GUJARAT TECHNOLOGICAL UNIVERSITY
Master of Engineering
Subject Code - 3723024
Semester II
Subject Name: Advanced Reaction Engineering

Type of course: Core Course – IV

Prerequisite: Knowledge of Reaction engineering at undergraduate Level

Rationale: This subject deals with the heterogeneous reactions and non-ideal flow systems including performance of various types of reactors. The non-isothermal systems are introduced with its application. The catalyst systems are also be covered in this.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Syllabus Content:

Sr. No.	Content	Total Hrs
1	Overview of Reaction Engineering & challenges, Stoichiometric Table & gas law, Reactor Design Equations for ideal Vessels, Effect of Pressure Drop on performance of Plug Flow vessels, Plug Flow Recycle Reactors design equation, Advantages of plug flow recycle reactor, Effect of Condensing gas on Reactor design	7
2	Multiple Reactions, finding number of independent reactions and independent set, Polymerization reaction in a CSTR, Energy Balance for stirred vessels, Semi batch reactor operation, Stability of Steady States in CSTR, Plotting Liapunov Contours, Understanding Multiple steady states in a CSTR	8
3	Heat Effects in reversible exothermic reactions, Need for Multi-staging, Optimal Design of Reactors for Reversible exothermic reactions, One Dimensional & Two-dimensional models for PFR, Design of Packed Tubular Reactors	7
4	Non-ideal Flow, Residence Time Distribution of ideal vessels, Deriving RTD from velocity field, Modelling Non-ideal Flow (Dispersion, Tanks in series, Recycle reactor)	9
5	Gas Solid Non-Catalytic Reactions, The shrinking Core Model, Case of Pseudo steady state hypothesis & ash diffusion control, Gas Solid reactions in Rotary Kiln - tracking gas and solid composition changes for reversible reactions, Gas Liquid Reactions, Reaction Regimes	9
6	Introduction to population balance modelling, Deriving RTD from PBE, Deriving particle size distribution for continuous fluid beds via PBE, Deriving design equations for gas solid reactions via PBE, Deriving property distributions in reactor regenerator systems,	7

	Applications of PBE modelling to real life problems, Reaction Engineering and mitigation of Global warming, CO_2 absorption in high pressure water	
7	Catalyst deactivation, Design for deactivating catalyst, Flow and Reaction through porous media, Acid Leaching of Rocks, Fluidized bed reactor modelling	**4**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
5	**25**	**15**	**10**	**10**	**5**

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) K.G. Denbigh: Chemical Reactor Theory, Cambridge University Press, Second Edition, 1971
2) J.M. Smith: Chemical Engineering Kinetics, Mcgraw Hill, Third Edition, 1981
3) Levenspiel O., Chemical Reaction Engineering, Wiley, 1998
4) Foggler,H.S., Elements of Chemical Reaction Engineering, Prentice Hall of India, 2008
5) Fromment G.F. and Bischoff K.B., Chemical Reactor Analysis and Design, John Wiley, 2010

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Evaluate heterogeneous reactions and reactor performance.	10
CO-2	Perform the energy balance and obtain concentration profiles in multiphase reactors.	10
CO-3	Estimate the performance of multiphase reactors under non-isothermal conditions.	20
CO-4	Understand non-ideal flow and reactor models.	20
CO-5	Understand catalysts deactivation and application of catalysts.	10

List of Experiments:

- To study RTD in PFR, CSTR and CSTR in series.
- To compare conversion in CSTR and PFR.
- To Compare catalytic and non-catalytic reaction conversion.
- To study the performance of fluidized bed reactor.

Major Equipment:

- Plug flow reactor
- CSTR in series
- CSTR
- Fluidized bed reactor

List of Open Source Software/learning website:

NPTEL open source

www.academia.edu/.../A_NOVEL_DESIGN_OF_HETEROGENEOUS_C