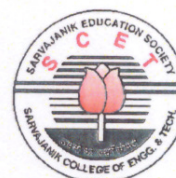




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Sarvajani College of Engineering and Technology



Bachelor of Technology (B.Tech)

B.Tech. Semester V

Subject Name: Chemical Reaction Engineering-I

Subject Code: BTCH13502

Type of course: PCC

Prerequisite (if any): Physical Chemistry, Mathematics – I & II, Basic Calculation in Chemical Engineering, Chemical Engineering Thermodynamics-I and II, Mass Transfer Operation, Heat Transfer Operations

Rationale: Chemical Reaction Engineering is concerned with the utilisation of chemical reactions on a commercial scale. This course is very relevant to different industries to understand and utilize the concept for design, operate and control the reactors i.e. CSTR, PFR, Batch, fixed/packed bed, fluidized bed reactor etc.

Teaching and Examination Scheme:

TEACHING SCHEME				Theory Marks			Practical Marks		Total
L	T	P	C	TEE	CA1	CA2	TEP	CA3	
3	0	2	4	60	25	15	30	20	150

CA1: Continuous Assessment (assignments/projects/open book tests/closed book tests **CA2:** Sincerity in attending classes/class tests/ timely submissions of assignments/self-learning attitude/solving advanced problems **TEE:** Term End Examination **TEP:** Term End Practical Exam (Performance and viva on practical skills learned in course) **CA3:** Regular submission of Lab work/Quality of work submitted/Active participation in lab sessions/viva on practical skills learned in course

Content:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1.	Introduction of Chemical reaction Engineering: Thermodynamic, Chemical Kinetics, Ideal reactors, Classification of reaction, Rate of reaction ,variable affecting the rate of reactions	2	5%
2.	Kinetics of Homogenous Chemical Reactions: Concentration dependent term of a rate equation, Single & multiple reactions, Elementary & non elementary reactions, Kinetic view of equilibrium for elementary reactions, Molecularity & order of reaction, Rate constant, Representation of rate constant, Kinetic models for non elementary reactions, Testing kinetic models, Temperature dependence of rate equation, Arrhenius theory, Collision theory & Transition state theory, Comparisons of the theories.	5	11%
3.	Interpretation of Batch Reactor Data: Constant volume batch reactor, Analysis of Total Pressure data for constant volume system, Methods to find the kinetics of homogenous chemical reaction, Integral method, Differential method, Half life method, Irreversible reaction in parallel, homogenous catalyzed reactions, Auto catalytic reactions, Irreversible reaction in series, First-order and Second order reversible reactions, variable volume batch reactor, integral method of analysis, differential method of analysis, Temperature and reaction rate, The search for a rate equation	12	27%





4.	Introduction to Reactor Design and ideal reactors for single reaction: Mass and Energy balances, ideal batch reactor, space time & space velocity, steady state mixed flow reactor, steady state plug flow reactor, holding time & space time for flow systems, performance equation for the Batch, Plug flow and Mixed Flow reactors. Selection criteria of PFR and MFR in industry, their advantage and disadvantages.	7	15%
5.	Design for Single Reactions: Size comparison of single reactors, batch reactor, mixed reactor versus plug flow reactors, first & second order reactions, variation of reaction rates for second order reactions, general graphical comparison, multiple reactor system, plug flow reactors in series and/or in parallel, equal sized mixed reactors in series, mixed flow reactors of different sizes, reactors of different types in series, recycle reactor.	7	15%
6.	Multiple Reactions: Parallel reactions of different orders, Yield and selectivity, Product distribution and design for single and multiple-reactors, Series reactions: first-order reactions and zero-order reactions, Mixed series parallel complex reactions.	7	15%
7.	Temperature Effects for Single and Multiple Reactions: Thermal stability of reactors and optimal temperature progression for first order reversible reactions, Adiabatic and heat regulated reactions, Design of non-isothermal reactors, Effect of temperature on product distribution for series and parallel reactions.	5	12%

Suggested Specification table with Marks (Theory/Practical):

% Distribution of Marks					
R Level	U Level	A Level	N Level	E Level	C Level
25	25	25	20	05	-

Legends: R: Remembrance, U: Understanding; A: Application, N: Analyze, 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 Text Books:

Sr. No.	Title of book /article	Author(s)	Publisher and details like ISBN	Year of publication	Publication Edition
1	Chemical Reaction Engineering	Octave Levenspiel	John Wiley & Sons	1999	3 rd Edition

Course Outcome:

Sr. No.	CO Statement After learning this subject, students will be able to	Marks % weightage
CO-1	Comprehend the concepts of rate of reaction, variables affecting rate of reaction, reaction mechanism.	15%





CO-2	Recognize temperature dependency term of Arrhenius equation and comparison between collision and transient state theory.	15%
CO-3	Interpret batch reactor data to obtain reaction rate expressions and calculate volume of batch and flow reactors in constant- and variable-volume systems.	35%
CO-4	Design the batch reactor, plug flow reactor, mixed flow reactor and recycle reactor.	20%
CO-5	Analyze multiple reactions carried out both isothermally and non-isothermally in flow, batch and semi batch reactors	15%

Mapping with POs:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO-1	2	2	3	3	2	2	2	3	1	2	1	2	3	3	1
CO-2	2	2	2	3	2	2	3	3	3	2	1	3	2	3	1
CO-3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO-4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO-5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Rationale*	13	13	14	15	13	13	14	15	14	13	11	14	14	15	11

Rationale*: Explaining why it is matching this particular program outcome

LIST OF PRACTICALS:

Simulation using any simulator should be included in each experiment to explain how kinetic data can be utilized in the simulator for design or to check the performance of the reactor.

1. To determine the kinetics of the reaction between Methyl Acetate & Sodium hydroxide in equal concentration at room temperature by integral method of analysis.
2. To determine the kinetics of the reaction between ethyl acetate & NaOH at room temperature by the integral method of analysis.
3. To determine the kinetics of the reaction between n - butyl acetate & NaOH at room temperature by the integral method of analysis (non equimolar).
4. To obtain the kinetics of the reaction between ethyl acetate & NaOH by differential method of analysis.
5. To determine the kinetics of the reaction between ethyl acetate & Sodium hydroxide at room temperature by the method of half-life method.
6. To determine the kinetics of the reaction between ethyl acetate & sodium hydroxide under the condition of excess ethyl acetate at room temperature.
7. To determine the activation energy and frequency factor for the reaction between ethyl acetate & Sodium hydroxide.
8. To determine the activation energy and frequency factor for the reaction between ethyl acetate & Sodium hydroxide (non equimolar).
9. Application of simulator for design and rating of different type of reactor.





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Reference Text Books:

Sr. No.	Title of book /article	Author(s)	Publisher and details like ISBN	Year of publication	Publication Edition
1	Elements of Chemical Reaction Engineering	H. Scott Fogler	Prentice Hall	2008	4 th Edition
2	Chemical Engineering Kinetics	J. M. Smith	McGraw Hill Publishing	1981	3 rd Edition
3	Reaction Kinetics for Chemical Engineers	S. M. Walas	McGraw Hill Publishing	2013	1 st Edition
4	The Engineering of Chemical Reactions	Lanny D. Schmidt	Oxford University Press USA	2004	2 nd Edition

List of Open Source/learning website:

- <https://nptel.ac.in/courses/103/103/103103153/>
 - Detail of coverage as per syllabus

