SRI VENKATESWARA COLLEGE OF ENGINEERING

COURSE DELIVERY PLAN - THEORY

Department of Chemical Engineering	LP: CH222403 Rev. No: 00 Date: 24.01.2023
~~B.E~~/B.Tech/~~M.E/M.Tech~~ :**Chemical Engineering** Regulation:**2022** PG Specialisation: - Sub. Code / Sub. Name : **CH22403 / Chemical Reaction Engineering I** Unit : **I**	

Unit Syllabus: KINETICS AND ANALYSIS OF EXPERIMENTAL KINETIC DATA

Overview of Chemical Reaction Engineering - Kinetics of homogeneous reactions - Elementary and Non- elementary reactions - Theories on reaction rates - Temperature dependence of rate constants- Activation Energy and Arrhenius Equation - Kinetics of Bio-Chemical Reactions: Michaelis Menton model; Auto-catalytic reactions. , Analysis of experimental kinetics data, integral and differential analysis.

Objective: Attain familiarity in the fundamentals of reaction engineering and analyze the kinetic data, to determine the rate of reaction.

Session No *	Topics to be covered	Ref	Teaching Aids
1	Overview of Chemical Reaction Engineering - Kinetics of homogeneous reactions	T1 – Ch. 1; pg. 1-8 T2 – Ch. 1; pg. 1-7	BB, PPT
2	Elementary & non-elementary reactions; Theories of reaction rates	T1 – Ch. 2; pg. 13-21 T1 – Ch. 2; pg.27-29	BB, PPT
3	Theories of reaction rates and Problems on Arrhenius theory	T1 – Ch. 2; pg.27-29	BB, PPT
4	Temperature dependence of reaction rates	T3 – Ch. 3; pg.91-98 T1 – Ch. 3; pg.72-74	BB, PPT
5	Analysis of experimental reaction data & their interpretation in deriving at the rate constants for various order of the reactions	T3 – Ch. 13; pg. 868	BB, PPT
6	Integral method of analysis of data for constant and variable volume reactors, problems	T1 – Ch. 3; pg. 41-63	BB, PPT
7	Differential method of analysis of data for constant and variable volume reactors.	T1 – Ch. 3; pg.63-67	BB, PPT
8	Problems on kinetic analysis of data using integral and differential method & Auto Catalytic Reactions	T1 – Ch. 3; pg. 41-67 T1 – Ch 3 ;pg: 102-104	BB, PPT
9	Design equation of constant volume batch reactor and mechanism for a enzyme catalyzed reaction: Michaelis -Menten Equation	T1 – Ch. 3; pg. 38-41 T1 – Ch. 5; pg. 90-94	BB, PPT

Content beyond syllabus covered (if any):-

* Session duration: 50 minutes

Sub. Code / Sub. Name: **CH18502 / Chemical Reaction Engineering I**

Unit: **II**

Unit Syllabus: **IDEAL REACTOR DESIGN FOR HOMOGENEOUS SINGLE REACTIONS**
Performance equations for ideal batch, Plug flow, Back-mix flow and semi batch reactors for isothermal condition, Size comparison of single reactors, Multiple-reactor systems, Recycle reactor.

Objective: Perform calculations associated with design equation of reactors and determine the volume ofa reactor for a given conversion and vice-versa for single reactions.

Session No *	Topics to be covered	Ref	Teaching Aids
10	Performance/Design equations for continuous reactors - CSTR	T1 – Ch. 5; pg. 94-96	BB, PPT
11	Problems – Using performance equation of CSTR	T1 – Ch. 5; pg. 96-100	BB, PPT
12	Design equations for PFR	T1 – Ch. 5; pg. 101-104	BB, PPT
13	Problems – Using performance equation of PFR	T1 – Ch. 5; pg. 104-110	BB, PPT
14	Performance equation of recycle reactors	T1 – Ch. 6; pg. 136 -138	BB, PPT
15	Problems – Using performance equation of recycle reactors	T1 – Ch. 6; pg. 139 -140	BB, PPT
16	Multiple reactor systems – Arrangement of reactors in series/parallel	T1 – Ch. 6; pg.124-130	BB, PPT
17	Problems – Multiple reactor systems	T1 – Ch. 6; pg.125,129,130	BB, PPT
18	Size comparison of reactors	T1 – Ch. 6; pg.120 - 124	BB, PPT

Content beyond syllabus covered (if any): -

* Session duration: 50 mins

Sub. Code / Sub. Name: **CH22403 / Chemical Reaction Engineering I**

Unit: **III**

Unit Syllabus: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.

Objective: Evaluate systems and perform calculations for multiple reactions, to suggestreactor/combination of reactors for the yield of desired product.

Session No *	Topics to be covered	Ref	Teaching Aids
19	Multiple reactions – Consecutive, parallel and mixed reactions	T1 – Ch. 8; pg. 170 -176	BB, PPT
20	Design of reactors for multiple reactions	T1 – Ch. 8; pg. 170 -176	BB, PPT
21	Factors affecting the choice of reactors for single and multiple reactors.	T1 – Ch. 8; pg. 176 -200	BB, PPT
22	Optimum yield & conversion	T1 – Ch. 7; pg. 152- 161	BB, PPT
23	Selectivity for consecutive, parallel reactions	T1 – Ch. 7; pg. 158	BB, PPT
24	Selectivity and yield for mixed reactions	T1 – Ch. 7; pg. 158	BB, PPT
25	Problems – selectivity and yield	T1 – Ch. 7; pg. 158	BB, PPT
26	Problems based on Optimum yield & conversion	T1 – Ch. 7; pg. 152- 161	BB, PPT
27	Maximization of yield and selectivity for the desired reaction in different reactor schemes	T1 – Ch. 8; pg. 176-181	BB, PPT

Content beyond syllabus covered (if any):-

* Session duration: 50 mins

Sub. Code / Sub. Name: **CH22403 / Chemical Reaction Engineering I**

Unit: **IV**

Unit Syllabus: **TEMPERATURE EFFECTS FOR SINGLE AND MULTIPLE REACTIONS**
Thermal stability of reactors and optimal temperature progression for first order reversible reactions – Equilibrium conversion - Adiabatic and heat regulated reactors, Multiple Steady States in Continuous Stirred Tank Reactor (CSTR) - Design of non-isothermal reactors.

Objective: Investigate the temperature effects associated with the reactors during reaction and determineconversion.

Session No *	Topics to be covered	Ref	Teaching Aids
28	Thermal Stability and Non-isothermal homogeneous reactor systems	T1 – Ch. 9; pg. 207 - 210	BB, PPT
29	Optimal temperature progression for first order reversible reactions	T3 – Ch. 8; pg. 486 - 489	BB, PPT
30	Equilibrium conversion & Problems	T3 – Ch. 8; pg. 495-497	BB, PPT
31	Adiabatic and heat regulated reactors	T3 – Ch. 9; pg. 504-511	BB, PPT
32	Batch and Continuous reactors, Equilibrium conversions at different temperatures	T3 – Ch. 8; pg. 511 – 515 T1 – Ch. 9; pg. 211 - 215	BB, PPT
33	Optimum temperature progression in CSTR & PFR Systems	T1 – Ch. 13; pg. 868	BB, PPT
34	Design of non-isothermal reactors.	T1 – Ch. 9; pg. 220-223	BB, PPT
35	Optimum temperature progression, Reaction Stability	T1 – Ch. 9; pg. 219-220	BB, PPT
36	Problems – Optimum temperature progression	T1 – Ch. 9; pg. 219-220	BB, PPT

Content beyond syllabus covered (if any): Effect of temperature on product distribution in multiple reactions.

* Session duration: 50 mins

Sub. Code / Sub. Name: **CH22403 / Chemical Reaction Engineering I**

Unit: **V**

Unit Syllabus:NON-IDEAL FLOW REACTORS

Concept of residence time distribution (RTD), Measurement and moments of RTD, RTD in batch reactors, Plug Flow Reactor and CSTR. Zero Parameter Model: One parameter model: Tanks in series model and Dispersion Model.

Objective: Explore the various non-idealities in the real reactors and modeling suitable reactorsincorporating the effects of various non-idealities.

Session No *	Topics to be covered	Ref	Teaching Aids
37	Introduction to Non-Ideal Reactors	T3 – Ch. 13; pg. 868 T1 – Ch. 11; pg. 257-259	BB, PPT
38	Residence Time Distribution Studies, Stimulus Response Techniques, Pulse and Step Input, Other Types of Inputs	T3 – Ch. 13; pg. 871 – 876 T1 – Ch. 11; pg. 261-263	BB, PPT
39	Definition of C, E and F Curves and Relationship between these Curves.	T3 – Ch. 13; pg. 878 T1 – Ch. 11; pg. 260-266	BB, PPT
40	Problems illustrating the mean residence time, E (t) curve. Micro and macro mixing with examples	T3 – Ch. 13; pg. 881 – 884 T1 – Ch. 11; pg. 267-269	BB, PPT
41	Problems on mean residence time and C, E curve	T3 – Ch. 13; pg. 881 – 884 T1 – Ch. 11; pg. 267-269	BB, PPT
42	Reactor Modeling using RTD Data, Zero Parameter model	T3 – Ch. 13; pg. 902 - 904	BB, PPT
43	One Parameter model - Tanks-in-series model, Determining E (θ) & standard mean deviation	T3 – Ch. 14; pg. 947 T1 – Ch. 14; pg. 321-334	BB, PPT
44	Variance, problems related to finding the number of tanks. (analytical method)	T3 – Ch. 14; pg. 948 T1 – Ch. 14; pg. 321-334	BB, PPT
45	Variance, problems related to finding the number of tanks. (Graphical method)	T3 – Ch. 14; pg. 948 T1 – Ch. 14; pg. 321-334	BB, PPT

Content beyond syllabus covered (if any): Derivation of Dispersion model – closed and open vessel, Dispersion modelwith reaction

* Session duration: 50 mins

Sub Code / Sub Name: CH18502 / Chemical Reaction Engineering I

TEXTBOOKS:

1. Levenspiel O, "Chemical Reaction Engineering", Wiley Eastern Ltd., Third Edition, 2006
2. Fogler. H. S., "Elements of Chemical Reaction Engineering", Prentice Hall of India Ltd.,Fifth Edition, 2016.

REFERENCES:

1. Froment. G. F, B.Bischoff, K. B., and De Wilde., J "Chemical Reactor Analysis and Design",John Wiley &Sons, 1979.
2. Keith, J. Laidler, "Chemical Reaction kinetics", Pearson Education Asia, Third Edition,2004.
3. Smith, J.M, "Chemical Engineering Kinetics", McGraw Hill, Third Edition, 1981.
4. M.E.Davis, R.J.Davis,*Fundamentals of Chemical Reaction Engineering*, McGraw Hill, 2003.

	Prepared by	Approved by
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Date	24.01.2024	24.01.2024

Remarks *:

Remarks *:

* If the same lesson plan is followed in the subsequent semester/year it should be mentioned and signed by the Faculty and the HOD