Course Code	Course Title	L	T	P	C
1151BT109	Bioprocess Engineering	3	0	0	3

Course Category : *Program Core*

a. **Preamble** : *Bioprocess is an important subject to introduce the concepts of biological processes from laboratory to the commercial scale.*

b. Prerequisite Courses : *Biochemistry*

c. Related Courses : *Microbiology*

d. **Course Outcomes** : *Upon the successful completion of the course, students will be able to:*

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Will gain familiarity with the fermentation processes involved in the production of a wide variety of bioproducts	K2
CO2	To design, formulate and sterilize the media for different inocula on large scale fermentation	K2
CO3	To endow the students with the basics of stoichiometry of microbial reactions	K3
CO4	Ability to select, design and to devise scale up strategy for bioreactors	K3
CO5	To describe and explain the kinetics of cellular processes for microbial growth, substrate consumption and product formation	K3

		PROGRAMME OUTCOMES											
COs		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Will gain familiarity with the fermentation processes involved in the production of a wide variety of bioproducts	H	H	H	L	L	L	L	L	L	L	L	M
CO2	To design, formulate and sterilize the media for different inocula on large scale fermentation	L	M	L	L	H	H	L	L	L	L	L	L
CO3	To endow the students with the basics of stoichiometry of microbial reactions	M	H	L	L	L	L	L	L	L	L	L	M

CO4	Ability to select, design and to devise scale up strategy for bioreactors	M	H	H	H	M	L	L	L	L	L	L	L
CO5	To describe and explain the kinetics of cellular processes for microbial growth, substrate consumption and product formation	H	H	M	L	L	L	L	L	L	L	L	L

e. Course Content:

UNIT I: INTRODUCTION

Introduction to bioprocess development; current scenario of fermentation industry, general requirements of fermentation processes, types of fermentation process: Batch, fed batch and continuous. Construction of fermentor and ancillaries, main parameters to be monitored and controlled in fermentation processes; properties of fermented products.

UNIT II: MEDIA OPTIMIZATION AND STERILIZATION KINETICS

Media formulation and optimization-one factor at a time method, Plackett Burman and Response surface methodology; design of various commercial media for industrial fermentations; Thermal death kinetics of microorganisms, Sterilization: batch and continuous- air, heat and filter sterilization of liquid media.

UNIT III: STOICHIOMETRIC ANALYSIS

Stoichiometry and kinetics of bioprocesses, Stoichiometry of microbial reactions, Stoichiometry- Mass-balance equations, elemental balance, 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 IV: BIOREACTOR STRATEGIES

Types of bioreactor - Modes of operation of bioreactor - Kinetics of cell growth in batch culture - Kinetics of cell growth in fed-batch culture - Kinetics of cell growth in continuous culture -Stability analysis of bioreactor Scale up criteria for bioreactors (Constant power per Unit volume, Constant KLa, Constant mixing quality, Constant impeller tip speed, Constant momentum factor, Constant mixing rate number, Similar drop size distribution)

UNIT V: KINETICS OF MICROBIAL GROWTH AND PRODUCT FORMATION

Phases of cell growth in batch cultures; simple unstructured kinetic models for microbial growth - Monod model, growth of filamentous organisms, product formation kinetics - Leudeking-Piret models, substrate and product inhibition on cell growth and product formation; homogeneous and heterogeneous reaction kinetics. Biomass estimation- Direct and Indirect methods.

TEXT BOOKS

1. Shuler, Michael L. and Fikret Kargi, "Bioprocess Engineering ", Prentice Hall, 1992.

2. Doran, Pauline "of Bioprocess Engineering Principles ". Elsevier, 1995

REFERENCES

1. Lydersen, Bjorn K. "Bioprocess Engineering Systems, Equipment and Facilities" John Wiley, 1994.

2. Bailey, James E. and David F. Ollis, " Biochemical Engineering Fundamentals", 2nd Edition. McGraw Hill , 1986.

3. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, Principles of Fermentation Technology, Science & Technology Books.

4. Harvey W. Blanch, Douglas S. Clark, Biochemical Engineering, Marcel Dekker, Inc.