



GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3162310

Semester – VI

Subject Name: Kinetics and Rheology of Plastics

Type of course: Professional Core Course

Prerequisite: - NA

Rationale: This course helps students to understand the kinetics of polymerisation and types of reactors used for polymerization. It also helps in understanding the rheology, viscoelastic behaviour of plastics and its related models to know the plastic material properties. Students should be able to know various instruments used for measurements of rheological properties of plastics.

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	1	0	4	70	30	00	00	100

Content:

Sr. No.	Content	Total Hrs
1	Kinetics of homogeneous reactions and reactors: Chemical Kinetics, classification of chemical reactions, rate of reaction, factors affecting rate of reaction, rate constant, Elementary and non elementary reactions,, order of reaction, Temperature dependency from Arrhenius law, collision theory and transition state theory, activation energy. Types of chemical reactors, their working principle, advantages, limitations and applications, Batch reactor, Semibatch reactor, Continuous reactor, Tank and tubular reactor, Fixed bed reactor, Fluidised bed reactor etc.	06
2	Kinetics of Polymerization: Kinetics of free radical polymerisation, kinetic chain length kinetics of cationic and anionic polymerisation kinetics of polycondensation, molecular weight distribution, Extent of reaction and degree of polymerisation, Kinetics of Copolymerisation, Reactivity ratio and Copolymerisation behaviour	08
3	Rheology: Stress and strain, stress-strain behaviour, viscoelastic behaviour of plastics, Definition & importance of Rheology, types of fluids, Non Newtonian fluids, time-dependent fluids, time independent fluids, Pseudoplastic fluids, Dilatant fluids, Bingham plastic fluids.	04
4	Rheological Models : Mechanical models: The linear elastic spring (Hooks model) and the linear viscous dash-pot (Newton's Model),	10



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	The Maxwell Model for viscoelasticity The Kelvin (Voigt) Model for viscoelasticity Burger model, Creep (retardation) and relaxation Four-parameter model, Zener model	
5	Viscoelastic Behaviour: Boltzman principle, Time temperature superposition principle WLF equation, Free volume theory, Power law, Weisenberg effect Parameters Influencing Viscosity: Effect of Shear rate on viscosity, Effect of molecular weight on viscosity, Effect of temperature on viscosity, Effect of pressure on viscosity, zero shear viscosity Die Swell, and Melt fracture, Sharkskin defects	08
6	Measurements of rheological properties: Capillary rheometers Cone and plate viscometer Concentric cylinder rheometer, Parallel disc rheometer Torque rheometers	06

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	25	10	3	10	2

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Polymer Rheology: Fundamentals and Applications by Tim A. Osswald Natalie Rudolph (Hanser Publications)
2. Plastics Fundamentals, Properties, and Testing- Manas Chanda and Salil K.Roy (CRC Press)
3. Chemical Reaction Engineering I by K A Gavhane



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4. Polymer Science by V R Gowariker
5. Polymer and Composite Rheology, Second Edition, by Rakesh Gupta (Marcel Dekker, Inc.)
6. Polymer Rheology: Fundamentals and Applications by Natalie Rudolph and Tim Osswald
7. Polymer Reaction Engineering by J.M Asua (Blackwell Publishing)

Course Outcomes:

After learning the course the students should be able to:

Sr. No.	CO statement	Marks % weightage
CO-1	Identify and describe the types of chemical reactors and know the basics of chemical kinetic.	25
CO-2	Understand the kinetics of polymerization.	20
CO-3	Understand the significance of rheology and viscoelastic behaviour of polymers.	25
CO-4	Apply knowledge of different rheological models for studying the behaviour of viscoelastic materials.	20
CO-5	Acquire knowledge about working and applications of various rheological instruments.	10

List of Experiments: - As per the above syllabus topics-

Major Equipment:

List of Open Source Software/learning website:

1. <https://nptel.ac.in>