CH312	CHEMICAL REACTION ENGINEERING-II	L	T	P	C	Int	Ext
		2	1	-	3.0	30	70

Semester V [Third Year]

COURSE OBJECTIVES:

1. To understand the concept of real reactor behavior using Residence Time Distribution (RTD) curves (E, F, C-curves) to diagnose flow patterns, channeling, and dead zones
2. To Develop models for non-catalytic reactions (e.g., shrinking core model) used in metallurgical and industrial processes.
3. To Analyze internal diffusion within porous catalysts (Thiele modulus, effectiveness factor) and external mass transfer resistance between fluid and solid phases
4. To Study kinetics of catalyst deactivation (poisoning, fouling) and design reactors that account for catalyst

COURSE OUTCOMES:

After successful completion of the course, the students are able to

1. Predict real reactor behavior using residence time distribution (RTD), tank-in-series, and dispersion models to determine conversions.
2. Understand adsorption/desorption, surface reactions, and determine rate-controlling steps. Design packed bed and fluid-bed catalytic reactors.
3. Analyze the combined effect of mass transfer and chemical reaction within catalyst pores, including effectiveness factors
4. Analyze the effects of coking and poisoning on reactor performance and lifetime.

UNIT I [CO:1] **(12)**

Non-ideal reactors:

Residence time distribution of fluid in vessel, measurement of the RTD (Tracer Techniques), Characteristics of the RTD, RTD in ideal reactors, Reactor modeling with the RTD: Segregation model, the Tanks in series model, the Dispersion (plug flow) model for closed vessel. Concept of micro and macro mixing

Analysis of Non-ideal reactors-Dispersion number from C and F curves, Conversion using Dispersion and Tanks in series models for the first order irreversible reaction.

UNIT II [CO:2] **(12)**

Introduction to design for heterogeneous reacting systems:

Rate equations for heterogeneous reactions, contacting patterns for two phase systems.

Fluid particle reactions: Selection of a model, un-reacted core model for spherical particles, rate of reaction for shrinking spherical particles, determination of rate controlling steps.

UNIT III [CO:3] **(12)**

Catalyst properties:

Solid catalysts - Adsorption, Adsorption isotherms, Surface area, Void volume and solid density, Pore volume Distribution.

Theories of heterogeneous catalysis, Classification of catalysts, Catalyst preparation, Promoters and inhibitors. (to the extent covered in J.M. Smith only)

UNIT IV [CO:4] **(12)**

Heterogeneous catalysis:

Pore diffusion resistance combined with surface kinetics (Single cylindrical pore, first order reaction) Porous catalyst particles. Data analysis for heterogeneous catalytic reactors, isothermal packed bed (PFR) reactor design Experimental methods for finding rates.

Deactivating catalysts, Mechanisms of catalyst deactivation, the rate and performance equations: The rate equation from experiment. Determining the rate for batch solids in contact with fluid in batch, mixed flow and plug flow modes for independent deactivation. Effect of pore diffusion resistance.

LEARNING RESOURCES:

TEXT BOOK(s):

1. Chemical Reaction Engineering, Levenspiel, Octave, 3rd edition, Wiley Eastern (UNITS-I - III)

2. Chemical Engineering Kinetics, Smith J.M. McGraw Hill. (UNIT-IV)

REFERENCE BOOK(s):

1. Elements of Chemical Reaction Engineering, Fogler, H.S., 2nd edition, PHI
2. Chemical Reaction Engineering-II by K.A. Gavhane, Nirali Prakhasan