17BT005- Advanced Biochemical Reaction Engineering

Hours Per Week:

L	T	P	C
3	-		3

Total Hours:

L	T	P
45	-	-

BS	SA	CS	WA/RA	SSH	S
5	8	1-5	5	40	1-5

Course Description and Objectives:

This course gives immense knowledge on reaction kinetics and searching for reaction mechanism of non elementary reactions. In addition it also provides insights into different types of bio-reactors, their design and operation. The objectives of the course are to impart knowledge of bio-reactor designing and operation for specific conditions and also to compare performances of various bio-reactors.

Course Outcomes:

The student will be able to:

- *Develop rate equation for chemical reaction and determine rate kinetics.*
- *Get knowledge on basic concepts of reactor design.*
- *Optimization of reactor operation,*
- *Estimate thermodynamic parameters of reactions.*

SKILLS TO BE ACQUIRED:

- *Searching for reaction mechanism*
- *Development of reactor design equation*
- *Optimization of reactor operation*
- *Determination of reaction thermodynamics*

ACTIVITIES:

- *Measurement of microbial growth kinetics in fermentor*
- *Determination product formation kinetics in continuous mode in fermentor*
- *Measurement of RTD by tracer injection methods*

UNIT - I **L-9**

OVERVIEW OF CHEMICAL REACTION ENGINEERING: Classification of reactions, variables affecting the rate of reaction, Concept of order, molecularity of a reaction, definition of reaction rate, concentration dependent term of rate equation, Temperature dependent term of rate equation, Evaluation of rate constants using Arrhenius equation. Searching for a mechanism

UNIT - II **L-9**

IDEAL REACTORS: Types of reactions, interpretation of batch reactor data. Introduction to reactor design, general discussion, symbols and relationship between C_A and X_A. Ideal batch reactor, Steady-state mixed flow reactor, Steady-state plug reactors.

UNIT - III **L-9**

MULTIPLE REACTIONS AND NON ISOTHERMAL REACTIONS: Introduction to multiple reactions, qualitative discussion about product distribution, quantitative treatment of product distribution and of reactor size. Heats of reaction, equilibrium constants from thermodynamics, equilibrium conversion, general graphical design procedure, optimum temperature progression, heat effects, adiabatic operations and non adiabatic operations.

UNIT - IV **L-9**

CHARACTERIZATION OF REACTORS: Batch bioreactor design, Definition of chemostat, turbidostat, single flow single stage chemostat, single flow multistage chemostat, recycle flow in chemostat, Plug flow behavior, design of plug flow reactor.

UNIT - V **L-9**

NON-IDEAL REACTORS & HETEROGENEOUS REACTIONS: Concepts of residence time distribution, micro mixing and macro mixing, Reasons for non-ideality, concept of macro using –RTD analysis (E-C-F functions), diagnosing the ills of non-ideal bioreactors.

HETEROGENEOUS REACTIONS: Solid catalyzed reactions, the rate equation for surface kinetics, Pore diffusion, resistance combined with surface kinetics, performance equation for reactors containing porous catalyst particles, product distribution in multiple reactions.

TEXT BOOKS :

1. Octave Levenspiel, “Chemical Reaction Engineering” , 3rd ed. JohnWiely & Sons, 1999.
2. D.G.Rao, “Introduction to Biochemical Engineering”, McGraw-Hill, 2005.
3. P.M.Doran , “Bioprocess Engineering Principles”, Academic Press, 1995.
4. M.L.Shuler and F. kargi , “Bioprocess Engineering”, Prentice Hall of India ,1992.

REFERENCE BOOKS :

1. H.S. Fogler, “Elements of Chemical Reaction Engineering”, 2nd ed. PHI, 1992.
2. J.M.Smith, “Chemical Engineering Kinetics”, 3rd ed. Mc Graw Hill, 1981.