity & Solubility of Simple Gases, Permeability of Simple Gases & Permachor, Moisture Solution & Diffusion, Permeation of Higher Activity Permeants, Polymer-Polymer Diffusion, Measurement Techniques & their materials.	**6**	**10**
10.	**Polymer reactor design**: Introduction, ideal batch, mixed flows, plug flow, reactors, space time, space velocity, holding time mixed Vs. plug flow reactors 1st and 2nd order reaction.	**6**	**10**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks				
Remembrance **R Level**	**Understanding U Level**	**Application A Level**	**Analyze** **N Level**	**Evaluate E Level**
12	**12**	**16**	**15**	**15**

Reference Books:

- Polymer Reaction Engineering. By: Anil Kumar
- Chemical Reaction Engineering By: Octave Levenspiel
- Chemical Reaction Engineering By: Fogler
- Polymer Science & Technology By: By Gowarikar
- Polymer Processing Principles and Design, by Donald G. Baird, Dimitris I. Collias

- Science & Technology of Rubber,edited by James E. Mark, Burak Erman, Frederich R. Eirich

Course Outcome:

After learning the course the students should be able to:

- Able to learn about Kinetics of homogenous reactions.
- Learn about the Arrhenius law.
- Compare the Kinetics of homogenous & heterogeneous reactions.
- Understand the Chemical Modification of Rubbers & Polymers.
- Able to develop about Polymer reactor design.
- Learn about Diffusivity, Solubility & Permeability in Rubber & Polymer Systems.
- Understand the Kinetics of free radical polymer & ionic Co-polymerization.
- Learn about the methods of determination of Molecular Weights of polymers.

List of Experiments:

Tutorials/Presentation/Practicals based on above topics.

Design based Problems (DP)/Open Ended Problem:

- Kinetics of Homogeneous Reactions in Ionic Liquids.
- Reaction kinetics, geospeedometry, and relaxation theory.
- Effective kinetic modeling of multistep homogeneous reactions.
- Chemical Modification of Natural Rubber in the Latex Stage by Grafting Cardanol, a Waste from the Cashew Industry and a Renewable Resource

Major Equipments:

CSTR, Plug Flow Reactor, Weighing balance, Batch Reactor, etc.

List of Open Source Software/learning website:

- http://www.electrochemsci.org/
- http://www-personal.umich.edu/
- http://pubs.acs.org/
- http://www.mnrubber.com/

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.