Subject Code: 09CH1502

Subject Name: Chemical Reaction Engineering & Thermodynamics

Semester: 5th

Objective: To learn basic mechanism behind fluid behavior in various reactors and to solve heat & work requirement problem in chemical industries.

Credits Earned:4 Credits

Course Outcomes: After completion of the subject students will be able to

1. Identify & classify various types of chemical reactions
2. Analyze various chemical reactors
3. Calculate rate, rate constant, activation energy and order of reaction
4. Apply concept of various laws of thermodynamics to solutions
5. Analyze PVT behaviors of various fluids

Pre-requisite of course: Basic knowledge Chemical Process Industries, Heat Tansfer operation and Mass & Energy balances.

Teaching and Examination Scheme

Teaching Scheme (Hours)			Credits	Theory Marks			Tutorial/ Practical Marks		Total Marks
Theory	Tutorial	Practical		ESE (E)	Mid Sem (M)	Internal (I)	Practical Exam (V)	Term work (TW)	
3	2	0	4	50	30	20	25	25	150

Contents:

Unit	Topics	Contact Hours
1	**Introduction to Chemical Reaction Engineering :** Scope and importance of chemical reaction engineering, Classification of chemical reactions (Homogeneous vs. Heterogeneous, Catalytic vs. Non-catalytic, Reversible vs. Irreversible, By Molecularity, Exothermic vs. Endothermic, By order of reaction), Reaction rate on various basis and variables affecting the rate of reaction, Activation energy, Arrhenius equation.	06
2	**Types of Reactors & Characteristics** Batch, Semi-Batch, Continuous stirred tank reactor, Tubular, Multiphase, Trickle bed, Fluidized bed, Selection criteria of various reactors, Ideal reactors, Space time, Space velocity.	06

3	**Kinetics of Homogeneous Reactions:** Rate equation/ Rate law, Concentration dependent term of rate (Equation, Rate constant, Elementary and non-elementary reactions), Molecularity and order of reaction.	06
4	**Introduction & Basic concept of thermodynamics:** System, functions, properties Process and surrounding, System-Homogeneous and heterogeneous, Closed and open, State of System Properties -Extensive and Intensive, Function -State and Path function, Process -Reversible and irreversible process, Force, Pressure, Work and Energy, Steady state, Equilibrium state and Phase rule, Temperature and Zeroth law of thermodynamics, Simple examples (numerical)on Force, Pressure, Work and Energy physical quantities, phase rule and laws of thermodynamics.	10
5	**Laws of thermodynamics:** First law of thermodynamics, Definitions of Internal Energy, Enthalpy and Heat capacity, Simple numerical on first law and energy - Internal Energy, Enthalpy and Heat capacity, Limitations of first law, Statements of Second law, Heat reservoir, Heat engine and Heat pump, Concept of Entropy, Carnot cycle.	08
6	**PVT Behaviour:** PVT behavior of pure fluids, Ideal gas and equation of state, Ideal gas Process (Constant Volume process, Constant Pressure process, Constant Temperature process, Adiabatic Process) Vander Waals Equation, Virial Equation, Simple examples.	06
	Total Hours	**42**

Text Books:

1. Chemical Reaction Engineering – I & II, K.A.Gavhane, NiraliPrakashan.
2. Chemical Engineering Thermodynamics – I & II, K.A.Gavhane, NiraliPrakashan.
3. H. Scott Fogler, Essentials of Chemical Reaction Engineering, Prentice Hall International.
4. Chemical Engineering Kinetics, J.M.Smith, McGraw-Hill Education.
5. Chemical Engineering thermodynamics, K.V.Narayanan, PHI publishers.

Reference Books:

1. Chemical Reaction Engineering, Octave Levenspiel, Third edition John Wiley and Sons

List of Tutorials:

Numerical/Problems given based on following topics:

1. Activation energy
2. Half-life test method
3. Mixed reactor in series
4. Rate equation from CSTR data
5. Rate equation from PFR data
6. PFR & CSTR parallel

7. Enthalpy
8. Heat & Work requirement
9. Gibbs free energy
10. Total pressure

Suggested Theory Distribution:

The suggested theory distribution as per Bloom's taxonomy is as follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process.

Apply	Analyze	Understand	Remember
10 %	10 %	40 %	40 %

List of Learning Website:

1. https://nptel.ac.in/course.php
2. http://www.library.iitkgp.ac.in/