LOK JAGRUTI UNIVERSITY (LJU)

INSTITUTE OF ENGINEERING & TECHNOLOGY

Department of Chemical Engineering

Bachelor of Technology (B.E.) – Semester - VI

Course Code:	017083601
Course Name:	**Chemical Reaction Engineering**
Category of Course:	Professional Core Course (PCC)
Prerequisite Course:	Thermodynamics MEBC

Teaching Scheme				
Lecture (L)	**Tutorial (T)**	**Practical (P)**	**Credit**	**Total Hours**
3	**0**	**2**	**4**	**30**

Syllabus				
Unit No.	**Topic**	**Prerequisite Topic**	**Successive Topics**	**Teaching Hours**
01	**Kinetics of Homogeneous Reactions**			**3 (10%)**
	1.1 Introduction to chemical kinetics, classification of reactions	---	---	
	1.2 Variables affecting reaction rate			
	1.3 Concentration dependent term of rate equation	---	---	
	1.4 Temperature dependent term of rate equations	---	---	
	1.5 Testing kinetic models, Arrhenius theory, collision theory, comparison of theories	---	---	
02	**Interpretation of Batch Reactor Data**			**4 (13%)**
	2.1 Integral, differential and half-life methods of analysis of data for constant volume and variable volume cases	Basics of Differentiation	---	
	2.2 Searching a rate equation			
03	**Reactor Design for Single and Multiple Reactions**			**3 (10%)**
	3.1 Mass and energy balances for steady state and unsteady state reactors	Basic Equation of mass and energy balance	---	
	3.2 Reactors- Batch reactor, Plug flow reactor, Mixed flow reactor and their comparison.			
	3.3 Multiple reactor system, plug flow reactors in series, mixed flow reactors in series, reactors of different types in series	---	---	
	3.4 Recycle reactors and auto catalytic reactions	---	---	
	3.5 Series and Parallel reactions, product distribution	---	---	
04	**Temperature and Pressure Effects on rate of reaction**			**3 (10%)**
	4.1 Heat of reaction	Chemical Reaction Equilibria	---	
	4.2 Chemical Equilibrium			
	4.3 Equilibrium constants	---	---	
	4.4 Equilibrium Conversion		---	
	4.5 Optimum Temperature Progression		---	
05	**Non-Ideal Flow**			**3 (10%)**
	5.1 Basics of non-ideal flow	---	---	
	5.2 Residence time distribution			
	5.3 The E,F and C Curves, their interrelationship	---	---	
	5.4 Dispersion model, Chemical Reaction and dispersion	---	---	
	5.5 Tanks in series model	---	---	
06	**Heterogeneous Non-Catalytic Systems**			**3 (10%)**
	6.1 Rate steps involved in heterogeneous systems	---	---	
	6.2 Fluid-Fluid systems: Rate equation, rate equation for straight mass transfer, rate equation for mass transfer and chemical reactions, film conversion parameter	---	---	
07	**Fluid-Particle systems**			**3 (10%)**
	7.1 Fluid partial reaction kinetics, selection of a model.	---	---	
	7.2 Shrinking Core Model for unchanging and changing size spherical partials.			
	7.3 Diffusion through gas film and through ash layer controlling.			
	7.4 Chemical reaction controlling.			
08	**Catalysis**			**4 (13%)**
	8.1 Introduction to Catalysts	---	---	
	8.2 Physical properties of catalyst, surface area, void volume, solid density, pore volume distribution			
	8.3 Classification and preparation of catalyst, catalyst promoters			
	8.4 Catalyst inhibitors, Catalyst poisons			
	8.5 Nature and Mechanism of Catalytic reactions			
09	**Kinetics of Solid-Catalysed reactions**			**2 (7%)**
	9.1 Adsorption isotherms and rates of adsorption and desorption	---	---	
	9.2 Kinetic regimes, rate equations for surface kinetics			
	9.3 Pore diffusion, determining rate controlling step			
10	**Introduction to Catalytic Reactors**			**2 (7%)**
	10.1 Packed bed catalytic reactors	---	---	
	10.2 Fluidized bed reactors			

	10.3 Slurry reactors			

Proposed Theory + Practical Evaluation Scheme by Academicians (% Weightage Category Wise and it's Marks Distribution)					
L:	**3**	**T:**	**0**	**P:**	**2**
Note: In Theory Group, Total 4 Test (T1+T2+T3+T4) will be conducted for each subject. Each Test will be of 25 Marks. Each Test Syllabus Weightage: Range should be 20% - 30%					
Group (Theory or Practical)	**Group (Theory or Practical) Credit**	**Total Subject Credit**	**Category**	**% Weightage**	**Marks Weightage**
Theory	3	4	MCQ	15%	20
Theory			Theory Descriptive	11%	15
Theory			Formulas and Derivation	23%	30
Theory			Numerical	26%	35
Expected Theory %	**75%**		**Calculated Theory %**	**75%**	**100**
Practical	1		Individual Project	0%	0
Practical			Group Project	0%	60
Practical			Internal Practical Evaluation (IPE)	10%	40
Practical			Viva	0%	0
Practical			Seminar	15%	0
Expected Practical %	**25%**		**Calculated Practical %**	**25%**	**100**
Overall %	**100%**			**100%**	**200**

Course Outcome	
1	To understand, analyze, and apply principles of chemical kinetics and batch reactor data interpretation for effective reaction rate prediction and experimental design.
2	Able to design and optimize single and multiple reaction reactors, considering mass and energy balances, various reactor types, temperature and pressure effects, and their impact on reaction kinetics and equilibrium.
3	To analyze non-ideal flow systems, including residence time distribution and dispersion models, and understand heterogeneous non-catalytic systems, encompassing fluid-fluid and fluid-particle reactions, for optimization in chemical engineering applications.
4	To understand catalyst properties, mechanisms, and kinetics, facilitating the design and optimization of diverse catalytic reactors for industrial use.
Suggested Reference Books	
1	Chemical Reaction Engineering, Octave Levenspiel, John Wiley & Sons (Asia) pvt. Ltd, 3rd Edition.
2	Elements of Chemical Reaction Engineering, H. Scott Fogler, Prentice Hall of India Pvt Ltd, 3rd Edition November.
3	Chemical Engineering Kinetics, J.M.Smith , McGraw-Hill, 2nd edition.
4	The Engineering of Chemical Reactions, L. D. Schmidt, Oxford Press.
5	Chemical and Catalytic Reaction Engineering, J. J. Carberry, McGraw Hill, New York, 1976.
6	Chemical Reaction Engineering-I, K.A Gavhane, Nirali Publication

Proposed Evaluation Scheme by Academicians (Percentage of Weightage out of 100%)					
Theory Descriptive Test		**MCQ Test**		**Hands on Project**	
Formulas and Derivation Test		**Numerical Test**		**Seminar**	

Practical Project/Hands On Project		
Sr. No.	**List of Practical Projects**	**Linked with Unit**
1	To determine the activation energy of the reaction between sodium thio-sulphate and HCl using Arrhenius Equation.	Unit 1
2	To determine order of reaction for the reaction between sodium thiosulphate and HCl.	Unit 2
3	To measure the kinetics of a reaction between ethyl acetate and sodium hydroxide under condition of excess ethyl acetate at room temperature.	Unit 2
4	RTD studies in different reactors.	Unit 5
5	Various models for non-ideal flow.	Unit 5
6	Heterogeneous reaction kinetics etc.	Unit 6

7	Study of Shrinking core model.	Unit 7
8	Determining properties of catalyst.	Unit 8