19BT311 BIOCHEMICAL REACTION ENGINEERING

Source: *https://www.dtu.dk/english/education/msc/joint-international-programmes-1-/chemical-and-biochemical-engineering*

Hours Per Week :

L	T	P	C
3	-	2	4

Total Hours :

L	T	P
45	-	30

WA/RA	SSH/HSH	CS	SA	S	BS
5	50	-	2	2	2

COURSE DESCRIPTION AND OBJECTIVES:

To apply principles of chemical engineering to biology and develop familiarity with chemical reaction kinetics, types of reactions and basic concepts of reactor design and its operations.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to achieve the following outcomes:

COs	Course Outcomes	POs
1	Understand fundamentals of reaction kinetics.	1,2
2	Apply material and energy balances to bioreactor systems.	1
3	Analyze various bioreactor systems and models.	2
4	Evaluate RTD of non-ideal bio-reactors.	1, 3, 5
5	Design a fermenter.	1, 3

SKILLS:

- ✓ *Calculation of rate of biochemical reactions.*
- ✓ *Design a bioreactor.*
- ✓ *Estimation of RTD.*
- ✓ *Development of performance equations for various bioreactors.*

UNIT - I **L-9**

FUNDAMENTALS OF REACTION ENGINEERING: Concept of order, Molecularity of a reaction, Searching a mechanism for a reaction, Evaluation of rate constants, Temperature using Arrhenius equation; Irreversible unimolecular type first order reactions, Irreversible bimolecular type second order reactions and interpretation of batch reactor data.

UNIT - II **L-9**

IDEAL REACTORS: Batch, Mixed flow, Plug-flow reactors; PFRs connected in series and parallel, MFRs connected in series, Reactors of different types in series.

UNIT - III **L-9**

BIOREACTOR DESIGN AND ANALYSIS: Design of ideal reactors using material and energy balance; Performance equation for batch, continuous (chemostat and turbidostat) and fed batch bioreactor; Multiple stage chemostat, Recycle flow in chemostat, Design of plug flow reactors, Comparison of productivity in plug flow and single stage single flow chemostat.

UNIT - IV **L-9**

MODELING OF GROWTH KINETICS AND DESIGN OF FERMENTATION PROCESSES: Model structure and complexity, A general structure for kinetic models, Unstructured growth kinetics; Simple structured models, Mechanistic models, Morphologically structured models, The stirred tank bioreactor, The plug flow reactor; Dynamic analysis of continuous stirred tank bioreactors.

UNIT - V **L-9**

NON- IDEAL REACTORS AND REACTOR APPLICATIONS: 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; Design and analysis of airlift bioreactors; Application in animal cell culture; Basic concept of scale-up.

LABORATORY EXPERIMENTS

LIST OF EXPERIMENTS **TOTAL HOURS: 30**

1. Estimation of rate constant for continuous stirred tank reactor.
2. Determination of rate constant for plug flow reactor.
3. Calculation of rate constant for combined reactor.
4. Determination of rate constant for batch reactor.
5. Determination of rate constant for adiabatic batch reactor.
6. Estimation of RTD for continuous stirred tank reactor.
7. Estimation of RTD for continuous stirred tank reactors in series and determine number of reactors in series theoretically.
8. Calculation of RTD for plug flow reactor.
9. Determination of RTD for combined reactor.

TEXT BOOKS:

1. O. Levenspiel, “Chemical Reaction Engineering”, 3rd edition, John Wiley and Sons, 2006.
2. P.M. Doran, “ Bioprocess Engineering Principles”, 2nd edition, Academic Press, 2013.
3. H.S. Fogler, “Elements of Chemical Reaction Engineering”, 2nd edition, Prentice Hall of India, 1999.

REFERENCE BOOKS:

1. James E.Bailey and David F. Ollis, “Biochemical Engineering Fundamentals”, 2nd edition, McGrawHill, 1989.
2. D.G. Rao, “Introduction to Biochemical Engineering”, 1st edition, McGraw Hill, 2005.
3. M. L. Shuler and F. Kargi, “Bioprocess Engineering”, 2nd edition, Prentice Hall of India, 2001.