17BT001 ADVANCED BIOPROCESS ENGINEERING

Hours Per Week:

L	T	P	C
3	-	2	5

Total Hours:

L	T	P
45	-	2

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

Course Description and Objectives:

This course helps to familiarize various aspects of bioreactors, to understand the media requirements and working conditions for profitable run of bioprocess industries with the help of data analysis

Course Outcomes:

Upon successful completion of this course, the student will be able to

- *Operate the fermenter*
- *Design the medium for production of metabolites*
- *Understand the modes of fermentation*

SKILLS TO BE ACQUIRED:

- *Operation of autoclave and fermentation reactor*
- *Able to design and optimize the medium*
- *Solid-state fermentation*
- *Shake-flask fermentation*

ACTIVITIES:

- *Preparation fermentation medium*
- *Use of batch and fed batch systems for production of bio-based products*
- *Yield calculations*
- *Software usage for Medium design and optimization*

UNIT - I **L-9**

Kinetics of Microbial Growth, Sterilisation and Product Formation: Different modes of operation - batch, fed batch and continuous cultivation. Simple unstructured kinetic models for microbial growth- Monod model, Growth of filamentous organisms, Substrate and product inhibition on cell growth and product formation. Different types of industrial sterilization, Thermal death kinetics of microorganisms, Batch and continuous heat sterilization of liquid media, Filter sterilization of liquid media, Air sterilization and design of depth filters.

UNIT - II **L-9**

Metabolic Stoichiometry and Energetics: Stoichiometry of cell growth and product formation, Elemental balances, degrees of reduction of substrate and biomass, Available electron balances, Yield coefficients of biomass and product formation, Maintenance coefficients energetic analysis of microbial growth and product formation, Oxygen consumption and heat evolution in aerobic cultures.

UNIT - III **L-9**

Bioreactor Operation: Choosing the cultivation method, design and operation of a typical aseptic, aerobic fermentation process, Environmental requirements for animal cell cultivations, Reactors for large scale production using animal cell, plant cell cultivation, Active and Passive Immobilization of cells, Diffusional limitations in Immobilized cells, Bioreactor considerations in Immobilized cell.

UNIT - IV **L-9**

Transport Phenomena in Bioprocess System: Gas – Liquid mass transfer in cellular systems, Determination of oxygen rates, Mass transfer for freely rising or falling bodies, Correlations for mass transfer coefficient and interfacial area, Mass transfer across free surface, Other factors affecting K_La, Heat transfer correlations.

UNIT - V **L-9**

Mixed culture and Solid State Fermentation: Introduction, Major classes of interactions in mixed cultures, simple models describing mixed cultures interactions, Mixed cultures in nature and industrial utilization of mixed cultures, Solid-state fermentation.

LABORATORY EXPERIMENTS

LIST OF EXPERIMENTS Total hours: 30

Microbial Culture Studies:

1. Culturing of different types of microorganisms used in the production of commercially important products.
2. Growth of microorganisms.
3. Temperature effect on growth-estimation of energy of activation and Arrhenius Constant for microorganisms.
4. Study of Growth substrate utilization and product formation kinetics in shake – flask cultures.
5. Batch and fed batch cultures
   a) Estimation of Monod parameters
   b) Pure and mixed cultures
   c) Production of secondary metabolites in synthetic and complex industrial media.

Enzyme Kinetics:

6. Extraction of commercially important enzymes, Development of enzyme assays and quantification of enzyme activity and specific activity.
7. Estimation of Michaelis - Menten parameters
8. Effect of pH and temperature on enzyme activity
9. Kinetics of inhibition, Techniques of enzyme immobilization - matrix entrapment, ionic and cross linking.

TEXT BOOKS:

1. Shuler, M.L. and Kargi, F. "*Bioprocess Engineering – Basic concepts* – 2nd Ed., Prentice Hall of India Pvt. Ltd., 2005
2. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, *Principles of Fermentation Technology,* 2nd ed., Butterworth – Heinemann an Imprint of Elsevier India Pvt. Ltd., 2005.

REFERENCE BOOKS:

1. Bailey and Ollis, "Biochemical Engineering Fundamentals", 2nd Ed., McGrawHill, 1986.
2. Pauline M. Doran, "Bioprocess Engineering Calculation", Blackwell Scientific Publications.
3. Harvey W. Blanch, Douglas S. Clark, "Biochemical Engineering," Marcel Dekker, Inc.