I Year M.Tech. Chemical Engg., I Semester	L	T	P	TO	C
	3	1	-	4	4

(CH509) BIOPROCESS ENGINEERING

Objective of the Course:
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.

UNIT - I
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, product formation kinetics, 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, design of sterilization equipment - batch and continuous.

UNIT - II
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, thermodynamic efficiency of growth.

UNIT - III
Bioreactor Operation: Choosing the cultivation method, design and operation of a typical aseptic, aerobic fermentation process, alternate bioreactor configurations. 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

Transport Phenomena in Bioprocess Systems: Gas – Liquid Mass Transfor 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 $K_l a^1$, heat transfer correlations, sterilization of gases and liquids by filtration.

UNIT - V

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.

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", McGraw Hill, 2nd ed., 1986.
2. Pauline M. Doran, "Bioprocess Engineering Calculation", Blackwell Scientific Publications.
3. Harvey W. Blanch, Douglas S. Clark, "Biochemical Engineering", Marcel Dekker, Inc.