

**KL UNIVERISTY**  
**FIRST SEMESTER 2010-11**  
**Course Handout**  
**Academic Division**

Dated: 07-07-2010

**Course No.** : BT C205  
**Course Title** : Bioprocess Engineering  
**Course Structure** : 3-1-0  
**Course coordinator** : Sri K.Maheswar Reddy

**1. Course Description:**

Bioprocess Engineering involves an integrated approach for studying a process or products obtained through fermentation of micro-organisms. The course deals with basic calculations required for bioprocess applications, studying various fermentation and enzyme processes. Different aspects of metabolic stiochiometry, microbial growth and product formation will be dealt in the course.

**2. Scope and Objective of the Course:**

The discipline relate to studying the process from test tube to market, which involve exploitation of fundamental principles of both biology and chemical engineering. The objective of this course is to acquit the student with fundamental aspects of bioprocess engineering studying metabolic aspects, energy and mass balances, growth and product formation models

**3. Books:**

**(i) Textbook:**

1. D.G.Rao, Introduction to Biochemical Engineering, McGraw-Hill, 2005.
2. Pauline and Doran , Bio Process Engineering Principles , Elsevier

**(ii) Reference Book:**

1. Bailey Ollis, Biochemical Engineering fundamentals, 2nd edition, McGraw-Hill, 1986.
2. M.L.Shuler and F. kargi Bioprocess engineering, Prentice Hall of India 1992

**4. Syllabus:**

**UNIT-I: Introduction to Bioprocess**

An of overview of traditional and modern applications biotechnology industry, outline of an integrated bioprocess (upstream and downstream) with process flow sheet, steps in development of a complete bioprocess for commercial manufacture of recombinant-DNA derived product. -9 hrs

**UNIT- II: Dimensions and system units**

Basic Biochemical Calculations: atomic, molecular and equivalent weights. Molarity, Molality, Normality and partial pressures, laws of chemical combination, Definition of stoichiometry, Composition of mixtures and solutions, weight fractions, volumetric composition, Density and Specific gravity -9hrs

### UNIT –III: Fermentation and Enzyme Processes

Aerobic and Anaerobic fermentation processes and their application in the biotechnology industry behavior of microbes in different reactors (air lift, batch, continuous ,fed batch condition). Production of enzymes in submerged and solid-state processes, extraction and purification of enzymes, methods of characterization, specific activity and activity definitions. -9hrs

### UNIT–IV: Metabolic Stoichiometry and Energetics

Stoichiometry of cell growth and product formation; Elemental balances; degree of reduction of substrate and biomass.available electron balance; yield coefficients of biomass and product formation, maintenance coefficients, Energetic analysis of microbial growth and product formation; thermodynamic efficiency of growth -9hrs

### 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. Growth associated (primary) and non-growth associated (secondary) product formation Kinetics. Leudeking-Piret models. -9hrs

### 5.Course Plan:

Lect. No	Learning Objectives	Topics to be Covered	Reference	Chapters
1.	Introduction	Over view of traditional and modern applications of biotechnology industry	T <sub>1</sub> p-2	CH-1
2.	Process Flow know how	Out line of integrated bioprocess(up stream and downstream) with process flow sheet	T <sub>1</sub> p-6	CH-1
	Process Flow know how	Out line of integrated bioprocess(up stream and downstream) with process flow sheet	T <sub>1</sub> p-6	CH-1
3.	Up stream and down stream of products in bioprocess	Steps in development of bioprocess for commercial r-DNA derived products	T <sub>2</sub> .P-3	CH-1
4	Up stream and down stream of products in bioprocess	Steps in development of bioprocess for commercial r-DNA derived products	T <sub>2</sub> .P-3	CH-1
5	Basic calculations in bioprocess	Atomic , molecular and equivalent weights , molarity , molality , normality and parital pressures,	T <sub>2</sub> P:9-20	CH-2
6	Basic calculations in bioprocess	Atomic , molecular and equivalent weights , molarity , molality , normality and parital pressures,	T <sub>2</sub> P:9-20	CH-2
7	Basic calculations in bioprocess	Laws of chemical combinations , stiochiometry, composition of mixtures and solutions.	T <sub>2</sub> P:9-20	CH-2
8	Basic calculations in bioprocess	Laws of chemical combinations , stiochiometry, composition of mixtures and solutions.	T <sub>2</sub> P:9-20	CH-2

9	Basic calculations in bioprocess	Weight fractions, volumetric composition, density and specific gravity	T <sub>2</sub> P:9-20	CH-2
10	Classification of fermentations	Aerobic and anaerobic fermentations processes and their applications in industry	T1 P117-118	CH- 5
11	Classification of fermentations	Aerobic and anaerobic fermentations processes and their applications in industry	T1 P117-118	CH-5
12	Bioreactor applications in bioprocess	Behavior of microbes in batch reactors	T1 P:124	CH-5
13	Bioreactor applications in bioprocess	Behavior of microbes in fed batch reactors	T1P:124	CH-5
14	Bioreactor applications in bioprocess	Behavior of microbes in Continuous reactors	T1P:124	CH-5
15	Bioreactor applications in bioprocess	Behavior of microbes in Airlift reactors	T1P:124	CH-5
16	Bioreactor applications in bioprocess	Behavior of microbes in airlift reactors	T1P:124	CH-5
17	Various Enzyme fermentations	Enzyme production in solid state	T1P:118	CH-5
18	Various Enzyme fermentations	Enzyme production in solid state	T1P:118	CH-5
19	Various Enzyme fermentations	Enzyme production in submerged cultures	T1P:119	CH-5
20	Various Enzyme fermentations	Enzyme production in submerged cultures	T1P:119	CH-5
21	Unit Operations in Enzyme bioprocess Technology	Extraction and purification of enzymes	T <sub>2</sub> P:218-252	CH-10
22	Unit Operations in Enzyme bioprocess Technology	Extraction and purification of enzymes	T <sub>2</sub> P:218-252	CH-10
23	Characterization of Enzyme in terms of activity	Characterization of enzymes; Specific activity and Enzyme activity	T2P:261-262	CH-11
24	Characterization of Enzyme in terms of activity	Characterization of enzymes; Specific activity and Enzyme activity	T2P:261-262	CH-11
25	Introduction to metabolic stoichiometry	Stoichiometry of cell growth and product formation;	T2 P:74	CH-4
26	Introduction to metabolic stoichiometry	Elemental balances, degree of reduction of substrate and biomass	T2 P:74-75	CH- 4

27	Introduction to metabolic stoichiometry	Elemental balances, degree of reduction of substrate and biomass	T2P:74-75	CH-4
28	Metabolic stoichiometry in bioprocess applications	Available electrons, yield coefficients of biomass and product formation	T2 P-78	CH-4
29	Metabolic stoichiometry in bioprocess applications	Available electrons, yield coefficients of biomass and product formation	T2 P275-288	CH-11
30	Energy balance in microbial growth and product formation	Maintenance coefficients	T2 P-283	CH-11
31	Energy balance in microbial growth and product formation	Maintenance coefficients, Energetic analysis of microbial growth	T2P-283	CH-11
32	Energy balance in microbial growth and product formation	Energetic analysis of microbial product formation	T2 P282-283	CH-11
33	Thermodynamics of microbial growth	Thermodynamic efficiency of growth	T2 P:99	CH- 5
34	Understanding batch growth of micro-organisms	Phases of cell growth in batch cultures	T1P:168	CH-8
35	Understanding batch growth of micro-organisms	Phases of cell growth in batch cultures	T1P:168	CH- 8
36	Growth kinetic models of micro-organisms	Simple unstructured kinetic models for microbial growth	T1P:169	CH- 8
37	Growth kinetic models of micro-organisms	Simple unstructured kinetic models for microbial growth	T1P:169	CH- 8
38	Growth kinetic models of micro-organisms	Monad growth model	T1P:169	CH- 8
39	Growth kinetic models of micro-organisms	Monad growth model	T1P:169	CH-8
40	Fungal growth aspects	Growth of filamentous micro-organism	T1P:173	CH-8
41	Product formation models	Growth associated and non growth associated product formation kinetics	T1P:179	CH- 8
42	Product formation models	Growth associated and non growth associated product formation kinetics	T1P:179	CH-8
43	Product formation models	Growth associated and non growth associated product formation kinetics	T1P:179	CH- 8

44	Product formation models	Leudiking –piret model	R-1P 23;453	CH-7
45	Product formation model	Leudiking –Piret model	R-1 P 23;453	CH-7

### **6.Self learning material:**

Unit	Topic	Source
I	a. overview of traditional applications in biotech industry b. definitions of upstream an downstream process	DG . Rao , Introduction to Biochemical Engineering , Mc Graw –Hill ,2005
II	a. Definations of atomic , molecular and equivalent weights b. Molarity and Normality	Pauline and Doran , Bio Process Engineering Principles , Elsevier
III	a. Aerobic and Anaerobic fermentation basics	Bailey Ollis , Biochemical Engineering Fundametals , 2 <sup>nd</sup> Edition , McGraw-Hill,1986
IV	a. Electron availability in organic molecules	Pauline and Doran , Bio Process Engineering Principles , Elsevier
V	a. Definition of batch culture , primary and secondary metabolites	DG . Rao , Introduction to Biochemical Engineering , Mc Graw –Hill ,2005

### **7.Evaluation Scheme:**

Component	Duration (minutes)	% Weightage	Marks (%)	Date & Time	Venue
Test-1	50 Min	10	10	13.08.2010 09.30 – 10.20	NSH
Test-2	50 Min	10	10	17.09.2010 09.30 – 10.20	NSH
Assignement submission		5	5	Continuous	NSH
Assignment Test	50 Min	5	5	29.10.2010 09.00 – 10.30	NSH
Quiz	30 Min	5	5	29.10.2010 09.00 – 10.30	NSH
Regular Lab Evaluation	Continuous	0	0		
Comprehensive Lab Exam	3 Hrs	0	0		
Comprehensive Exam	3 Hrs	60	60		
Attendance for Theory & Tutorial		5	5	Continuous	
Attendance for Lab		0	0	Continuous	

**8. Chamber consultation hour:** Informed in the class in first week.

**9. Notices:** All notices regarding the course will be put in E-learning website.

**10.Tutorial:** Tutorial will be conducted by the respective in charge faculty. The tutorials are planned to supplement the material taught in the lectures and clear doubts. Student must attend registered section for tutorial in the respective classroom. Class assignment, class tests and other evaluation components will also be conducted during tutorials. Students must actively participate in the tutorial and come prepared for it.

**Course Coordinator**