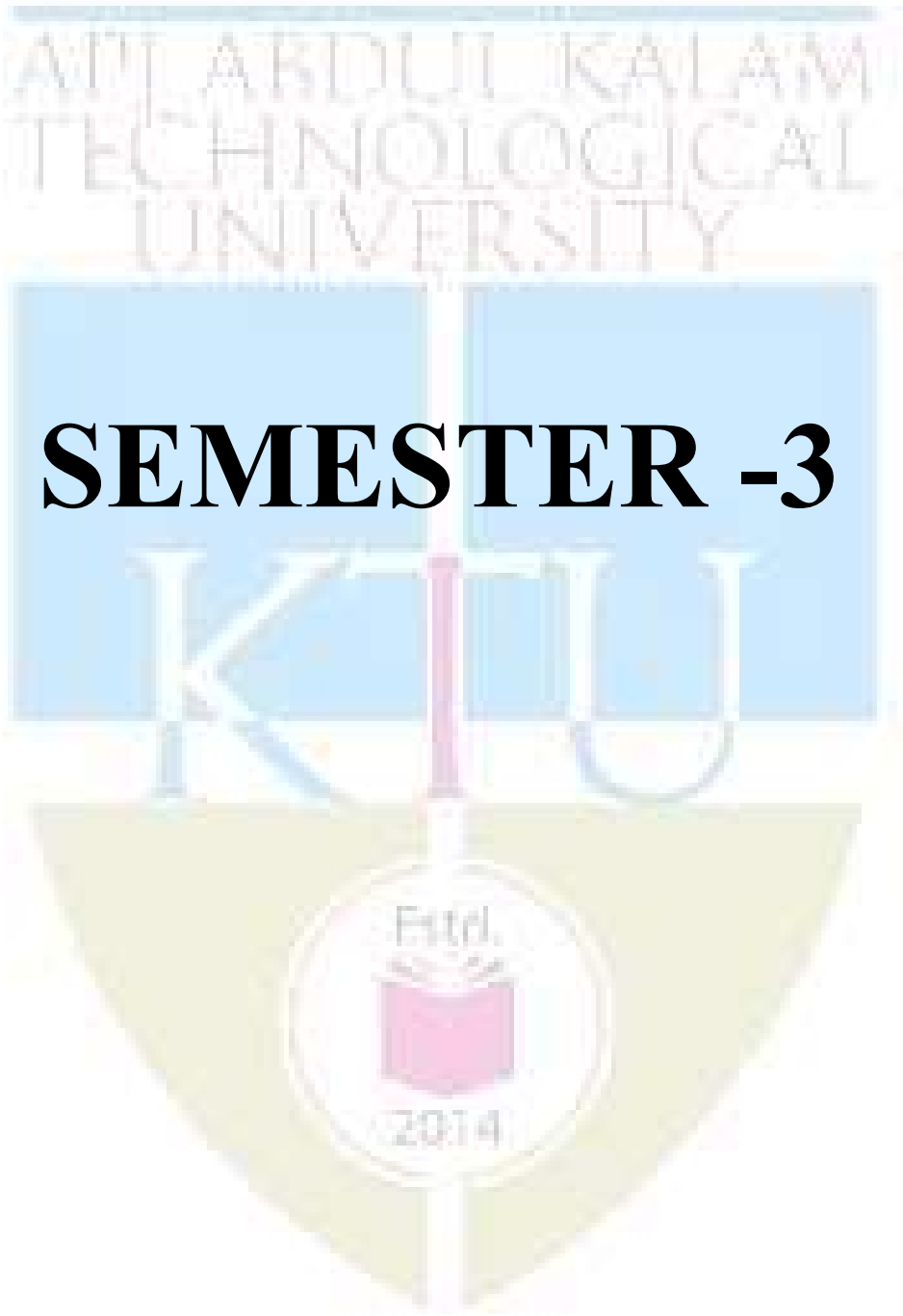


SEMESTER -3

BTT201	BIOPROCESS CALCULATIONS	CATEGORY	L	T	P	CREDIT
		PCC	3	1	0	4

Preamble: To familiarise with material and energy balances that is very important for the designing and functioning of bioprocess plants

Prerequisite: Basic knowledge about percentage and fractions, Units and conversions, Molarity, normality, Gas laws

Course Outcomes: After the completion of the course the student will be able to

CO 1	Use an appropriate system of units for quantities in engineering problem solving.
CO 2	Solve the material balance and energy balance equations for unit operations and unit processes in bioprocess engineering
CO 3	Formulate growth medium based on stoichiometry and elemental balances.
CO 4	Calculate heat of reaction for microbial growth and product formation

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	3		-	-	-	-	-	1	-	-	1
CO 2	2	3	1	-	-	-	-	-	2	-	-	2
CO 3	2	3	1	-	-	-	-	-	-	-	-	-
CO 4	2	3	1	-	-	-	-	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	20
Apply	20	20	70
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Use appropriate system of units for quantities in engineering problem solving.

1. The pressure reading from a barometer is 742 mm Hg. Express this reading in kilopascals, kPa.

2. Density of water = ----- g/cm^3 = ---- kg/liter = --- ton/m^3

3. The average commercial jet flies around an altitude of 32,500 feet. How high is this in meters?

Course Outcome 2 (CO2): Solve the material balance and energy balance equations for unit operations and unit processes in bioprocess engineering

1. A soap plant produces raw soap containing 50% moisture. This is to be dried to 20% moisture before it is pressed into cakes for sale. How many 100g soap pieces can be obtained from 1000 Kg of original raw soap?

2. A weak acid containing 12.5% H_2SO_4 and the rest water is fortified by adding 500Kg of concentrated acid containing 80% H_2SO_4. Determine the amount of the solution obtained if it contains 18.5% H_2SO_4.

3. Gas analyzing CO_2 -5.5 %, CO- 25%, H_2 -14%, N_2 -55%, CH_4 - 0.5% is burned in furnace with 10% excess air. Calculate the Orset analysis of the flue gas

Course Outcome 3(CO3):Formulate growth medium based on stoichiometry and elemental balances.

1. The aerobic degradation of Benzoic acid by mixed culture can be represented by

following reaction: $C_6H_5COOH + a\ O_2 + b\ NH_3 cC_5H_7O_2N + d\ H_2O + e\ CO_2$. Find the

stoichiometric coefficients where RQ value is 0.9.

2. Write a note on thermodynamics of microbial growth

3. The growth of yeast cells on glucose under anaerobic conditions can be described by the following equation:

$C_6H_{12}O_6 + a\ NH_3 \quad 0.59CH_{1.74}N_{0.2}\ O\ 0.45 + 1.3C_2H_5OH + bC_3H_8O_3 + 1.54\ CO_2 + 0.036H_2O$

(i)Determine the stoichiometric coefficients a and b.

Course Outcome 4 (CO4): Calculate heat of reaction for microbial growth and product formation

1. Explain how degrees of reduction is useful in finding out stoichiometric coefficients.
2. Find out degrees of reduction for the following Methanol, ethanol,CO 2 ,Ammonia and glucose?(5)
3. Explain how a degree of reduction is useful in finding out stoichiometric coefficients.

Model Question paper

			Total Pages:
Reg No.:_____		Name:_____	
APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY THIRD SEMESTER B. TECH DEGREE EXAMINATION _____ ____ 20__			
Course Code: BTT201			
Course Name: BIOPROCESS CALCULATIONS			
Max. Marks: 100			Duration: 3 Hours
PART A			
		Answer all questions, each carries 3 marks.	
1	a)	State Ideal Gas Law	
	b)	How many moles of solute are contained in 3 L of 2 M solution?	
	c)	Differentiate between unit operations and unit processes.	
	d)	Describe about steady state, batch and continuous process	
	e)	Wood containing 40% moisture is dried to 5% moisture. What mass of water in kilograms is evaporated per kg of dry wood?	
	f)	Compare Bypass and recycle operations with neat sketch	
	g)	Explain the following: (i)Yield, (ii)Conversion,(iii)Degree of completion	

	h)	For the purpose of most engg calculations, air is assumed to be composed of 21 mol% O_2 and 79 mol% N_2. Calculate the average mol.wt.of air?	
	i)	A compound whose molecular weight is 103, has the following composition, C-81.5%, H-4.9%, N- 13.9% . What is the formula?	
	j)	Calculate the degrees of reduction for (i)Ethanol,(ii) Methanol (iii) CO_2	
PART B			
Answer any one full question from each module. Each carries 14 marks.			
2	a)	Natural gas is piped from the well at 300 K and 400 kPa. The gas is found to contain 93% methane, 4.5% ethane and the rest nitrogen. Calculate the following: a. The partial pressure of nitrogen b. The pure-component volume of ethane in 10 m^3 of the gas c. The density at standard conditions in kg/m^3 d. The density of gas as piped in kg/m^3 e. The average molecular weight of gas	(10)
	b)	What is compressibility factor? Explain using the various compressibility charts?	(4)
		OR	
3	a)	What are humidity, Percent humidity and Dew point? Explain about relative humidity and percent humidity. Give a brief idea about the humidity chart.	(8)
	b)	Explain Raoults law and Henrys law	(6)
4	a)	List out steps for solving material balance problems.	(8)
	b)	Illustrate with an example, the energy balance in a cyclic process.	(6)
		OR	
5	a)	Wet sewage sludge enters a continuous thickener at a rate of 100 kg/h and dehydrated sludge leaves the thickener at a rate of 75 kg/h. Determine the amount of water removed in the thickener in one hour, assuming steady state operation.	(8)
	b)	Give the importance of the following concepts in solving material balance problems (i) Number of degrees of freedom and material balance equations. (ii) Key component.(iii) Selection of basis for calculations.	(6)
6		It is required to make 1000kg of mixed acid containing 60% H2SO4, 32% HNO3,8% H2O by blending the following.Spent acid containing 11.3% HNO3, 44.4% H2SO4, 44.3% H2O,ii)Concentrated HNO3 containing 90% HNO3, remaining H2O Concentrated H2SO4 containing 98% H2SO4, balance ,H2O. All this percentage is by weight. Calculate the quantity of each of the acids required for blending.	(14)
		OR	

7	a)	Soybean seeds are extracted with hexane in batch extractors. The flaked seed contains 20% oil, 68% solids and 12% moisture. At the end of the extraction, the cake is separated from the hexane – oil mixture. The cake analysis yields 0.8% oil, 88% solids and 11.2%moisture. Find the percentage recovery of oil.	(10)
	b)	Explain Absorption with necessary material balance equation	(4)
8		The following data was obtained during an analysis in a coal fired steam generator. The ultimate analysis of coal: 80.5% C, 4.6% H2, 5% O, 1.1 % N2 and 8.8% ash. No carbon is lost in the refuse. The Orsat analysis o the flue gas: 16.4 % CO2, 2.3% O2, 0.4% CO, 80.9% N2. Calculate the weight of dry gaseous products formed per 100 kg of coal fired.	(14)
		OR	
9	a)	Coal contains 85% carbon and 15 % ash. The cinder formed as a result of combustion of coal contains 80% ash and 20% carbon. Determine the weight of cinder formed by the combustion of 100 kg of coal.	(4)
	b)	Interpret the working and application of Orsatanalyzer with neat sketch	(10)
10		*Candida utilis*cells convert glucose to CO_2 and H_2O during growth. The cell composition is $CH_{1.84}O_{0.55}N_{0.2}$ plus 5% ash. Yield of biomass from substrate is 0.5 g g-1. Ammonia is used as a nitrogen source. What is the oxygen demand with growth compared to that without?	(14)
		OR	
11	a)	Corn steep liquor contains 2.5 % invert sugars and 50% water; the rest can be considered solids. Beet molasses contains 50% sucrose, 1% invert sugars, 18% water and the remaining solids is mixed with corn steep liquor in a mixing tank.Water is added to produce diluted sugar mixture 2% (w/w) invert sugars. An amount of 125 kg of corn steep liquor and 45 kg molasses are fed into the tank.Draw a schematic representation for the given system and calculate the following:i) How much water is required for the process?ii) What is the concentration of sucrose in the final mixture?	(10)
	b)	Explain theoretical oxygen demand and maximum possible yield.	(4)
		****	

Syllabus

Module 1

Fundamentals of Units and dimensions: Chemical arithmetic: Mole concept, atomic weight, molecular weight and equivalent weight.

Chemical composition: Methods of expressing compositions of mixtures and solutions- mole percent, mass percent, volume percent, molarity, molality, normality, ppm, density and specific gravity, specific gravity scales.

Use of mole concept in biological and chemical reactions, Ideal gas laws, gaseous mixtures, real gas laws, gas constant.Composition of gases on dry basis and on wet basis, Average molecular weight and density.Critical properties.

Humidity: Humidity and saturation: various terms associated with humidity and saturation. Use of Psychrometric charts and determination of humidity.

(A treatment using numerical examples on all the above topics is required)

Module 2

Fundamentals of material balances and energy balances:

Definition of unit operations and unit processes.

Law of conservation of mass, types of material balance problems – total and component balances, steady and unsteady state processes, batch and continuous processes. Concept of tie element, basis for calculations, independent material balance equations, degrees of freedom and steps for solving material balance problems.

(A treatment using numerical examples on all the above topics is required)

Fundamentals of energy balances: Law of conservation of energy, qualitative study of components of energy balance equations.

Module 3

Material balances without chemical reactions: Material balances for unit operations like evaporation, crystallization, drying, leaching, extraction, absorption and distillation. Qualitative study of bypass, recycle and purging operations

(A treatment using numerical examples on all the above topics is required)

Module 4

Material balances with chemical reactions: Definition of terms like limiting reactant, excess reactant, percentage yield and selectivity, extent of reaction:- simple numerical examples. Combustion of solid, liquid and gaseous fuels, heating value of fuels, proximate and ultimate analysis of coal, Orsat analysis. Qualitative treatment of Recycle and purge involving reactions

(A treatment using numerical examples on all the above topics is required)

Module 5

Stoichiometry of cell growth and product formation

Material and energy balances for sterilization, industrial fermentation and downstream processing, Waste treatment processes – simple numerical examples and case studies. Stoichiometry of cell growth and product formation: Overall growth stoichiometry- medium formulation and yield factors, Elemental material balances for growth, Electron balances, Product formation stoichiometry, Theoretical oxygen demand and maximum possible yield – simple numerical examples

(A treatment using numerical examples on all the above topics is required)

Text Books

1. K.V. Narayanan, B. Lakshmikutty, *Stoichiometry and Process Calculations*, Prentice Hall of India, 2006

2. Michael L Shuler &FikretKargi – *Bioprocess Engg. Basic Concepts* – Prentice – Hall India.

Reference Books

1. B.I. Bhatt, S.M. Vora, *Stoichiometry*, Fourth edition, Tata McGraw Hill, 2004.
2. Venkataramani&N.N.Ananthraman – *Process calculation* – Prentice Hall India.
3. David M. Himmelblau, James B. Riggs, *Basic Principles and Calculations in Chemical Engineering*, Prentice Hall, 2012.
4. Pauline M Doran, *Bioprocess Engineering Principles,* 2/e, Elsevier- Academic Press, 2013

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Module 1: Fundamentals of Units and dimensions**	
1.1	Chemical arithmetic: Mole concept, atomic weight, molecular weight and equivalent weight. Use of mole concept in biological and chemical reactions,	1
1.2	Chemical composition: Methods of expressing compositions of	2

	mixtures and solutions- mole percent, mass percent, volume percent,	
1.3	Molarity, molality, normality, ppm,	1
1.4	Density and specific gravity, specific gravity scales.	1
1.5	Ideal gas laws, gaseous mixtures, real gas laws, gas constant.	2
1.6	Composition of gases on dry basis and on wet basis, Average molecular weight and density. Critical properties.	1
1.7	Humidity and saturation: various terms associated with humidity and saturation. Use of Psychrometric charts and determination of humidity.	1
2	**Module 2: Fundamentals of material balances and energy balances:**	
2.1	Definition of unit operations and unit processes.	1
2.2	Law of conservation of mass, types of material balance– total and component balances	1
2.3	steady and unsteady state processes, batch and continuous processes.	1
2.4	Concept of tie element, basis for calculations, independent material balance equations, degrees of freedom **Problem solving**	2
2.5	steps for solving material balance problems. **Problem solving**	1
2.6	Fundamentals of energy balances: Law of conservation of energy, qualitative study of components of energy balance equations.	1
3	**Material balances without chemical reactions**	
3.1	Material balances for evaporation and drying **Problem solving**	1
3.2	Material balances for crystallization **Problem solving**	2
3.3	Material balances for leaching **Problem solving**	1
3.4	Material balances for absorption **Problem solving**	1
3.5	Material balances for distillation **Problem solving**	1
3.6	Material balances for extraction **Problem solving**	2

3.7	Qualitative study of bypass, recycle and purging operations **Problem solving**	2
4	**Material balances with chemical reactions**	
4.1	Definition of terms like limiting reactant, excess reactant, percentage yield and selectivity, extent of reaction:-	1
4.2	Simple numerical examples.	1
4.3	Combustion of solid, liquid and gaseous fuels	1
4.4	Simple numerical examples.	2
4.5	Heating value of fuels,	1
4.6	Proximate and ultimate analysis of coal,	1
4.7	Orsat analysis.	2
4.8	Simple numerical examples.	1
4.9	Qualitative treatment of Recycle and purge involving reactions	1
5	**Stoichiometry of cell growth and product formation**	
5.1	Material and energy balances for sterilization,	1
5.2	industrial fermentation and downstream processing	1
5.3	Waste treatment processes – simple numerical examples and case studies.	1
5.4	Stoichiometry of cell growth and product formation: Overall growth stoichiometry- medium formulation and yield factors,	1
5.5	Elemental material balances for growth,	1
5.6	Electron balances,	1
5.7	Product formation stoichiometry,	1
5.8	Theoretical oxygen demand and maximum possible yield – simple numerical examples	1

BTT203	MICROBIOLOGY	CATEGORY	L	T	P	CREDIT
		PCC	3	1	0	4

Preamble: Familiarise with the characteristics and function of microorganisms which are helpful as well as harmful for life and its existence

Prerequisite: Nil

This course is a pre-requisite for gaining a fundamental understanding of microbe based bioprocess systems. This course shall equip the students in applying their knowledge of microorganisms to a variety of bioprocess situations, in all realms of human endeavour.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Demonstrate the ability to visualize, cultivate and classify microorganisms
CO 2	Describe the diversity of microorganisms and methods to control their growth
CO 3	Demonstrate that microorganisms have a vital role in the environment
CO 4	Cite examples of the vital role of microorganisms in the industries important to human well being.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	-	-	2	2	-	2	2	-	-	-	-	-
CO 2	-	-	2	2	-	2	2	-	-	-	-	-
CO 3	-	-	2	2	-	3	3	-	-	-	-	-
CO 4	-	-	2	2	-	3	3	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	20
Apply	20	20	70
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. State the features of eukaryotic cells.

2. Provide a classification scheme based on size, shape and arrangement of microorganisms.

3. Define the functionality of Scanning Electron Microscope.

Course Outcome 2 (CO2)

1. Illustrate the microbiological principles of Disinfection, Sanitization and Antisepsis

2. List the features of HEPA filter

3. Justify giving reasons the need to evaluate and assess the diversity of microorganisms

Course Outcome 3(CO3):

1. Describe Biogeochemical cycling with reference to Carbon cycle

2. Discuss on Microbial analysis of water purity

3. Illustrate the role of microorganisms in organic matter decomposition

Course Outcome 4 (CO4):

1. Narrate the role of microorganisms in food spoilage.

2. Signify the application of microbiology in Agriculture through Bio fertilization

3. Detail the microbial sources in preparation of Bio pesticide. Signify the application of microbiology in Human health through Biopesticides

Model Question paper

			Total Pages:
Reg No.:_____		Name:_____	
APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY THIRD SEMESTER B. TECH DEGREE EXAMINATION _____ ____ 20__			
Course Code: BTT203			
Course Name: MICROBIOLOGY			
Max. Marks: 100			Duration: 3 Hours
PART A			
		Answer all questions, each carries 3 marks.	
1	a)	What are the contributions of Robert Koch to the field of microbiology?	
	b)	What is differential staining? Explain acid fast staining with examples.	
	c)	Tabulate the differences between gram +ve and gram –ve bacterial cell wall structure with a neat labelled diagram and give two examples for gram +ve and –ve bacteria.	
	d)	Give the importance of serial dilution. What are the techniques that can be used to obtain specific cultures in a pure form from a given environmental samples	
	e)	Derive the mathematical expression for exponential growth phase.	
	f)	Explain physical and chemical agents used for the control of microorganisms	
	g)	What are extremophiles? Describe the effect of environmental factors on growth	
	h)	Explain host pathogen interaction with an example	

	i)	Mention the process for the production of any two fermented food products	
	j)	Explain the various food infections caused by microorganisms. How is food infection different from food intoxication?	
PART B			
Answer any one full question from each module. Each carries 14 marks.			
2		Classify microorganisms based on their requirement for energy, carbon and electron source and describe the major nutritional groups with examples.	(14)
		OR	
3	a)	Discuss in detail the eukaryotic cellular features	(14)
4	a)	Define media. Discuss in detail the types of media	(6)
	b)	Detail the stepwise preparation of PDA media	(8)
		OR	
5		Define Numerical Aperture. Detail the principle and working of Bright field microscope	(14)
6	a)	Sketch and explain the Bacterial Growth curve	(6)
	b)	Signify the Bacterial growth curve giving reasons	(8)
		OR	
7		Define sterilization. Narrate the principle and working of dry heat method of sterilization	(14)
8		Explain the principle, procedure and expected results of IMViC series of tests	(14)
		OR	
9		What are extremophiles? Describe the effect of any four environmental factors on growth	(14)
10		Explain the role of microorganisms in the production of pesticides and insecticides	(14)
		OR	
11		Mention the process for the production of any two fermented food products	(14)
****			

Syllabus

Historical aspects and the landmark discoveries of microbiology; microscopy and staining techniques. Eukaryotic and prokaryotic cell structure and function; microbial taxonomy; classification systems, Microbial nutrition and cultivation, Microbial growth and control of microorganisms. Microbial interactions and ecology; microorganisms in different environments- aquatic and soil. Application of microbiology.

Module 1:

Historical perspectives: Landmark discoveries relevant to the field of microbiology; Scope and relevance of microbiology.

Microbial taxonomy: Evolution and diversity of microorganisms, classification systems. Bacteria, archaea; Eukaryotic microbes: Fungi, algae, protozoa. Viruses, viroids and prions

Eukaryotic and prokaryotic cell structure and function: size, shape and arrangement, cell membranes, cell organelles, cell walls.

Module 2:

Microscopic techniques: light microscopy, dark field microscopy, phase contrast microscopy, fluorescence microscopy, SEM, TEM. **Staining techniques**: cell staining- simple staining, gram staining and acid fast staining; staining of specific structures.

Microbial nutrition and cultivation: Nutritional classes of microbes, Macro and micronutrients, sources and physiological functions of nutrients. Growth factors and their functions in metabolism

Cultivation of microorganisms: Culture media- synthetic, complex media, solidifying agents, types of media - selective, differential and enrichment media, pure culture methods - spread plate, pour plate and streak plate, special techniques for cultivation of anaerobes.

Module 3:

Microbial Growth: Definition of growth; growth curve; mathematical expression of exponential growth phase; measurement of growth and growth yields; synchronous growth; effect of environmental factors on growth.

Control of microorganisms: Basic terminology- sterilization, disinfection, sanitization, antisepsis. Physical methods for microbial control- heat, low temperature, filtration and radiation. Use of chemical agents, evaluation of effectiveness of antimicrobial agents

Microbial diseases – examples of bacterial diseases and host pathogen interaction

Module 4:

Microbial ecology: Biogeochemical cycles: cycles of nitrogen, carbon and sulphur

Microbiological analysis of water purity - sanitary tests for coliforms (presumptive test, confirmed test, completed test), MPN test, defined substrate test, IMVIC test. Quality standards for drinking water

Soil microbiology: Soil as a habitat for microorganisms, role of microorganisms in organic matter decomposition.

Module 5:

Application of microbiology: **Food microbiology:** Role of microorganisms in food spoilage and contamination, food preservation methods - physical and chemical methods, food borne diseases and intoxications, examples of fermented food products.

Industrial microbiology - Microorganisms as biofertilizers and biopesticides, commercially important microorganisms for industrial fermentation

Text Books

1. Prescott, Harley and Klein, *Microbiology*, McGraw Hill International Edition, 2008.
2. Pelczar M. J., E. C. E. Chan and N. R. Krieg, *Microbiology*, Tata McGraw Hill, 1993.

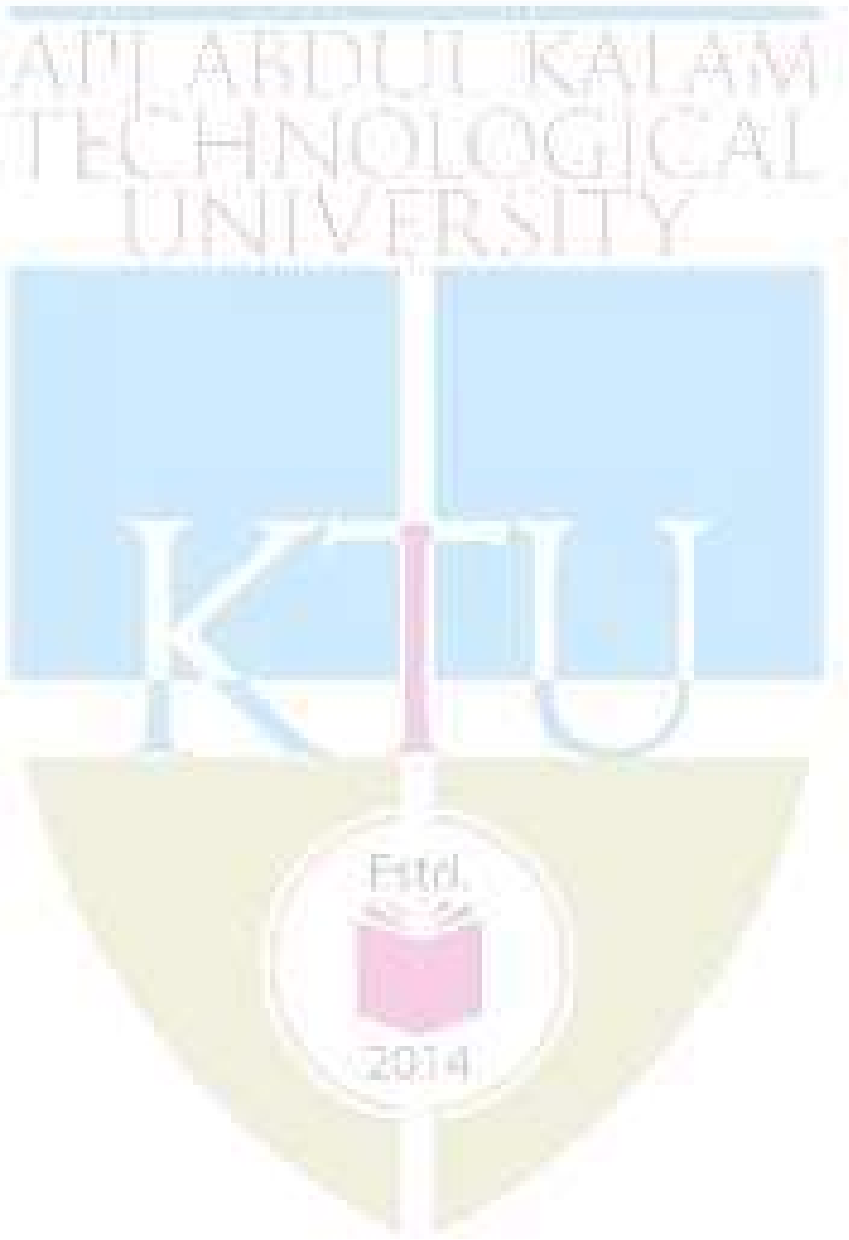
Reference Books

1.Ingraham J. L. and C. A. Ingraham, *Introduction to Microbiology A Case History Approach,* 3/e, Thomson Publications, 2003.
2.Brock, *Biology of Microorganism*, Prentice Hall, International Inc, 2005.
3. Schlegel H. G., *General Microbiology*, Cambridge University Press, 1993.

Course Contents and Lecture Schedule

No		No. of Lectures
1	**Historical perspectives**	
1.1	Landmark discoveries relevant to the field of microbiology; Scope and relevance of microbiology.	3
1.2	**Microbial taxonomy**: Evolution and diversity of microorganisms, classification systems. Bacteria, archaea; Eukaryotic microbes: Fungi, algae, protozoa. Viruses, viroids and prions	3
1.3	**Eukaryotic and prokaryotic cell structure and function**: size, shape and arrangement, cell membranes, cell organelles, cell walls.	3
2	**Microscopic techniques**	
2.1	Light microscopy, dark field microscopy, phase contrast microscopy, fluorescence microscopy, SEM, TEM. **Staining techniques**: cell staining- simple staining, gram staining and acid fast staining; staining of specific structures.	4
2.2	**Microbial nutrition and cultivation**: Nutritional classes of microbes, Macro and micronutrients, sources and physiological	3

	functions of nutrients. Growth factors and their functions in metabolism	
2.3	**Cultivation of microorganisms**: Culture media- synthetic, complex media, solidifying agents, types of media - selective, differential and enrichment media, pure culture methods - spread plate, pour plate and streak plate, special techniques for cultivation of anaerobes.	3
3	**Microbial Growth**	
3.1	Definition of growth; growth curve; mathematical expression of exponential growth phase; measurement of growth and growth yields; synchronous growth; effect of environmental factors on growth.	3
3.2	**Control of microorganisms**: Basic terminology- sterilization, disinfection, sanitization, antisepsis. Physical methods for microbial control- heat, low temperature, filtration and radiation. Use of chemical agents, evaluation of effectiveness of antimicrobial agents	3
3.3	**Microbial diseases –** examples of bacterial diseases and host pathogen interaction	3
4	**Microbial ecology**	
4.1	Biogeochemical cycles: cycles of nitrogen, carbon and sulphur	3
4.2	**Microbiological analysis of water purity** - sanitary tests for coliforms (presumptive test, confirmed test, completed test), MPN test, defined substrate test, IMVIC test. Quality standards for drinking water	3
4.3	**Soil microbiology**: Soil as a habitat for microorganisms, role of microorganisms in organic matter decomposition	3
5	**Application of microbiology**	
5.1	**Food Microbiology:** Role of microorganisms in food spoilage and contamination, food preservation methods - physical and chemical methods, food borne diseases and intoxications, examples of fermented food products.	4
5.2	**Industrial Microbiology** - Microorganisms as biofertilizers and biopesticides, commercially important microorganisms for industrial fermentation	4


APJ ABDUL KALAM
TECHNOLOGICAL
UNIVERSITY
KTU
Estd.
2014

BTT205	FLUID FLOW AND PARTICLE TECHNOLOGY	CATEGORY	L	T	P	CREDIT
		PCC	3	1	0	4

Preamble: Enhance knowledge with momentum transfer mechanisms in industrial bioprocessing.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Compute the fluid properties associated with principles of fluid statics and dynamics of fluid flow.
CO 2	Use basic momentum and energy balance equations in specific domains of frictional flow/boundary layer flow of incompressible fluids in pipe flow.
CO 3	Explore the fluid moving machineries and principles of flow measurement in different flow metering equipments
CO 4	Examine the equipments for size reduction of solids, particle size analysis methods and solid liquid separation processes

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	-	-	-	2	-	-	-	-	-	2
CO 2	3	3	2	-	-	2	-	-	-	-	-	-
CO 3	3	3	2	-	-	2	-	-	-	-	-	2
CO 4	3	3	-	-	-	2	-	-	-	-	-	2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
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Apply	20	20	70
Analyse			

Evaluate			
Create			

Mark distribution

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Continuous Internal Evaluation Pattern:

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Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Define capillarity, surface tension, specific weight and specific volume.
2. Differentiate absolute and gauge pressure.
3. Summarize the forces on submerged bodies.

Course Outcome 2 (CO2)

1. With a neat diagram, explain Reynolds experiment.
2. State and explain Newton's law of viscosity. Discuss Newtonian and non-Newtonian Fluids with examples.
3. Explain boundary layer formation and boundary layer separation.

Course Outcome 3(CO3):

1. Derive Bernoulli's equation with all correction factors stating the assumptions.

2. Explain the principle of using flow measurement by orifice meter, rotameter andpitot tube.

3. Derive Ergun equation for pressure drop of flow through packed bed.

Course Outcome 4 (CO4)

1. Explain various factors affecting choice of size reduction equipments.
2. Write notes on photo sedimentation and ICI sedimentation.
3. Explain the Differential and cumulative method of particle size analysis.

Model Question paper

			Total Pages:
Reg No.:_____		Name:_____	
APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY THIRD SEMESTER B. TECH DEGREE EXAMINATION _____ ____ 20__			
Course Code: BTT 205			
Course Name: FLUID FLOW AND PARTICLE TECHNOLOGY			
Max. Marks: 100			Duration: 3 Hours
PART A			
		Answer all questions, each carries 3 marks.	
1	a)	State Newton's law of viscosity.	
	b)	What is the significance of priming?	
	c)	Write any three applications of Hagen-Poiseuille equation.	
	d)	What are the necessary conditions to be satisfied for a good streamlining?	
	e)	Which are the equations used to calculate the pressure drop through a packed bed?	
	f)	Define capillarity, viscosity and compressibility.	
	g)	Distinguish real fluid and ideal fluid.	
	h)	Explain with necessary equations as to how you would find out the surface tension of a soap bubble and a liquid droplet.	
	i)	Differentiate absolute and gauge pressure.	

	j)	Outline the term momentum flux and velocity distribution in pipe flow.	
PART B			
Answer any one full question from each module. Each carries 14 marks.			
2	a)	Explain the conditions for stability of floating and submerged bodies.	(10)
	b)	What is meant by hydrostatic equilibrium? Write down the hydrostatic equation and explain its significance.	(4)
		OR	
3	a)	The surface tension of water in contact with air at 20^0c is 0.0725N/m. The pressure inside the droplet of water is to be 0.02N/cm^2 than the outside pressure. Calculate the diameter of droplet of water	(6)
	b)	A simple U-tube manometer is installed across an orifice meter. The manometer is filled with mercury having specific gravity of 13.6 and the liquid above the mercury has specific gravity1.6. Manometer reading is 200 mm. Calculate the pressure difference in N/m^2	(8)
4	a)	Discuss Bernoulli's equation, clearly stating the assumptions made.	(10)
	b)	Explain the principle behind the operation of a Pitot tube. How is it different from other flow measuring devices?	(4)
		OR	
5	a)	Distinguish between orifice meter and venturi meter. (10 marks)	(10)
	b)	Write a note on cavitation and NPSH.	(4)
6		Derive the shear stress and velocity distribution for laminar flow of fluid through a circular channel. And also drive the relationship between local and maximum velocity.	(14)
		OR	
7		Derive Ergun equation for pressure drop of flow through packed bed.	(9)
8		Explain the principle of using flow measurement by orifice meter, rotameter and pitot tube.	(14)
		OR	
9	a)	Explain various factors affecting choice of size reduction equipment.	(10)
	b)	Write notes on photo sedimentation and ICI sedimentation	(4)
10	a)	Explain the Differential and cumulative method of particle size analysis.	(10)

	b)	Explain drag coefficient and Stokes law.	(4)
		OR	
11		Explain: i) Air classification, ii) Screen capacity and screen efficiency and iii) Any two types of storage methods used industrially	(14)
		****	

Syllabus

Properties and nature of fluids, fluid flow characteristics, flow through pipe, transportation and metering of fluids, flow past immersed bodies, Particle technology, describing the size of a single and populations of particles, particle size analysis, particle size reduction, solid-solid and solid-liquid separations, storage and transport of solids.

Module 1: Introduction to fluid

Definition of Fluid, continuum concept of fluid; properties and nature of fluids - Density, Specific weight, Specific Volume, Capillarity and Surface Tension, Viscosity, Vapour pressure, Absolute and Gauge Pressures. (Numerical problems)

Fluid Statics - Forces on fluids and hydrostatic equilibrium, Measurement of Pressure using different types of manometers. Forces on submerged bodies - Buoyancy, Stability of floating and submerged bodies. (Numerical problems)

Introduction to fluid flow- Ideal fluid, Flow of incompressible fluids, flow visualization using the concept of streamline.Classification of flow - Steady and unsteady state flow, uniform and non-uniform flow, rotational and irrotational flow, velocity potential and stream function.

Module 2: Flow Characteristics

Laminar and Turbulent flow - Reynold's Experiment, Equations of Change for isothermal systems - Equation of Continuity, Qualitative treatment of Equation of Motion – Navier-Stoke's Equation and Euler equation (derivations not required). Rheology of fluids, Newtonian and non- Newtonian fluids.

Momentum flux and Newton's Law of Viscosity. Flow in boundary layers: concept of types of drag, boundary layer development in external and internal flow (mathematical analysis is not desired), Overview of boundary layer separation and wake formation.

Flow through pipe - Bernoulli Equation (derivation required), Correction factors in Bernoulli Equation, Pump work – Numerical problems. Outline of pressure losses (Numerical problems not desired) in straight pipes and in fittings. Schedule number of pipes, concept of equivalent diameter.

Module 3: Internal incompressible viscous flow

Introduction; flow of incompressible fluid in circular pipe; laminar flow for Newtonian fluid; Hagen-Poiseullie equation (Derivation required); Shear stress and Velocity distribution in circular channel, energy consideration in pipe flow, relation between average and maximum velocity.

Introduction to turbulent flow in a pipe-Prandtl mixing length; Universal velocity distribution, head loss; friction factor-Fanning and Darcy, Moody diagram.
Transportation and Metering of Fluids - Pumps- Reciprocating and Centrifugal pumps, Characteristics of centrifugal pumps - Priming, cavitation, NPSH, water hammer, loss of head and power in centrifugal pumps.

Flow measurement - Introduction; general equation for internal flow meters; Orifice meter; Venturimeter; Weirs, concept of area meters: rotameter; Local velocity measurement: Pitot tube. Hot wire anemometer, mass flow meter.

Module 4: Resistance of immersed bodies

Introduction; concept of drag and drag coefficient; variation of drag coefficient with Reynolds number. Motion from gravitational and Centrifugal fields - Terminal Settling velocity (Derivation of the equation using force balance is required), Stoke's law-Intermediate law - Newton's law – Hindered Settling. Flow through packed bed; Introduction, Derivation of Kozney Carman equation, Blake Plummer equation and Ergun equation, Applications of packed beds.
Fluidization: Introduction; different types of fluidization; minimum fluidization velocity; governing equation.

Module 5: Particle Technology

Particle technology – Describing the size of a single particle-Shape factor, mean diameter, Particle size analysis-methods of particle size measurement-Sieving, common methods of displaying size distribution. Description of populations of particles, electrozone sensing, laser diffraction, ICI sedimentation, Photosedimentation, Elutriation.

Particle size reduction – Introduction of comminution theory and associated laws, Mechanics of fracture, comminution mechanism, particle size distribution, types of size reduction equipment, factors affecting choice of equipment. Particle size enlargement – flocculation & granulation.

Text Books

1. McCabe, W.L., J.C. Smith and P.Harriot Unit Operations of Chemical Engineering, 6th Edition, Mc Graw Hill, 2001.
2. Coulson J. M and J. F Richardson, *Chemical Engineering: Particle technology and Separation processes (Vol - II),* 5/e*,* Butterworth-Heinemann, 1999.

Reference Books

1. Geankoplis, C.J. Transport Processes and Separation Process Principles, 5th Edition, Pearson, 2015.
2. Younus A. Cengel and John M. Cimbala, Fluid Mechanics: Fundamentals and Applications, Third Edition, Mc Graw Hill Education.
3. Enrique Ortega-Revas, Unit Operations of Particulate Solids: Theory and Practice, CRC Press.
4. Martin J. Rhodes, Introduction to Particle Technology, 2/e, John Wiley & Sons, 2008.
5. Coulson J. M and J. F Richardson, Chemical Engineering: Fluid flow, Heat transfer and Mass transfer (Vol - I), 5/e, Butterworth-Heinemann, 1999.
6. Perry R. H. and D.W. Green, Eds., Perry's Chemical Engineer's Handbook, 7/e, McGraw Hill, 1997.
7. Narayanan C.M. & Bhattacharya B.C. Mechanical Operations For Chemical Engineers: Incorporating Computer Aided Analysis, Khanna Publishers.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Fluid**	
1.1	Definition of Fluid, continuum concept of fluid; properties and nature of fluids - Density, Specific weight, Specific Volume, Capillarity and Surface Tension, Viscosity, Vapour pressure, Absolute and Gauge Pressures. (Numerical problems)	3
1.2	Fluid Statics - Forces on fluids and hydrostatic equilibrium, Measurement of Pressure using different types of manometers. Forces on submerged	3

	bodies - Buoyancy, Stability of floating and submerged bodies. (Numerical problems)	
1.3	Introduction to fluid flow- Ideal fluid, Flow of incompressible fluids, flow visualization using the concept of streamline. Classification of flow - Steady and unsteady state flow, uniform and non-uniform flow, rotational and irrotational flow, velocity potential and stream function.	4
2	**Flow Characteristics**	
2.1	Laminar and Turbulent flow - Reynold's Experiment, Equations of Change for isothermal systems - Equation of Continuity, Qualitative treatment of Equation of Motion – Navier-Stoke's Equation and Euler equation (derivations not required). Rheology of fluids, Newtonian and non-Newtonian fluids.	3
2.2	Momentum flux and Newton's Law of Viscosity, Flow in boundary layers: concept of types of drag, boundary layer development in external and internal flow (mathematical analysis is not desired) - Overview of boundary layer separation and wake formation	3
2.3	Flow through pipe - Bernoulli Equation (derivation required), Correction factors in Bernoulli Equation, Pump work – Numerical problems. Outline of pressure losses (Numerical problems not desired) in straight pipes and in fittings,Schedule number of pipes, concept of equivalent diameter.	4
3	**Internal Incompressible viscous flow**	
3.1	Introduction; flow of incompressible fluid in circular pipe; laminar flow for Newtonian fluid; Hagen-Poiseullie equation (Derivation required); Shear stress and Velocity distribution in circular channel,energy consideration in pipe flow, relation between average and maximum velocity.	3
3.2	Introduction to turbulent flow in a pipe-Prandtl mixing length; Universal velocity distribution,head loss; friction factor-Fanning and Darcy, Moody diagram. Transportation and Metering of Fluids - Pumps- Reciprocating and Centrifugal pumps, Characteristics of centrifugal pumps - Priming, cavitation, NPSH, water hammer, loss of head and power in centrifugal pumps.	5
3.3	Flow measurement - Introduction; general equation for internal flow meters; Orifice meter; Venturimeter; Weirs, concept of area meters: rotameter; Local velocity measurement: Pitot tube. Hot wire anemometer, mass flow meter.	2
4	**Resistance of Immersed bodies**	

4.1	Introduction; concept of drag and drag coefficient; variation of drag coefficient with Reynolds number.	2
4.2	Motion from gravitational and Centrifugal fields - Terminal Settling velocity (Derivation of the equation using force balance is required), Stoke's law- Intermediate law - Newton's law – Hindered Settling.	3
4.3	Flow through packed bed; Introduction, Derivation of Kozney Carman equation, Blake Plummer equation and Ergun equation, Applications of packed beds. **Fluidization:** Introduction; different types of fluidization; minimum fluidization velocity; governing equation.	3
5	**Particle Technology**	
5.1	Particle technology – Describing the size of a single particle-Shape factor, mean diameter, Particle size analysis-methods of particle size measurement-Sieving, common methods of displaying size distribution. Description of populations of particles, electrozone sensing, laser diffraction, ICI sedimentation, Photosedimentation, Elutriation.	4
5.2	Particle size reduction – Introduction of comminution theory and associated laws, Mechanics of fracture, comminution mechanism, particle size distribution, types of size reduction equipment, factors affecting choice of equipment. Particle size enlargement – flocculation & granulation	3

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
BTL201	MICROBIOLOGY LAB	PCC	0	0	3	2

Preamble: Handle microorganisms and also to identify and characterise microorganisms

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Demonstrate proper usage, identify the parts/functions of a bright field microscope and visually recognize the microscopic characteristics of bacteria
CO 2	Apply appropriate laboratory techniques and methodology for isolation, characterization, propagation and enumeration of microorganisms in a given sample
CO 3	Demonstrate an understanding and appreciation of the impact of microorganisms on agriculture, environment, ecosystem, energy, and human health
CO 4	Apply appropriate microbiology laboratory techniques, methodologies, instruments and equipment in accordance with current laboratory safety protocol

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	-	-	2	2	-	1	1	-	3	2	-	-
CO 2	-	-	2	2	-	2	2	-	3	2	-	-
CO 3	-	-	2	2	-	3	3	-	3	2	-	-
CO 4	-	-	-	-	-	1	1	-	3	2	-	-

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	75	75	2.5 hours

Continuous Internal Evaluation Pattern:

Attendance : 15 marks

Continuous Assessment : 30 marks

Internal Test (Immediately before the second series test) : 30 marks

End Semester Examination Pattern: The following guidelines should be followed regarding award of marks

(a) Preliminary work : 15 Marks

(b) Implementing the work/Conducting the experiment : 10 Marks

(c) Performance, result and inference (usage of equipments and troubleshooting) : 25 Marks

(d) Viva voice : 20 marks

(e) Record : 5 Marks

General instructions: Practical examination to be conducted immediately after the second series test covering the entire syllabus given below. Evaluation is a serious process that is to be conducted under the equal responsibility of both the internal and external examiners. The number of candidates evaluated per day should not exceed 20. Students shall be allowed for the University examination only on submitting the duly certified record. The external examiner shall endorse the record.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. State the functionality of a Bright field microscope with reference to examination of microscopic characteristics.

2. List the steps involved in preparation of PDA media.

3. Demonstrate the preparation of EMB agar

Course Outcome 2 (CO2)

1. Enumerate the microbial cells through a Haemocytometer

2. Detail the procedure for isolation and characterize bacteria from leaf tissues

3. Demonstrate the isolation of bacteria from water

Course Outcome 3(CO3):

1. Demonstrate IMViC reactions. Signify the method giving reasons

2. Detail the principle and procedure for microbiological examination of water

3. Perform the methodology for long term storage of microorganisms

Course Outcome 4 (CO4):

1. Demonstrate the method for testing microbial capacity to produce biologically active substance

2. Monitor cell growth through wet weight and record the observations to evaluate the growth

3. List out the steps involved in obtaining a plant protoplast

Syllabus

1. Introduction to principles of sterilization techniques.
2. Principles of microscopy, phase contrast and fluorescent microscopy
3. Preparation of media and media components.
4. Media preparation: General purpose; differential and selective media
5. Selection and isolation of bacteria from natural sources
6. Staining: Gram, Giemsa , Trypan blue, endospore
7. Haemocytometer
8. Measurement of growth - Wet weight and dry weight measurements, extinction method of monitoring cell growth.
9. Isolation and characterization of bacteria from leaf tissues, leaf rot etc.
10. Taxonomic classification of isolated microbes
11. Long and short term storage of microbes (bacteria and fungi)

12. Testing of microbial capacity to produce biologically active substances
13. Isolation of fungal and plant protoplasts
14. Microbiological examination of water.
15. Biochemical tests: IMVIC test, Catalase test, Gelatinase test, Oxidase test and other related tests.

Any 12 experiments are compulsory

Text Books

1.Alfred Brown, *Benson's Microbiological Applications: Laboratory Manual in General Microbiology,* McGraw Hill Publications, 2004.
2.Gunasekharan P, *Laboratory manual in Microbiology*, New Age International Publishers, 2007.

Reference Books

1. Cappuccino J. G. and N. Sherman, A*Laboratory Manual*, 4/e, Addison and Wesley, 1999.

2. Molecular Microbiology: Diagnostic Principles and Practice by Persing DH, Tenover FC, Versalovic J, Tang Y, Unger ER, Relman DA, White TJ eds. American Society for Microbiology Press, 2004.

6. Infectious Disease Epidemiology: Theory and Practice by Nelson KE, Williams CM, Graham NMH eds. An Aspen Publication. 2001.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	Introduction to principles of sterilization techniques.	3
2	Principles of microscopy, phase contrast and fluorescent microscopy	3
3	Preparation of media and media components.	3
4	Media preparation: General purpose; differential and selective media	3
5	Selection and isolation of bacteria from natural sources	3
6	Staining: Gram, Giemsa , Trypan blue, endospore	3
7	Haemocytometer	3
8	Measurement of growth - Wet weight and dry weight measurements, extinction method of monitoring cell growth.	3
9	Isolation and characterization of bacteria from leaf tissues, leaf rot etc.	3
10	Taxonomic classification of isolated microbes	3

11	Long and short term storage of microbes (bacteria and fungi)	3
12	Testing of microbial capacity to produce biologically active substances	3
13	Isolation of fungal and plant protoplasts	3
14	Microbiological examination of water.	3
15	Biochemical tests:IMVIC test, Catalase test, Gelatinase test, Oxidase test and other related tests.	3

BTL203	FLUID FLOW AND PARTICLE TECHNOLOGY LAB	CATEGORY	L	T	P	CREDIT
		PCC	0	0	3	2

Preamble: Enhance practical skills with momentum transfer mechanisms in industrial bio processing.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Determine fluid properties, particle size, characterize flows, measure pressure, calibrate flow measuring equipment, and analyze frictional flows by performing experiments in the laboratory.
CO 2	Design experiments and analyze/interpret data collected from experimental investigation in fluid statics and kinematics.
CO 3	Use modern computing tools necessary for analysis of the experimental data in fluid statics and kinematics
CO 4	Exhibit ethical principles in the engineering profession by practicing ethical approaches in experimental investigation, collection and reporting of data and adhering to the relevant safety practices in the laboratory.

Mapping of course outcomes with program outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	3	2	-	-	2	2	2	-	-
CO2	3	3	-	3	-	-	-	-	-	-	-	-
CO3	3	3	-	3	2	-	-	-	-	-	-	-
CO4	3	3	-	3	-	-	-	2	-	-	-	-

Assessment Pattern

Mark distribution

Total Marks	CIE	ESE	ESE Duration

150	75	75	2.5 hours

Continuous Internal Evaluation Pattern:

Attendance : 15 marks

Continuous Assessment : 30 marks

Internal Test (Immediately before the second series test) : 30 marks

End Semester Examination Pattern: The following guidelines should be followed regarding award of marks

(a) Preliminary work : 15 Marks

(b) Implementing the work/Conducting the experiment : 10 Marks

(c) Performance, result and inference (usage of equipments and troubleshooting) : 25 Marks

(d) Viva voice : 20 marks

(e) Record : 5 Marks

General instructions: Practical examination to be conducted immediately after the second series test covering entire syllabus given below. Evaluation is a serious process that is to be conducted under the equal responsibility of both the internal and external examiners. The number of candidates evaluated per day should not exceed 20. Students shall be allowed for the University examination only on submitting the duly certified record. The external examiner shall endorse the record.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1.Study of measurement of pressure
2. Use of viscometers for measurement of viscosity of process fluids.
3. Study on factors influencing viscosity of process fluids

Course Outcome 2 (CO2)

1.Reynold's Experiment

2.Determination of venturi coefficient/ orifice coefficient.
3.Calibration of Rotameter for liquid flows.

Course Outcome 3(CO3):

1.Determination of velocity profile using Pitot tube.
2.Determination of energy losses in pipes and fittings
3.Estimation of pressure drop for flow through packed bed.

Course Outcome 4 (CO4):

1.Estimation of pressure drop for flow through fluidized bed.
2.Determination of drag coefficient and verification of Stoke's law.
3.Particle size analysis by Sieve analysis.

Model Question paper (Total marks-30)

Syllabus

1. Study of measurement of pressure
2. Use of viscometers for measurement of viscosity of process fluids.
3. Study on factors influencing viscosity of process fluids
4. Reynold's Experiment
5. Determination of venturi coefficient/ orifice coefficient.
6. Calibration of Rotameter for liquid flows.
7. Determination of velocity profile using Pitot tube.
8. Determination of energy losses in pipes and fittings
9. Estimation of pressure drop for flow through packed bed.
10. Estimation of pressure drop for flow through fluidized bed.
11. Determination of drag coefficient and verification of Stoke's law.
12. Particle size analysis by Sieve analysis.
13. Sub sieve particle size analysis using Beaker decantation.
14. Sub sieve particle size analysis using Pipette Analysis.
15. Studies on flocculation- Analysis of orthokinetic and perikinetic aggregation.

Text Books

1. McCabe W. L., J. C. Smith and P. Harriott, *Unit Operations of Chemical Engineering*, 6/e, McGraw Hill, 2000.
2. Coulson J. M and J. F Richardson, *Chemical Engineering: Particle technology and Separation processes (Vol - II),* 5/e*,* Butterworth-Heinemann, 1999.

Reference Books

1. Martin J. Rhodes, *Introduction to Particle Technology*, 2/e, John Wiley & Sons, 2008.

2. Coulson J. M and J. F Richardson, *Chemical Engineering: Fluid flow, Heat transfer and Mass transfer (Vol - I)*, 5/e, Butterworth-Heinemann, 1999.

3. Perry R. H. and D.W. Green, Eds., *Perry's Chemical Engineer's Handbook*, 7/e, McGraw Hill, 1997.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	Study of measurement of pressure	3
2	Use of viscometers for measurement of viscosity of process fluids.	3
3	Study on factors influencing viscosity of process fluids	3
4	Reynold's Experiment	3
5	Determination of venturi coefficient/ orifice coefficient.	3
6	Calibration of Rotameter for liquid flows.	3
7	Determination of velocity profile using Pitot tube.	3
8	Determination of energy losses in pipes and fittings	3
9	Estimation of pressure drop for flow through packed bed.	3
10	Estimation of pressure drop for flow through fluidized bed.	3
11	Determination of drag coefficient and verification of Stoke's law.	3
12	Particle size analysis by Sieve analysis.	3
13	Sub sieve particle size analysis using Beaker decantation.	3
14	Sub sieve particle size analysis using Pipette Analysis.	3
15	Studies on flocculation- Analysis of orthokinetic and perikinetic aggregation.	3

SEMESTER -3

MINOR

BTT281	UPSTREAM PROCESSING	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble: Methods to understand, identify the appropriate microorganism and its scale up process for a specific industrial purpose

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand the basics of isolation, screening and maintenance of industrially important microbes, preservation techniques and various culture collection centers available
CO 2	Practice the concepts in Media formulation and the effect of environmental conditions for cell growth and product synthesis
CO 3	Analyze the performance of sterilization of medium, sterilization methods, design of batch and continuous sterilization processes
CO 4	Development and implementation techniques for inoculums transfer and its applications
CO 5	Define and understand the different modes of fermentation process, fermenter design and monitoring of process variables

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	-	-	3	-	-	-	3	-	-	3	-	3
CO 2	-	-	3	-	-	-	3	2	-	3	-	3
CO 3	-	-	3	-	-	-	-	-	-	3	-	3
CO 4	-	-	-	-	-	-	-	-	-	3	-	3
CO 5	2	-	3	-	-	-	-	2	-	3	-	3

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10

Understand	20	20	20
Apply	20	20	70
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Understand the basics of isolation, screening and maintenance of industrially important microbes, preservation techniques and various culture collection centers available

1. Illustrate Protoplast fusion method for strain improvement.

2. Brief about the steps involved in the isolation of a pure culture.

3. Outline the objectives and need for Culture collection and Biological resource centres. Give examples

Course Outcome 2 (CO2) : Practice the concepts in Media formulation and the effect of environmental conditions for cell growth and product synthesis

1 List out the different nitrogen sources used in industrial scale fermentation process

2. Discuss the effect of environmental conditions on growth of microorganisms.

3. Write note on the characteristics of a fermentation media.

Course Outcome 3(CO3): Analyze the performance of sterilization of medium, sterilization methods**,** design of batch and continuous sterilization processes

1 Brief about the methods of sterilisation.

2. What are the factors to be considered during the insitu sterilisation of a fermenter?

3. Describe the design aspects of batch sterilisation

Course Outcome 4 (CO4): Development and implementation techniques for inoculum transfer and its applications

1. Discuss about the development of inocula for animal cell processes.

2. Explain the criteria for choosing an inoculum.

3. Outline the inoculum preparation for mycelia process.

Course Outcome 5 (CO5): Define and understand the different modes of fermentation process, fermenter design and monitoring of process variables

1. Compare solid state and submerged fermentation process

2. Explain the process of monitoring pH in a fermenter

3. Write a note on different types of impeller designs.

Model Question paper

			Total Pages:
Reg No.:_____		Name:_____	
APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY THIRD SEMESTER B. TECH DEGREE EXAMINATION _____ ____ 20__			
Course Code: BTT 281			
Course Name: UPSTREAM PROCESSING			
Max. Marks: 100			Duration: 3 Hours
PART A			
		Answer all questions, each carries 3 marks.	
1	a)	Write a note on culture collection and biological centres	
	b)	Discuss about the steps in preparing pure culture	
	c)	Mention about the raw materials and medium requirements for industrial	

		fermentation	
	d)	Explain the importance of anti foaming agents in medium formulation. Give two examples of anti foaming agents	
	e)	Sketch the diagram of batch sterilization and it's time profile	
	f)	Explain the significance of DEL factor	
	g)	Explain the various steps involved in the development of inoculums	
	h)	What are the characteristics of a good inoculums?	
	i)	What are the advantages of solid state fermentation over submerged sterilization	
	j)	List out the modes of fermentation process	
PART B			
Answer any one full question from each module. Each carries 14 marks.			
2		Explain the need for strain improvement. Brief about the strain improvement by protoplast fusion and r- DNA technology.	(14)
		OR	
3		Describe the different screening methods for the isolation of microorganisms	(14)
4		Discuss the role of each nutrient in fermentation media. Give examples	(14)
		OR	
5		Explain the effect of various environmental factors on growth and product formation	(14)
6		With a neat diagram explain the different types of continuous sterilizers.	(14)
		OR	
7		Explain the design of batch sterilizer. Write note on scale up of fermenter	(14)
8		Explain about the development of inoculums for yeast processes with neat sketches.	(14)
		OR	
9		Explain with an example development of inocula for bacterial process	(14)
10		Describe the monitoring and control of temperature and foam formation in a fermenter	(14)

		OR	
11		Briefly explain the different types of fermentation processes	(14)
		****	

Syllabus

Module 1

Isolation and strain development: Isolation, screening and maintenance of industrially important microbes. Strain improvement techniques to improve the yield- recombinant DNA technology, protoplast fusion, and mutation, preparation of pure culture at lab scale, preservation techniques, culture collection and biological resource centers.

Module 2

Media formulation: Nutritional requirement-energy source, carbon source, nitrogen source,oxygen requirement, micro nutrients, growth factors, buffers, antifoams, Formulation of media for fermentation, effect of environmental conditions for cell growth and product synthesis, optimization of growth parameters at lab scale.

Module 3

Sterilization: Sterilization of medium- Sterilization methods**,** Design of batch and continuous sterilization processes, methods for batch sterilization, scale up of batch sterilization, Sterilization of- fermenter, feed, liquid waste and filter

Module 4

Inoculum development: Criteria for the transfer of inoculum, Development of inocula for animal cell processes, Development of inocula for yeast processes, Development of inocula for unicellular bacterial processes, Development of inocula for mycelial processes, Aseptic inoculation of plant fermenters.

Module 5

Fermentation and scale up: Different modes of fermentation process- batch, continuous, fed batch, Different types of fermentation process- solid state and submerged fermentation. Fermenter design- body construction, aeration and agitation, maintenance of aseptic conditions, monitoring of process variables- temperature, pressure, pH, foaming, dissolved oxygen content.

Text Books

1. Peter F. Stanbury Allan Whitaker Stephen Hall, *Principles of Fermentation Technology*,2nd Edition, Butterworth-Heinemann 1995

2. Pauline M. Doran Bioprocess Engineering Principles Academic press - 2nd Edition 2012

3. WulfCruger and AnnelieseCrueger, Biotechnology: *A Textbook of Industrial Microbiology*, 2nd Edition, Panima Publishing Corporation, 2004.

Reference Books

1. Michael C Flickinge (Ed.), *Upstream Industrial Biotechnology*, Volumes 1 & 2, Wiley 2013
2. Brian McNeil, Linda Harvey (Eds.), *Practical Fermentation Technology*, Wiley, 2008.
3. J E Bailey, D F Ollis, *Biochemical Engineering Fundamentals*, 2/e, McGraw-Hill Chemical Engineering Series, 1986.
4. Michael L Shuler, FikretKargi, *Bioprocess Engineering Basic Concepts*, Prentice Hall, 1992.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**ISOLATION AND STRAIN IMPROVEMENT**	
1.1	Isolation, screening and maintenance of industrially important microbes.	3
1.2	Strain improvement techniques to improve the yield-recombinant DNA technology, protoplast fusion, and mutation	2
1.3	Preparation of pure culture at lab scale	1
1.4	Preservation techniques,	1
1.5	Culture collection and biological resource centers.	1
2	**MEDIA FORMULATION**	
2.1	Nutritional requirement-energy source, carbon source, nitrogen source, oxygen requirement, micro nutrients, growth factors, buffers, antifoams,	3
2.2	Formulation of media for fermentation	2
2.3	Effect of environmental conditions for cell growth and product synthesis	2
2.4	Optimization of growth parameters at lab scale.	2
3	**STERILIZATION**	
3.1	Sterilization of medium- Sterilization methods	1
3.2	Design of batch and continuous sterilization processes,	3

3.3	Methods for batch sterilization	2
3.4	Scale up of batch sterilization	2
3.5	Sterilization of- fermenter, feed, liquid waste and filter	2
4	**INOCULUM DEVELOPMENT**	
4.1	Criteria for the transfer of inoculums, Development of inocula for animal cell processes	2
4.2	Development of inocula for yeast processes	2
4.3	Development of inocula for unicellular bacterial processes	2
4.4	Development of inocula for mycelial processes	2
4.5	Aseptic inoculation of plant fermenters.	2
5	**FERMENTATION AND SCALE UP**	
5.1	Different modes of fermentation process- batch, continuous, fed batch	2
5.2	Different types of fermentation process- solid state and submerged fermentation	2
5.3	Fermenter design- body construction, aeration and agitation	2
5.4	Maintenance of aseptic conditions, monitoring of process variables- temperature, pressure, pH, foaming, dissolved oxygen content.	2

BTT283	CELL BIOLOGY AND BIOMOLECULES	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble: Have a clear knowhow of the biomolecules in maintaining life and health

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Outline the basics fundamental aspects of life
CO 2	Interpret the biomolecules and their function
CO 3	Understanding vitamins, enzymes and their function
CO 4	Fundamentals of *in vitro* culture and applications

Mapping of course outcomes with program outcomes

	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	-	-	-	2	-	-	-	2	-	2
CO 2	3	3	2	-	-	2	-	-	-	2	-	2
CO 3	3	3	3	2	-	-	-	-	-	2	-	-
CO 4	-	-	3	3	-	-	-	-	-	2	2	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	20
Apply	20	20	70
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. State the Cell theory.

2. Explain about the extracellular matrix.

3. Define the functions of mitochondria.

Course Outcome 2 (CO2)

1. Classify carbohydrates and explain their role in maintenance of cellular integrity.

2. Give a detailed note on cell cycle.

3. Demonstrate the significance of cholesterol.

Course Outcome 3(CO3):

1. Exemplify the nomenclature of enzymes

2. Give a detailed note on fat soluble vitamins.

3. Describe the basic functions of enzymes.

Course Outcome 4 (CO4):

1. Demonstrate the laboratory requirements for animal cell culture.

2. Give examples of various culture media used in animal cell culture

3. Describe the significance of stem cells

Model Question paper

			Total Pages:
Reg No.:_____		Name:_____	

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B. TECH DEGREE EXAMINATION _____ ____ 20__

Course Code: BTT 283

Course Name: CELL BIOLOGY AND BIOMOLECULES

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions, each carries 3 marks.

1	a)	Enumerate on the various transport systems present on the cell membranes.
	b)	Exemplify the role of extracellular matrix in the maintenance of structural integrity of a cell.
	c)	Enumerate the checkpointsin the cell cycle.
	d)	Recall Cell theory.
	e)	Describe the formation of peptide bonds.
	f)	List any three roles of vitamins in our body.
	g)	Elaborate the process of hydrolysis of fats.
	h)	Describe the significance of serum in animal cell culture
	i)	Describe base pairing rule.
	j)	Give the significance of mucopolysaccharides.

PART B

Answer any one full question from each module. Each carries 14 marks.

2		Elaborate on the structural levels of organization of proteins with suitable diagrams.	(14)
		OR	

3		Give a detailed note on classification and nomenclature of enzymes	(14)
4		Enumerate the types of culture media used in animal cell culture.	(14)
		OR	
5		Elaborate on the double helical model of DNA.	(14)
6		Enumerate the structure and properties of phospholipids and glycolipids	(14)
		OR	
7		Elaborate on the general structure and properties of monosaccharides	(14)
8		Elaborate the different stages of mitosis with suitable diagrams.	(14)
		OR	
9		Describe what stem cells are and give its biological importance.	(14)
10		Explain about passive and active transport system with suitable examples.	(14)
		OR	
11		Enumerate endocytosis and exocytosis with suitable examples.	(14)
****			

Syllabus

Module 1

Cell and cellular organelles

Discovery of cells.Basic properties of cells.Cell theory.Prokaryotic & Eukaryotic cells.Plasma membrane – structure and function.Passive and active transport across membranes.Endocytosis and Exocytosis.Functions of Nucleus, Endoplasmic reticulum, Golgi complex, Lysosomes, Peroxisomes, Chloroplast & Mitochondria.

Module 2

Cell cycle and Extracellular matrix

Overview of the cell cycle, Different stages of mitosis – significance of meiosis and cytokinesis. Fertilization.Components in cell cycle control - Cyclin, CDKs, Check points in cell cycle.General characteristics of cell differentiation.The extracellular matrix-collagen, elastin, fibrillin, fibronectin, laminin and proteoglycans.(Functions Only). Stem cells and its biological importance.

Module 3

Carbohydrates and Lipids

Importance of carbon and water.Introduction to biochemistry.A historical perspective. General features of biomolecules. General structure and properties of monosaccharides, oligosaccharides and polysaccharides. Significance of Homo heteropolysaccharides and Mucopolysaccharides . Blood group substances.
Lipids - classification and structure, essential fatty acids- glycerides, hydrolysis of fats, structure and properties of phospholipids and glycolipids. Significance of Cholesterol and Prostaglandins (Structure NOT needed) .

Module 4

Proteins and Vitamins

Nomenclature and properties of amino acids.General reactions of amino acids.Peptide bond.Classification of proteins, Basic understanding of primary, secondary, tertiary and quaternary structure of proteins.Denaturation and renaturation. Enzymes: Nomenclature and classification of enzymes.
Vitamins (only significance) : Fat soluble (A , D, E & K) and Water Soluble (B and C)

Module 5

Nucleic acids and Cell culture basics

Nucleic acids: structure and properties of Purine and pyrimidine bases. Nucleosides and nucleotides.Base pairing role.Structure and functions of DNA and RNA Double helical model of DNA structure.
Animal cell culture. Physical requirements for growing animal cell culture. Culture media for animal cell culture

Text Books

1. Gerald Karp ,Cell Biology
2. Fundamentals of Biochemistry by Jain & Jain
3. Textbook of Biochemistry by Vasudevan&Sreekumari
4. M.M Ranga, Animal Biotechnology, second Edition, Agrobios India

Reference Books

1. Essentials of Cell Biology by Bruce Alberts, Dennis Bray, Karen Hopkin, Alexander D.Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter
2. Lehninger's Principles of Biochemistry

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Cell and cellular organelles**	
1.1	Discovery of cells. Basic properties of cells. Cell theory. Prokaryotic & Eukaryotic cells. Plasma membrane – structure and function.	2
1.2	Passive and active transport across membranes. Endocytosis and Exocytosis.	3
1.3	Functions of Nucleus, Endoplasmic reticulum, Golgi complex	2
1.4	Functions of lysosomes, Peroxisomes, Chloroplast & Mitochondria	2
2	**Cell cycle and Extracellular matrix**	
2.1	Overview of the cell cycle, Different stages of mitosis – significance of meiosis and cytokinesis. Fertilization.	2
2.2	Components in cell cycle control - Cyclin, CDKs, Checkpoints in cell cycle. General characteristics of cell differentiation.	2
2.3	The extracellular matrix-collagen, elastin, fibrillin, fibronectin, laminin and proteoglycans. (Functions Only).	2
2.4	Stem cells and its biological importance.	2
3	**Carbohydrates and Lipids**	
3.1	Importance of carbon and water. Introduction to biochemistry. A historical perspective. General features of biomolecules.	1
3.2	General structure and properties of monosaccharides, oligosaccharides and polysaccharides. Significance of Homo heteropolysaccharides and Mucopolysaccharides . Blood group substances.	5
3.3	Lipids - classification and structure, essential fatty acids- glycerides, hydrolysis of fats	2
3.4	Structure and properties of phospholipids and glycolipids.	2
3.5	Significance of Cholesterol and Prostaglandins (Structure NOT needed).	1
4	**Proteins and Vitamins**	
4.1	Nomenclature and properties of amino acids. General reactions of amino acids. Peptide bond. Classification of proteins,	2
4.2	Basic understanding of primary, secondary, tertiary and quaternary structure of proteins. Denaturation and renaturation.	2
4.3	Enzymes: Nomenclature and classification of enzymes.	2

4.4	Vitamins (only significance) : Fat soluble (A , D, E & K) and Water Soluble (B and C)	2
5	**Nucleic acids and cell culture basics**	
5.1	Nucleic acids: structure and properties of Purine and pyrimidine bases.	2
5.2	Nucleosides and nucleotides. Base pairing role.	2
5.3	Structure and functions of DNA and RNA Double helical model of DNA structure.	2
5.4	Animal cell culture. Physical requirements for growing animal cell culture. Culture media for animal cell culture	3

BTT285	HEALTH, SAFETY AND ENVIRONMENT	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble: Acquire basic knowledge and relevant information regarding environment for human health and safety

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO 1	Explain the principles and practices in environmental protection
CO 2	Outline the key aspects of environmental impact assessment and economic analysis.
CO 3	Outline the rules and legislations for environment protection and social security.
CO 4	Explain the key attributes of energy efficient infrastructure.
CO 5	Highlight the major concerns in global climate change and its impact on the environment.

Mapping of course outcomes with program outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	3	3	-	-	-	-	-
CO3	3	-	-	-	-	-	-	2	-	-	-	-
CO4	3	-	-	-	-	2	3	-	-	-	-	-
CO5	3	-	-	-	-	-	-	-	-	-	-	2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	20
Apply	20	20	70
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

- **Course Outcome 1 (CO1): Principles and practices in environmental protection**

1. Explain the relationship between society and environment.
2. Illustrate the ecosystem and factors causing the imbalance.
3. Demonstrate the principles and practices in prevention and control of pollution.

- **Course Outcome 2 (CO2) :Environmental Impact Assessment**

1. Summarize the principles, production and assessment of impacts due to air pollution on the environment.
2. Elucidate the potentially applicable techniques of valuing environmental impacts.
3. Mention any two case studies on the limits of economical measurement of environmental impacts.

- **Course Outcome 3(CO3):Social Security Legislation, Miscellaneous acts and rules**
  1. Explain on the safety, health and welfare under legislative of India.
  2. Summarize on social security legislation.
  3. Specify on the prevention and control of pollution act 1981 and 1982, Environment protection act 1986.

- **Course Outcome 4 (CO4): Energy efficient infrastructure**

1. Summarize on energy efficient buildings.
2. Mention the energy management in buildings and energy audit of buildings.
3. Specify the energy conservation, reduce and recycle.

- **Course Outcome 5 (CO5): Major concerns in climate change and impacts**

1. Summarize on global climate changes.
2. Elucidate the Earth's carbon reservoirs.
3. Explain the global ocean circulation.

Model Question paper

			Total Pages:
Reg No.:_____			Name:_____ _
APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY THIRD SEMESTER B. TECH DEGREE EXAMINATION _____ ____ 20__			
Course Code: BTT 285			
Course Name: HEALTH, SAFETY AND ENVIRONMENT			
Max. Marks: 100			Duration: 3 Hours
PART A			
		Answer all questions, each carries 3 marks.	
1	a)	Define the relation between society and environment.	
	b)	Specify the factors causing the imbalance in the ecosystem.	
	c)	Point out the pollutants including liquid, gaseous, solid and hazardous waste.	
	d)	Explain the Environmental Impact Assessment.	
	e)	List out any five potentially applicable techniques of valuing environmental impacts.	
	f)	Explain the workmen's compensation act.	
	g)	Specify Environment Protection Act 1986.	
	h)	Define Earth's natural greenhouse effect.	
	i)	Explain the global ocean circulation.	
	j)	Specify the examples of Earth's carbon reservoirs.	

PART B			
Answer any one full question from each module. Each carries 14 marks.			
2		Summarize on principles and practices in prevention and control of pollution.	(14)
		OR	
3		Summarize on hazardous waste management.	(14)
4		Explain the principles, production and assessment of impacts due to air and water pollution on the environment.	(14)
		OR	
5	a)	Explain the economic measurement of environmental impacts.	(8)
	b)	Elucidate a case study on the economic measurement of environmental impacts.	(6)
6		Summarize on the safety, health and welfare under legislative of India	(14)
		OR	
7	a)	Explain on the general provision of gas cylinders rules.	(6)
	b)	Explain the Explosives Act 1884 and rules.	(8)
8		Elucidate the energy conservation, reuse and recycle with examples.	(14)
		OR	
9		Summarize on energy efficient buildings	(14)
10		Explain the global climate changes.	(14)
		OR	
11		Demonstrate the Earth's carbon reservoirs.	(14)
****			

Syllabus

Module 1: Ecosystem, Pollution and Environment Protection

ECOSYSTEM: Introduction to environment. Relationship between society and environment, ecosystem and factors causing imbalance.

POLLUTION: Pollution and pollutants including liquid, gaseous, solid and hazardous waste.

ENVIRONMENT PROTECTION: Right attitude towards environment, Maintenance of in-house environment.Safety and protection of existing environment, Principles & practices in prevention & control of pollution, water pollution, Introduction to hazardous waste management.

Module 2: Environmental Impact Assessment

ENVIRONMENTAL IMPACT ASSESSMENT: Principles, production and assessment of impacts due to air and water pollution on the environment. Environment impact assessment in the land and biological environment, methodologies for environmental impact assessment – Case studies.

Assessing impacts and setting priorities – Economic measurement of environmental impacts – Theoretical basis and practical applications. Selectively applicable techniques of valuing environmental impacts – Potentially applicable techniques of valuing environmental impacts.Maximum credible accident - Rapid environmental impact assessment - The limits of economic measurement of environmental impacts – Case studies.

Module 3: Legislation and rules

BASIC PROVISIONS: Idea of basic provision legislation of India. Safety, health and welfare under legislation of India.

SOCIAL SECURITY LEGISLATION: Social security legislation, Introduction to workmen's compensation act, contract labour regulation act.

MISCELLANEOUS ACTS & RULES: Explosives act 1884 and rules. General provision of gas cylinders rules, The building and other construction worker's welfare cess act & rules 1996. Environment protection legislation: Introduction to prevention and control of pollution act 1981 and 1982, Environment protection act 1986.

Module 4: Energy Conservation

ENERGY CONSERVATION: Conservation of energy, reuse and recycle.

ENERGY EFFICIENT BUILDINGS: Architecture- Building science and its significance. Indoor environment.Components of indoor environments.Quality of indoor environment.Human comfort-thermal, visual, acoustical and olfactory comfort.Concept of sol-air temperature and its significance.ventilation and its significance. Cooling and heating concepts, passive

concepts appropriate for the various climatic zones in India. Classification of building materials based on energy intensity.

Energy Management of buildings and energy audit of buildings - Energy management matrix monitoring and targeting.Energy efficient landscape design -Modification of microclimate through landscape elements for energy conservation.

Module 5: Global Climate Change

GLOBAL CLIMATE CHANGE:

Climate in the spotlight- Earth's natural greenhouse effect -General Overview- radiative balance- Importance of Water

Greenhouse gases :Role of carbon dioxide and methane- Major uncertainties, CO_2 emissions-Human emissions of CO_2 -Different concerns of rich and poor countries.

The Earth's carbon reservoirs –Biogeochemistry, carbon cycling: Some Examples - Physical carbon pump, Biological Carbon Pump- marine carbon cycle, terrestrial Carbon cycle.

Climate and Weather: The Earth's climate machine- Global wind systems. Clouds, storms and climate - Cloud formation and climate, Hurricanes and global warming.

Global ocean circulation -Introduction and overview.

El Niño and the southern oscillation -El Niño and its effects,-upwelling and climate.

Introduction to climate change-Advances in computer modelling -Physics versus fudge factors.

Text Books

1. Barthwal, R. R., Environmental Impact Assessment, New Age International publishers (P) Ltd., 2002
2. C.S. Holling, Adaptive environmental assessment and Management, John Wiley and Sons, 2000
3. S.A. Abbasi and N. Abbasi, Renewable Energy Sources and Their Environmental Impact, Prentice Hall of India, N. Delhi 2006
4. Sodha M.,Bansal, N.K., Bansal,P.K., Kumar, A. and Malik, M.A.S., Solar Passive Buildings, Pergamon Press, 1986

Reference Books

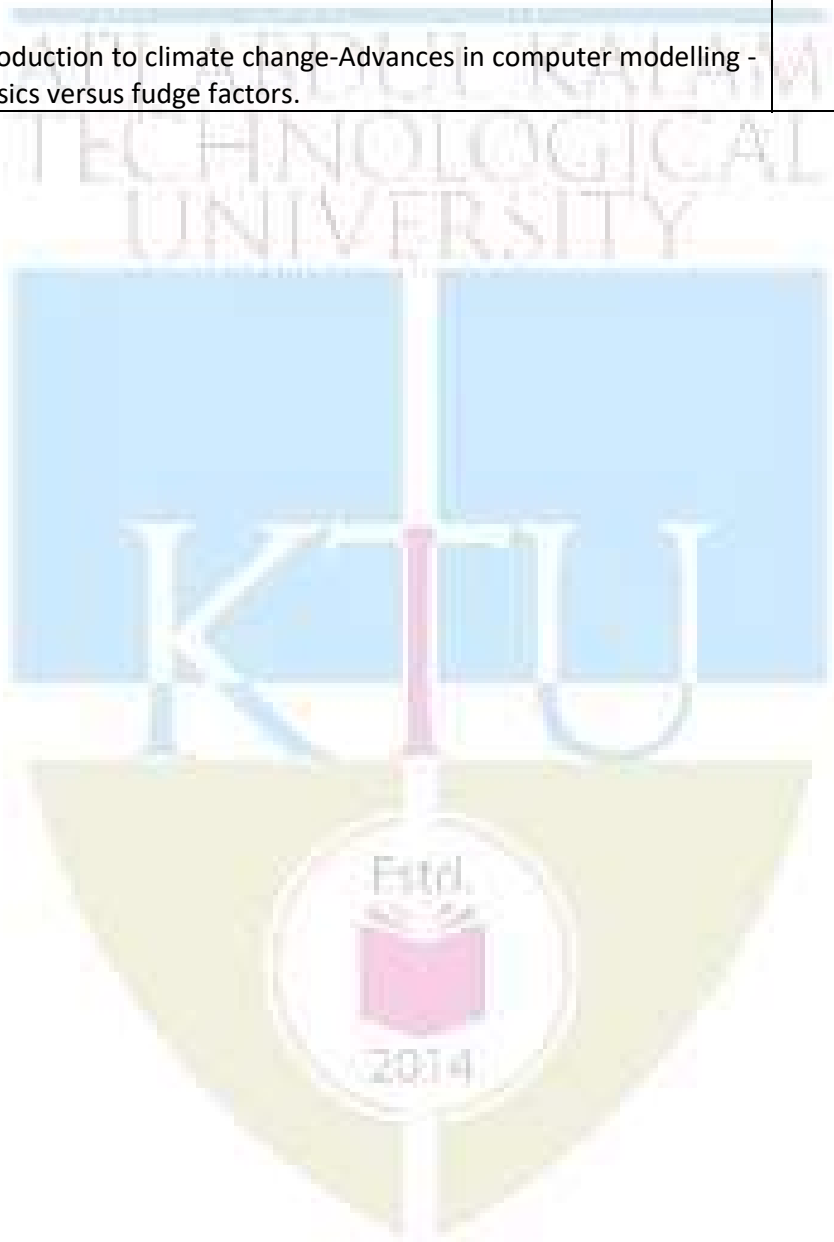
1. Koenigsberger, O.H., Ingersoll, T.G., Mayhew Alan and Szokolay, S. V., "Manual of Tropical Housing and Building part 1: Climatic Design", OLBN 0 00212 0011,Orient Longman Limited, 1973.
2. Bureau of Indian Standards, I.S. 11907 –1986 Recommendations for calculation of Solar Radiation Buildings, 1986.
3. Givoni,B., "Man, Climate and Architecture", Elsevier, Amsterdam, 1986.
4. Smith, R. J., Phillips, G.M. and Sweeney, M. "Environmental Science", Longman Scientific and Technical, Essex, 1982.
5. Trevor. M. Letcher, Climate Change: Observed impacts on planet Earth, Elsevier, 2016.

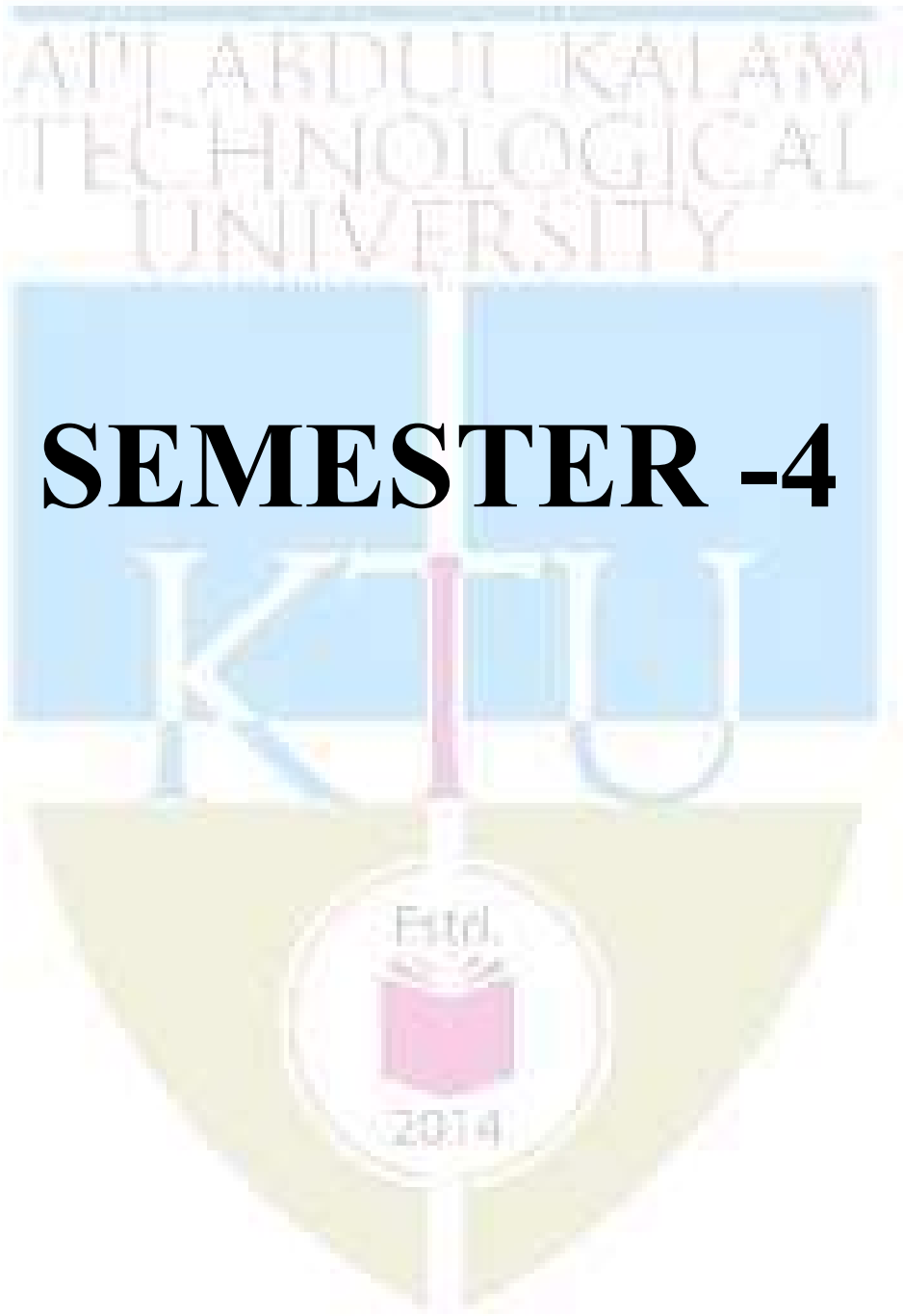
Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Ecosystem, Pollution and Environment Protection (8 hrs)**	
1.1	**ECOSYSTEM**: Introduction to environment. Relationship between society and environment, ecosystem and factors causing imbalance.	3
1.2	**POLLUTION**: Pollution and pollutants including liquid, gaseous, solid and hazardous wastes	2
1.3	**ENVIRONMENT PROTECTION**: Right attitude towards environment, Maintenance of in-house environment.Safety and protection of existing environment, Principles & practices in prevention & control of pollution, water pollution, Introduction to hazardous waste management.	3
2	**Environmental Impact Assessment (10 hrs)**	
2.1	**ENVIRONMENTAL IMPACT ASSESSMENT**: Principles, production and assessment of impacts due to air and water pollution on the environment.	2
2.2	Environment impact assessment in the land and biological environment, methodologies for environmental impact assessment – Case studies	2
2.3	Assessing impacts and setting priorities – Economic measurement of environmental impacts – Theoretical basis and practical applications. Selectively applicable techniques of valuing environmental impacts – Potentially applicable techniques of	4

	valuing environmental impacts.	
2.4	Maximum credible accident - Rapid environmental impact assessment - The limits of economic measurement of environmental impacts – Case studies	2
3	**Legislation and Rules (6 hrs)**	
3.1	**BASIC PROVISIONS**: Idea of basic provision legislation of India. Safety, health and welfare under legislation of India.	2
3.2	**SOCIAL SECURITY LEGISLATION**: Social security legislation, Introduction to workmen's compensation act, contract labour regulation act.	2
3.3	**MISCELLANEOUS ACTS & RULES:** Explosives act 1884 and rules. General provision of gas cylinders rules, The building and other construction worker's welfare cess act & rules 1996. Environment protection legislation: Introduction to prevention and control of pollution act 1981 and 1982, Environment protection act 1986.	2
4	**Energy Conservation (10 Hrs)**	
4.1	**ENERGY CONSERVATION**: Conservation of energy, reuse and recycle.	3
4.2	**ENERGY EFFICIENT BUILDINGS**: Architecture- Building science and its significance. Indoor environment. Components of indoor environments. Quality of indoor environment. Human comfort-thermal, visual, acoustical and olfactory comfort. Concept of sol-air temperature and its significance. ventilation and its significance. Cooling and heating concepts, passive concepts appropriate for the various climatic zones in India. Classification of building materials based on energy intensity.	4
4.3	Energy Management of buildings and energy audit of buildings - Energy management matrix monitoring and targeting. Energy efficient landscape design -Modification of microclimate through landscape elements for energy conservation.	4
5	**Global Climate Change (10 hrs)**	
5.1	Climate in the spotlight- Earth's natural greenhouse effect - General Overview- radiative balance- Importance of Water Greenhouse gases :Role of carbon dioxide and methane- Major uncertainties, CO_2 emissions-Human emissions of CO_2 -Different concerns of rich and poor countries.	4
5.2	The Earth's carbon reservoirs –Biogeochemistry, carbon cycling: Some Examples - Physical carbon pump, Biological Carbon Pump-marine carbon cycle, terrestrial Carbon cycle.	3

	Climate and Weather: The Earth's climate machine- Global wind systems. Clouds, storms and climate - Cloud formation and climate, Hurricanes and global warming.	
5.3	Global ocean circulation -Introduction and overview. El Niño and the southern oscillation -El Niño and its effects,- upwelling and climate. Introduction to climate change-Advances in computer modelling - Physics versus fudge factors.	3





SEMESTER -4

BTT202	CHEMICAL AND BIOLOGICAL REACTION ENGINEERING	CATEGORY	L	T	P	CREDIT
		PCC	3	1	0	4

Preamble: Study in detail the Chemical basis of Biological reactions

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO 1	Estimate the kinetics for chemical and biological reactions
CO 2	Analyze the performance of Batch and Continuous reactors and recommend modifications for improvement
CO 3	Predict the conversion for ideal and non-ideal reactors
CO 4	Explain the nature of catalytic reactions with regard to the multiple steps of mass transfer and surface reaction and the concept of rate limiting step

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	2	3	-	2	2	1	-	-	-	-	-
CO2	3	2	2	1	-	3	3	-	-	-	-	-
CO3	3	2	2	2	-	2	2	-	-	-	-	-
CO4	3	2	1	1	-	3	3	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	20
Apply	20	20	70
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

- **Course Outcome 1 (CO1):** Estimate the kinetics for chemical and biological reactions

1. On doubling the concentration of a reactant, the reaction rate triples, Find the reaction order

2. The activation energy of a non-catalysed reaction at 37^0C is 83.68 KJ/mol and the activation energy of the same reaction catalysed by an enzyme is 25.10 KJ/mol. Compare the speed of reactions

3. The first order reversible liquid reaction A R, CAo = 0.5 mol/litre , CR_0 = 0 takes place in a batch reactor. After 8 minutes, conversion of A is 33.3 % while equilibrium conversion is 66 %. Find the rate equation for this reaction

- **Course Outcome 2 (CO2) :**Analyze the performance of Batch and Continuous reactors and recommend modifications for improvement

1. Recommend a reactor which is better for handling fast reactions. Also write the features and the applications of the same reactor

2. Develop the design equation for constant and varying volume Ideal Batch Reactors

3. A first order gas phase reaction is carried out in a PFR of volume V. In 10 min, conversion is 1/3. What should be the volume of the reactor if conversion required in 10 min is 2/3?

- **Course Outcome 3(CO3):** Predict the conversion for ideal and non-ideal reactors

1. Distinguish between ideal and non-ideal reactors?

2. How conversion depends upon temperature in the case of non- isothermal reactors?

3. Find out the conversion for a first order reaction for micro and macro fluids if the reaction is carried out in a PFR

- **Course Outcome 4 (CO4):** Explain the nature of catalytic reactions with regard to the multiple steps of mass transfer and surface reaction and the concept of rate limiting step

1. Write the role of catalyst in heterogeneous reactions

2. Develop an equation for effectiveness factor for a first order reaction for the diffusion of catalyst through a single cylindrical pore

3. Develop the rate equations for adsorption and chemical reaction in the case of heterogeneous catalytic reactions

Model Question paper

			Total Pages:
Reg No.:_____		Name:_____	
APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY THIRD SEMESTER B. TECH DEGREE EXAMINATION _____ ____ 20__			
Course Code: BTT 202			
Course Name: CHEMICAL AND BIOLOGICAL REACTION ENGINEERING			
Max. Marks: 100			Duration: 3 Hours
PART A			
		Answer all questions, each carries 3 marks.	
1	a)	Define 'rate of a reaction'. Which are the variables affecting the rate of a reaction?	
	b)	Differentiate elementary and non-elementary reactions	
	c)	What is an ideal reactor? Give examples	
	d)	What is meant by 'Space time'? Write the difference between space time and space velocity?	
	e)	How is E curve related to F curve	
	f)	What is meant by 'Optimum temperature progression'	
	g)	Explain the best model for enzyme kinetics	
	h)	What are biological reactors?	
	i)	What is the role of inhibitors in catalytic processes?	

	j)	Write the characteristics of catalysts	

PART B

Answer any one full question from each module. Each carries 14 marks.

2		What is meant by activation energy?. Milk is pasteurized if it is heated to 63°C for 30 min, but if it is heated to 74°C it only needs 15 s for the same result. Find the activation energy of this sterilization process.	(14)
		OR	
3		Develop the integral rate expression for a second order reaction A+B+D Products	(14)
4		Prove that, for all positive reaction orders and particular conversion, MFR requires more volume than a PFR	(14)
		OR	
5		At present the elementary liquid-phase reaction A + B R + S takes place in a plug flow reactor using equimolar quantities of A and B. Conversion is 96%, C_{A0}= C_{B0}= 1 mol/lit. If a mixed flow reactor ten times as large as the plug flow reactor were hooked up in series with the existing unit, which unit should come first and by what fraction could production be increased for that setup?	(14)
6		What is the role of RTD, State of aggregations and Earliness/Lateness of mixing in determining reactor behaviour	(14)
		OR	
7	a)	Based on a tracer test performed on a reaction vessel, responses of impulse test conducted on the reaction vessel are reported below. Calculate the mean residence time and variance:	(14)

Time (Θ)	1	2	3	4	5	6	7	8	9	10	11	12
Tracer concentration C g/l	1.3	4	5	4.5	3.5	2.5	1.7	1.1	0.5	0.2	0	0

8		Illustrate the kinetics of cell growth	(14)

		OR	
9		Explain Monod-chemostat model	(14)
10		Develop an equation for effectiveness factor for the diffusion of reactants through a single cylindrical pore by a first order reaction	(14)
		OR	
11	a)	With the help of a neat diagram, explain the constructional details and the working of any 2 three phase catalytic reactors	(14)
		****	

Syllabus

Module 1: An overview of chemical & biological reaction engineering

Definition of reaction rate.Basic concepts of chemical kinetics.Classification of chemical reactions.Temperature & concentration dependency of reaction rate.Searching for mechanism- General considerations, hydrogen bromide reaction. Analysis of rate equations Interpretation of batch reactor data: integral and differential method of rate analysis.
Numerical examples.Numerical Problems for evaluation of activation energy and rate equation.

Module 2: Introduction to reactor design

Classification of reactors.Concept of Ideal reactors. Design equations for batch, mixed flow and plug flow reactors. Multiple reactor systems, Plug flow reactor in series and parallel, equal sized mixed reactors in series, mixed flow reactors of different sizes in series, determination of the best system for a given conversion. Numerical problems for evaluation of reactor volume, conversion, their comparison using ideal single and combination of ideal reactors for single/ multiple reactions

Module 3: Non isothermal reactor design

Heat effects in reactors- General graphical design procedure-Energy balance for batch, mixed flow and plug flow reactor. Optimum temperature progression (Qualitative treatment would be sufficient).
Basics of non-ideal flow-Residence time distribution. Measurement of the RTD-Pulse and step input -C, E, F curves-RTD in ideal reactors. Single parameter models of RTD- Tanks in Series and Analysis of Dispersion model (Derivation is not required). Reactor design using RTD data. (Quantitative treatment by solving Numerical problems on moments of RTD)

Module 4: Kinetics of cell growth and enzymes

Cell growth kinetics; substrate uptake and product formation in microbial growth; enzyme kinetics, Michaelis-Menten rate form- Biological reactors – chemostats-Theory of the chemostat. (A preliminary treatment would be sufficient as the topics would be covered in detail in the higher semesters in Enzyme Engineering and Bioprocess Engineering). Monod-

chemostat model. (A quantitative treatment for finding out the critical dilution rate, substrate and biomass concentration)

Module 5: Heterogeneous catalytic processes

Classification of catalysts, promoters, inhibitors, catalyst poisons-Rate equations for fluid-solid catalytic-reactions-Mass Transfer between fluid and catalyst surface-Internal transport effects- Pore diffusion combined with surface kinetics- Porous catalysts- Derivation for effectiveness of catalyst with spherical pore, Thiele Modulus. Heat effects during reaction-Performance equation for Reactors containing Porous catalyst particles.Commercially significant types of heterogeneous catalytic reactors.
(No numerical problems are expected from this module. Only qualitative treatment and derivations required)

Text Books

1. Octave Levenspiel, *Chemical Reaction Engineering*, 3/e, Wiley student Education, 2006.
2. H Scott Fogler, *Essentials of Chemical Reaction Engineering,* Pearson Education, 2011

Reference Books

1. J E Bailey, D F Ollis, *Biochemical Engineering Fundamentals*, 2/e, McGraw-Hill ChemicalEngineering Series, 1986.
2. Hill C G, Root T W, *Introduction to Chemical Engineering Kinetics & Reactor Design*, JohnWiley, 2014.
3. Martin Schmal, *Chemical Reaction Engineering, Essentials, Exercises and Examples*, CRC Press, 2011.
4. J M Smith, C*hemical Engineering Kinetics*, McGraw Hill International.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**An overview of chemical & biological reaction engineering**	
1.1	Definition of reaction rate. Basic concepts of chemical kinetics. Classification of chemical reactions. Temperature & concentration dependency of reaction rate	2
1.2	Searching for mechanism- General considerations, hydrogen bromide reaction	2
1.3	Analysis of rate equations. Interpretation of batch reactor data: integral and differential method of rate analysis.	5
1.4	Numerical examples. Numerical Problems for evaluation of activation energy and rate equation	3
2	**Introduction to reactor design**	
2.1	Classification of reactors	1
2.2	Concept of Ideal reactors. Design equations for batch, mixed flow and plug flow reactors	2

2.3	Multiple reactor systems, Plug flow reactor in series and parallel, equal sized mixed reactors in series, mixed flow reactors of different sizes in series, determination of the best system for a given conversion	4
2.4	Numerical problems for evaluation of reactor volume, conversion, their comparison using ideal single and combination of ideal reactors for single/ multiple reactions	2
3	**Non isothermal reactor design**	
3.1	**Heat effects in reactors** -General graphical design procedure-Energy balance for batch, mixed flow and plug flow reactor. Optimum temperature progression	2
3.2	**Basics of non-ideal flow**-Residence time distribution. Measurement of the RTD-Pulse and step input -C, E, F curves-RTD in ideal reactors	2
3.3	Single parameter models of RTD- Tanks in Series and Analysis of Dispersion model. Reactor design using RTD data.	2
3.4	Quantitative treatment by solving Numerical problems on moments of RTD	3
4	**Kinetics of cell growth and enzymes**	
4.1	Cell growth kinetics; substrate uptake and product formation in microbial growth	2
4.2	Enzyme kinetics, Michaelis-Menten rate form	1
4.3	Biological reactors – chemostats-Theory of the chemostat. Monod-chemostat model.	2
4.4	A quantitative treatment for finding out the critical dilution rate, substrate and biomass concentration	2
5	**Heterogeneous catalytic processes**	
5.1	Classification of catalysts, promoters, inhibitors, catalyst poisons. Rate equations for fluid-solid catalytic-reactions	2
5.2	Mass Transfer between fluid and catalyst surface-Internal transport effects- Pore diffusion combined with surface kinetics-Porous catalysts- Derivation for effectiveness of catalyst with spherical pore, Thiele Modulus	2
5.3	Heat effects during reaction-Performance equation for Reactors containing Porous catalyst particles	2
5.4	Commercially significant types of heterogeneous catalytic reactors.	2

BTT204	PRINCIPLES OF BIOCHEMISTRY	CATEGORY	L	T	P	CREDIT
		PCC	3	1	0	4

Preamble: To acquire knowledge of the all the biomolecules, its function and metabolism in maintaining life

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO 1	Describe the role of cellular chemicals and their functions.
CO 2	Describe biosynthetic pathways and understand the key aspects of metabolism.
CO 3	Explain cellular energy requirements and how energy is utilized by a cell.
CO 4	Understand the behaviour of enzymes and their kinetics.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	-	3	2	-	3	-	-	-	-	-	2
CO2	3	-	3	2	-	3	-	-	-	-	-	2
CO3	3	-	3	2	-	2	-	-	-	-	-	2
CO4	3	-	3	2	-	2	-	-	-	-	-	2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	20
Apply	20	20	70
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contains10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

- **Course Outcome 1 (CO1):** Describe the role of cellular chemicals and their functions.

1. State three important functions of nucleic acids.

2. How are polysaccharides classified according to their function?

3. Define iso electric pH and its significance.

- **Course Outcome 2 (CO2) :**Describe biosynthetic pathways and understand the key aspects of metabolism.

1. Which are the key steps regulating glycolytic pathway ?

2. How are fatty acids oxidised in the cell. Explain the process with the reactions involved

3. How is the Urea cycle linked to the TCA cycle

- **Course Outcome 3(CO3):** Explain cellular energy requirement and how energy is utilized by a cell.

1. Mitochondrial shuttles are important in generating energy in the cell. Justify ?

2. Give the significance of entropy and enthalpy in a biological context

3. Which are the steps where energy is produced during the complete oxidation of a glucose molecule?

- **Course Outcome 4 (CO4):** Understand the behavior of enzymes and their kinetics.

1. How are enzymes classified according to their function?

2. Describe the two mechanisms of action of enzymes with appropriate diagrams?

3. Describe the mechanism of Ribonuclease ?

Model Question paper

			Total Pages:
Reg No.:_____		Name:_____	
APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY THIRD SEMESTER B. TECH DEGREE EXAMINATION _____ ____ 20__			
Course Code: BTT 204			
Course Name: PRINCIPLES OF BIOCHEMISTRY			
Max. Marks: 100			Duration: 3 Hours
PART A			
		Answer all questions, each carries 3 marks.	
1	a)	What is the importance of biological buffers? Name two biological buffers and their specific role in Biological systems	
	b)	Enumerate two functions each of Carbohydrates, lipids, proteins and nucleic acid	
	c)	Draw the Fischer and Howarth projection of glucose?	
	d)	Differentiate triglyceride and sphingolipid?	
	e)	Why are vitamins important in metabolism Give two reasons with examples	
	f)	Compare and differentiate the principle of ion-exchange chromatography and gel filtration chromatography	
	g)	What is the difference between oxidative and substrate level phosphorylation?	
	h)	Why are mitochondrial shuttles important?	
	i)	How are enzymes inhibited?	
	j)	What do u understand by the term (a) Activation energy (b) Rate of a reaction	
PART B			
Answer any one full question from each module. Each carries 14 marks.			

2	a)	Describe the animal cell and its organelles with a neat diagram	8)
	b)	What is the function of the following organelles (i) Mitochondria (ii) endoplasmic reticulum (iii) Golgibodies	(6)
		OR	
3	a)	Derive the Hendersen –Haselbalch equation for determining the pH of Buffers	(8)
	b)	Describe the Watson and Crick Model of double stranded DNA with a neat diagram	(6)
4		Describe the different levels of the structural organization of proteins with appropriate diagrams	(14)
		OR	
5		How are lipids and amino acids classified according to the nutritional content? Give the names and structures under each types	(14)
6		Describe glycolysis with all the reactions, enzymes and Energetics both in aerobic and aerobic conditions? Mark neatly the steps at which the pathway is regulated. How is it connected to the TCA cycle?	(14)
		OR	
7		Describe the beta oxidation of fatty acids with appropriate reactions	(14)
8		Describe the electron transport chain	(14)
		OR	
9		Describe all the reactions in photosynthesis	(14)
10	a)	Derive the MichealsMenteen equation for determining the rate of a reaction?	(7)
	b)	What are the factors affecting the rate of a reaction?	(7)
		OR	
11		Describe the mechanism of action of (i) Chymotrypsin (ii) Ribonuclease	14)
		****	

Syllabus

Module 1: Cell organelles and Biomolecules

General features of the cell, organelles and macromolecular assemblies -, importance of buffers in cellular mechanism and pH regulation, Henderson – Hasselbalch equation, Introduction to biomolecules. Role of carbohydrates, proteins, lipids and nucleic acids in cellular functions.

Module 2: Properties of Biomolecules

Biomolecules: Carbohydrate – simple sugars and polysaccharides, complex polymers and glycoproteins; Lipids- structure and chemistry, fatty acids, complex lipids(phospholipids and sphingolipids- functions only) , cholesterol, steroids, prostaglandins and leukotrienes (only significance) ; Proteins- amino acids -structure, nomenclature, primary structure , secondary, tertiary structure of proteins, membrane proteins Nucleic acids – DNA, RNA ,primary structure, secondary, tertiary structure. Chemical properties and reactions of carbohydrates (stereoisomerism included), proteins, lipids and nucleic acids.

Module 3: Metabolism of Biomolecules

Overview of metabolism. Cellular energy requirement for vital functions, energy content of food materials, vitamins and cofactors (Importance only) . Techniques used in the study of metabolism (Chromatographic techniques – Principle only). Major metabolic Pathways: Glycolysis,. TCA cycle, Gluconeogenesis, HMP pathway (pathway and regulatory steps) Regulation of blood glucose level by Insulin and Glucagon, Metabolic regulation by Feedback inhibition (glycolysis only) . Biosynthesis of saturated fatty acids, β-oxidation pathway(only saturated fatty acids), ketone bodies, biosynthesis and degradation of selected amino acids (aromatic amino acids only)

Module 4: Bioenergetics

Bioenergetics –overview, Bioenergy: free and activation energy. Substrate level and oxidative phosphorylation ,ATP synthase complex, formation of ATP. Role of ATP, Redox reactions and reactions that generate reducing equivalents (NADH, NADPH and FADH2) Photosynthesis & Calvin Cycle (pathway only). Electron transport chain, chemiosmotic coupling, mitochondrial shuttles (glycerol phosphate and malate-aspartate shuttles.).

Module 5: Enzymes

Introduction to enzymes, nomenclature and classification of enzymes, structure–functionality relationships, concept and determination of enzyme activity, concepts of ligand-enzyme binding interactions activation energy and rates of reactions; Michaelis-

Menteen equation, inhibition and allosteric; Enzyme inhibition types- Competitive, Noncompetitive and uncompetitiveinhibitors. Inhibition kinetics.Allosteric regulation of enzymes.Mechanism of action of selected enzymes (Lysozyme, Ribonuclease, Chymotrypsin).

Text Books

1. Vasudevan&SreekumariTextbook of Biochemistry for Medical Students 7th Edition
2. Satyanarayana Biochemistry 5th Edition 2017
3. Jain & Jain Fundamentals of Biochemistry

Reference Books

1. **Lehninger A.L**, **Nelson D.L** and **Cox M.M**, *Principles of Biochemistry*, Palgrave Macmillan
2. **Stryer L, Berg J.M.** and **Tymoczko J.L**, *Biochemistry*, 5th Edn., W.H. Freeman and Co.
3. **Zubay G**, *Biochemistry*, 4th Edition, McGraw Hill Publishers.
4. **Voet. D and Voet. J.G,***Biochemistry*, John Wiley and Sons.
5. **Trevor Palmer, Philip L Boner**, *Enzymes- Biochemistry, Biotechnology and Clinical Chemistry*, Woodhead Publishing, 2007

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Cell organelles and Biomolecules**	
1.1	General features of the cell, organelles and macromolecular assemblies	2
1.2	Importance of buffers in cellular mechanism and pH regulation, Henderson – Hasselbalch equation	2
1.3	Introduction to biomolecules.	1
1.4	Role of carbohydrates, proteins, lipids and nucleic acids in cellular functions.	1
2	**Module 2: Properties of Biomolecules**	
2.1	Biomolecules: Carbohydrate – simple sugars and polysaccharides, complex polymers and glycoproteins;	2
2.2	Lipids- structure and chemistry, fatty acids, complex lipids(phospholipids and sphingolipids- functions only) , cholesterol, steroids, prostaglandins and leukotrienes (only significance)	3
2.3	Proteins- amino acids -structure, nomenclature, primary structure secondary, tertiary structure of proteins, membrane proteins	3
2.4	Nucleic acids – DNA, RNA ,primary structure, secondary, tertiary structure.	2
2.5	Chemical properties and reactions of carbohydrates (stereoisomerism included), proteins, lipids and nucleic acids.	2

3	**Module 3: Metabolism of Biomolecules**	
3.1	Overview of metabolism**.** Cellular energy requirement for vital functions, energy content of food materials, vitamins and cofactors (Importance only) .	2
3.2	Techniques used in the study of metabolism (Chromatographic techniques – Principle only). Major metabolic Pathways: Glycolysis,. TCA cycle, Gluconeogenesis, HMP pathway (pathway and regulatory steps) Regulation of blood glucose level by Insulin and Glucagon, Metabolic regulation by Feedback inhibition (glycolysis only) .	5
3.3	Biosynthesis of saturated fatty acids, β-oxidation pathway(only saturated fatty acids), ketone bodies, biosynthesis and degradation of selected amino acids (aromatic amino acids only)	4
4	**Module 4: Bioenergetics**	
4.1	Bioenergetics –overview, Bioenergy: free and activation energy. Substrate level and oxidative phosphorylation ,ATP synthase complex, formation of ATP. Role of ATP, Redox reactions and reactions that generate reducing equivalents (NADH, NADPH and FADH2)	4
4.2	Photosynthesis & Calvin Cycle (pathway only).	2
4.3	Electron transport chain, chemiosmotic coupling, mitochondrial shuttles (glycerol phosphate and malate-aspartate shuttles.).	2
5	**Module 5: Enzymes**	
5.1	Introduction to enzymes, nomenclature and classification of enzymes, structure–functionality relationships, concept and determination of enzyme activity, concepts of ligand-enzyme binding interactions activation energy and rates of reactions;	4
5.2	Michaelis-Menteen equation, inhibition and allosteric; Enzyme inhibition types- Competitive, Noncompetitive and uncompetitiveinhibitors.	2
5.3	Inhibition kinetics. Allosteric regulation of enzymes.Mechanism of action of selected enzymes (Lysozyme, Ribonuclease, Chymotrypsin).	2

BTT206	BIOPROCESS ENGINEERING	CATEGORY	L	T	P	CREDIT
		PCC	3	1	0	4

Preamble: Acquaint the students with the various methods of enhancing microbial growth in an industrial perspective

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO 1	Illustrate the isolation and preservation of microorganism and development of inoculums.
CO 2	Summarize medium and air sterilization methods
CO 3	Elucidate the mass transfer effects in bioreactors
CO 4	Outline bioreactor scale up and scale down procedures

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	-	-	3	-	-	-	3	-	-	3	-	3
CO 2	-	-	3	-	-	-	-	2	-	3	-	3
CO 3	-	-	-	-	-	-	-	-	-	3	-	-
CO 4	3	-	3	-	-	-	-	-	-	3	-	3

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	20
Apply	20	20	70
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Question

Course Outcome 1 (CO1): Illustrate the isolation and preservation of microorganism and development of the inoculum.

1. Illustrate Protoplast fusion method for strain improvement.

2. Compare wild and specific microorganisms

3. Outline the objectives and need for Culture collection and Biological resource centres. Give examples

Course Outcome 2 (CO2) : Summarize medium and air sterilization methods

1 Brief about extinction probability

2. Illustrate the thermal death kinetics of cells and spores

3. Describe the design aspects of batch sterilisation

Course Outcome 3(CO3): Elucidate the mass transfer effects in bioreactors

1. Illustrate the methods for the measurement of Kla

2. Explain the working of a chemostat with recycle.

3. Brief about oxygen uptake in cell cultures

Course Outcome 4 (CO4): Outline bioreactor scale up and scale down procedures

1. Discuss on the need for modelling and control in bioprocesses with the help of available softwares used in bioprocess industry

2. Enumerate the effect of scale on oxygenation in bioprocess.

3. Outline the steps in model building.

Model Question paper

			Total Pages:
Reg No.:_____		Name:_____	
APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY THIRD SEMESTER B. TECH DEGREE EXAMINATION _____ ____ 20__			
Course Code: BTT206			
Course Name: BIOPROCESS ENGINEERING			
Max. Marks: 100			Duration: 3 Hours
PART A			
		Answer all questions, each carries 3 marks.	
1	a)	Write a short note on protoplast fusion	
	b)	List any three functions of a culture collection centre?	
	c)	What are thegeneral requirements of a fermentation process?	
	d)	Explain the various classifications of fermentation processes	
	e)	Write a note on the concept of X90.	
	f)	Derive the equation for death kinetics of cells and spores.	
	g)	Discuss about chemostat with immobilised cells	
	h)	Explain the static method for the measurement of volumetric oxygen transfer coefficient	

	i)	What do you mean by regime analysis?	
	j)	Explain about the scale up window.	
PART B			
Answer any one full question from each module. Each carries 14 marks.			
2		What are the methods available for the isolation of microorganisms of potential interest? Explain.	(14)
		OR	
3		Define r-DNA technology and describe its application in strain improvement with suitable diagrams. Explain the preservation techniques used for long term preservation of cell cultures.	(14)
4		Briefly explain the different methods used for the measurements of cell viability.	(14)
		OR	
5		Explain any one method for media optimization. How do the age and size of inoculums affect the growth and productivity?	(14)
6		What do you mean by in situ sterilisation? Discuss the design aspects of fibrous type filters used for air sterilization.	(14)
		OR	
7		Explain the design aspects of batch and continuous sterilisation process	(14)
8	a)	Briefly explain oxygen uptake in cell cultures. Explain the role of diffusion in bioprocessing.	(14)
		OR	
9		Describe the ideal reactor operation of batch and fed batch reactors.	(14)
10		How the scale-up based on constant power consumption per volume, mixing time, impeller tip speed (shear) applicable in bioreactor system	(14)
		OR	
11		Comment on the major components in bioprocess modelling . Explain how KLa is measured using the Dynamic method.	(14)
****			

Syllabus

Module 1

Isolation of Microorganisms: Isolation, preservation, and improvement of industrially important microorganisms, screening methods, culture preservation.

Strain improvement: mutagenesis, protoplast fusion and r-DNA technology, culture collection and biological resource centres.

Module 2

Fermentation: General requirements of a fermentation process, classification of fermentation processes. Media Optimization

Industrial microorganisms - wild and specific microorganisms, GRAS microorganisms, characteristics of good industrial microorganisms, inoculum, inoculum development and maintenance, effect of age/size of inoculum on cell growth and product formation, cell viability measurements.

Module 3

Sterilization: Medium & air sterilisation methods, del factor, batch & continuous sterilization. Design of depth filter and estimation of efficiency, in-situ sterilization in fermenter, thermal death kinetics of cells and spores, extinction probability, batch and continuous steriliser design aspects, sterilisation of liquid wastes.

Module 4

Mass transfer in bioprocess

Role of diffusion in bioprocessing, oxygen uptake in cell cultures, oxygen transfer in bioreactors, measurement of volumetric oxygen transfer coefficient. Ideal reactor operation, batch, fed batch and continuous operation of mixed bioreactors, chemostat with immobilized cells, chemostat with cell recycle

Module 5

Modelling and optimisation of bioprocesses-definition of a model, need for modelling and control in bioprocesses, steps in model building, Scale-up and scale-down of bioreactors, correlations for oxygen transfer, effect of sale on oxygenation, mixing, bioreactor scale-up based on constant power consumption per volume, mixing time, impeller tip speed (shear), mass transfer coefficients, regime analysis of bioreactor processes.

Text Books

1. P F StanburyDr. A Whitaker, Principles Of Fermentation Technology, Elsevier, Second edition 1995

2. Pauline M. Doran Bioprocess Engineering Principles Academic press - 2nd Edition 2012

Reference Books

1. Rajiv Dutta, *Fundamentals of Biochemical Engineering*, Springer, 2008.

2. Brian McNeil, Linda Harvey (Eds.), *Practical Fermentation Technology*, Wiley, 2008.

3. J E Bailey, D F Ollis, *Biochemical Engineering Fundamentals*, 2/e, McGraw-Hill Chemical Engineering Series, 1986.

4. Michael L Shuler, FikretKargi, *Bioprocess Engineering Basic Concepts*, Prentice Hall, 1992.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	ISOLATION OF MICROORGANISMS AND STRAIN IMPROVEMENT	
1.1	Isolation & Screening methods	2
1.2	Preservation	1
1.3	Improvement of industrially important microorganisms	1
1.4	Mutagenesis , Protoplast fusion, r -DNA technology	3
1.5	Culture collection and biological resource centres	1
2	FERMENTATION AND INDUSTRIAL MICROORGANISMS	
2.1	General requirements of a fermentation process, Classification of fermentation processes	2
2.2	Media Optimization	1
2.3	Wild and specific microorganisms & GRAS microorganisms, Characteristics of good industrial microorganisms	2
2.4	Inoculums development and maintenance,	1
2.5	Effect of age/size of inoculum on cell growth and product formation	1
26	Cell viability measurements.	1
3	STERILISATION	
3.1	Medium & air sterilisation methods, Batch sterilisation and DEL factor	2
3.2	Continuous sterilisation, In -situ sterilisation in fermenter	3

3.3	Thermal death kinetics of cells and spores, Extinction probability	2
3.4	Batch and continuous steriliser design aspects, Sterilisation of liquid wastes.	2
4	MASS TRANSFER IN BIOPROCESS	
4.1	Role of diffusion in bioprocessing, Oxygen uptake in cell cultures	2
4.2	Oxygen transfer in bioreactors, Measurement of volumetric oxygen transfer coefficient	2
4.3	Ideal reactor operation, Batch, fed batch and continuous operation of mixed bioreactors	4
4.4	Chemostat with cell recycle	2
5	MODELLING AND OPTIMISATION OF BIOPROCESS	
5.1	Definition of a model, need for modelling and control in bioprocesses, Steps in model building	2
5.2	Scale-up and scale-down of bioreactors, Correlations for oxygen transfer	2
5.3	Effect of sale on oxygenation, Mixing	2
5.4	Bioreactor scale-up based on constant power consumption per volume, Mixing time	2
5.5	Impeller tip speed (shear), Mass transfer coefficients, Regime analysis of bioreactor processes.	2

BTL202	BIOCHEMISTRY LABORATORY	CATEGORY	L	T	P	CREDIT
		PCC	0	0	3	2

Preamble: Practical skills in handling and characterising biomolecules

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Prepare reagents for various biochemistry experiments.
CO 2	Qualitative and quantitative analysis of various biomolecules
CO 3	Perform enzyme isolation, estimation and assay
CO 4	Use some basic analytical instruments like spectrophotometer

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	-	-	-	1	-	-	1	-	3	2	-	3
CO 2	-	-	-	1	-	-	1	-	3	2	-	3
CO 3	-	-	-	1	-	-	1	-	3	2	-	3
CO 4	-	-	-	1	-	-	1	-	3	2	-	3

Assessment Pattern

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	75	75	2.5 hours

Continuous Internal Evaluation Pattern:

Attendance : 15 marks

Continuous Assessment : 30 marks

Internal Test (Immediately before the second series test) : 30 marks

End Semester Examination Pattern: The following guidelines should be followed regarding award of marks

(a) Preliminary work : 15 Marks

(b) Implementing the work/Conducting the experiment : 10 Marks

(c) Performance, result and inference (usage of equipments and troubleshooting) : 25 Marks

(d) Viva voice : 20 marks

(e) Record : 5 Marks

General instructions: Practical examination to be conducted immediately after the second series test covering the entire syllabus given below. Evaluation is a serious process that is to be conducted under the equal responsibility of both the internal and external examiners. The number of candidates evaluated per day should not exceed 20. Students shall be allowed for the University examination only on submitting the duly certified record. The external examiner shall endorse the record.

Syllabus

1. Preparation of buffers
2. Qualitative tests for Carbohydrates
3. Qualitative tests for Amino Acids
4. UV spectra of
    i. DNA
    ii. Protein

5. Quantitative estimation of sugars (any one)
    A. Estimation of reducing sugars by the Nelson Somogyi method.
    B. Estimation of reducing sugars by Benedict's method.
    C. Estimation of reducing sugars by the DNS method.
    D. Estimation of fructose by the Resorcinol method.

06 .Quantitative estimation of amino acids and proteins (any two)
    A. Estimation of protein Biuret method.
    B. Estimation of protein by Folin's method.
    C. Estimation of amino acid by sugars by the Ninhydrin method
    D. Estimation of Tyrosine by sugars by the Folin's method

07.Quantitative estimation of cholesterol by Zak's method
08.Quantitative estimation of nucleic acids
    A. Estimation of DNA by Diphenylamine reagent method.
    B. Estimation of RNA by Orcinol reagent method.

09.Enzyme isolation: (any 1)

i. Amylase from sweet potato or saliva
ii. Urease from horse gram
iii. Peroxidase from sweetpotato/ potato
iv. Papain from Papaya

10.Saponification of Fats
11.Paper Chromatography of amino acids.
12.Protein precipitation by Ammonium sulphate.
13.Estimation of AL3+ by flourimetry.
14.Estimation of SO-4 by nephelometry
15.Extraction of cholesterol from egg yolk

Textbooks

1. S. Sadasivam,BiochemicalMethods,New Age International, 1996.
2. Wilson K and Walker J, *Principles and Techniques of Practical Biochemistry*, Cambridge University Press.

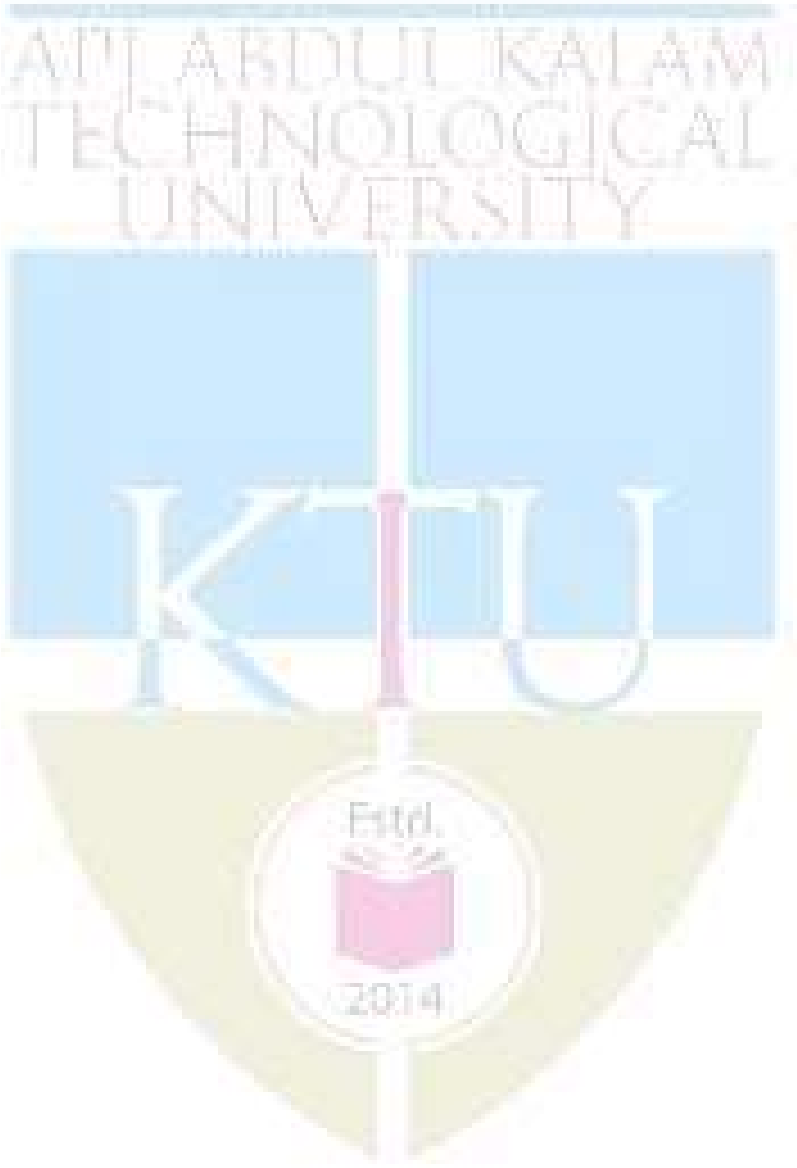
Reference Books

1. Rodney and Boyer, *Modern Experimental Biochemistry*, Pearson education, India.
2. Alexander J. Ninfa and David P. Ballou, *Fundamental Laboratory Approaches for Biochemistry and Biotechnology*, Fitzgerald Science Press Inc, USA.
3. David T. Plummer –*An introduction to Practical Biochemistry*, McGraw- Hill.

Course Contents and Lecture Schedule

No	Topic	No. of hours
1	Preparation of buffers	3
2	Qualitative tests for Carbohydrates	6
3	Qualitative tests for Amino Acids	3
4	UV spectra of DNA and protein	3
5	Quantitative estimation of sugars	3
6	Quantitative estimation of amino acids	3
7	Quantitative estimation of proteins	3
8	Quantitative estimation of cholesterol by Zak's method	3
9	Quantitative estimation of nucleic acids	3
10	Enzyme isolation: (any one)	3
11	Saponification of Fats	3
12	Saponification of fats	3
13	Paper Chromatography of amino acids	3
14	Protein precipitation by ammonium sulphate	3
15	Estimation of Al^{3+} by flourimetry	3

16	Estimation of Sulphate by nephelometry	3



BTL204	ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY LAB	CATEGORY	L	T	P	CREDIT
		PCC	0	0	3	2

Preamble:

This course aims to familiarize students with the basic instrumental techniques necessary for analysis of bioprocess systems. The techniques shall be learned in a flawless manner such as to enable the students to identify and implement appropriate techniques for analytical applications in diverse bioprocess contexts.

Prerequisite: Knowledge on basic tools needed for the identification of biomolecules

Course Outcomes: After the completion of the course the student will be able to

CO 1	Capability to perform and develop knowledge for the appropriate selection of instruments for the successful analysis of biomolecules.
CO 2	Critically evaluate the strengths and limitations of the individual analytical techniques with respect to selectivity and sensitivity for solving bioengineering problems.
CO 3	Possess and be capable of applying a knowledge of modern analytical techniques.
CO 4	Apply the knowledge and skills acquired to analyze and interpret experimental data obtained from different instrumental measurements and communicate results effectively.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	-	-	3	2	-	-	-	-	3	2	-	-
CO 2	-	-	2	2	-	-	-	-	3	2	-	-
CO 3	-	-	2	2	2	-	-	-	3	2	-	-
CO 4	-	-	2	2	-	-	-	-	3	2	-	-

Assessment Pattern

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	75	75	2.5 hours

Continuous Internal Evaluation Pattern:

Attendance : 15 marks

Continuous Assessment : 30 marks

Internal Test (Immediately before the second series test) : 30 marks

End Semester Examination Pattern: The following guidelines should be followed regarding award of marks

(a) Preliminary work : 15 Marks

(b) Implementing the work/Conducting the experiment : 10 Marks

(c) Performance, result and inference (usage of equipments and troubleshooting) : 25 Marks

(d) Viva voice : 20 marks

(e) Record : 5 Marks

General instructions: Practical examination to be conducted immediately after the second series test covering the entire syllabus given below. Evaluation is a serious process that is to be conducted under the equal responsibility of both the internal and external examiners. The number of candidates evaluated per day should not exceed 20. Students shall be allowed for the University examination only on submitting the duly certified record. The external examiner shall endorse the record.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Verify the Beer-Lambert's law-using UV-Vis spectrophotometer.

2. Find out the absorption maxima of the given sample.

3. **Course Outcome 2 (CO2)**

1. Determine the molecular weight of the given protein sample.

2. Precipitate the given sample of protein by suitable method.

3. Prepare the absorption spectra of nucleotides

Course Outcome 3(CO3):

1. Separate the given sample mixture of amino acids and determine the Rf value.

2. Extract the given lipid sample and separate using thin layer chromatography

3. Analyse the given protein by SDS- PAGE method.

3. **Course Outcome 4 (CO4):**

1. Demonstrate the isolation of leaf pigments by suitable chromatography technique.

2. Perform the isolation of different fractions from cells using centrifugation.

3. Analyse the sugars in fruits by thin layer chromatography.

Syllabus

(10 experiments are mandatory) - ***Visits to research institutions and industries for demonstration of the various analytical instruments may also be arranged.***

1. Atomic absorption spectroscopy-Precision and validity of an experiment using absorption spectroscopy.
2. Colorimetry and spectrophotometry - Validate Beer-Lambert's law.
3. Determination of absorption maxima of the given sample.
4. UV spectra of Nucleic Acids
5. Paper chromatography - Separation of amino acids by paper chromatography & determination of Rf value.
6. Thin Layer chromatography - Extraction of lipids and separation using thin layer chromatography.
7. Column chromatography -Determination of molecular weight of macromolecules

8. Separation and identification of protein on gel electrophoresis
9. Separation & identification of nucleic acids on gel electrophoresis.
10. PCR
11. Mass Spectrometry
12. IR spectroscopy
13. HPLC
14. NMR
15. Estimation of Thiamine and Riboflavin by Fluorimetry.

Textbooks

1. Wilson K and Walker J, Principles and Techniques of Practical Biochemistry, Cambridge University Press.

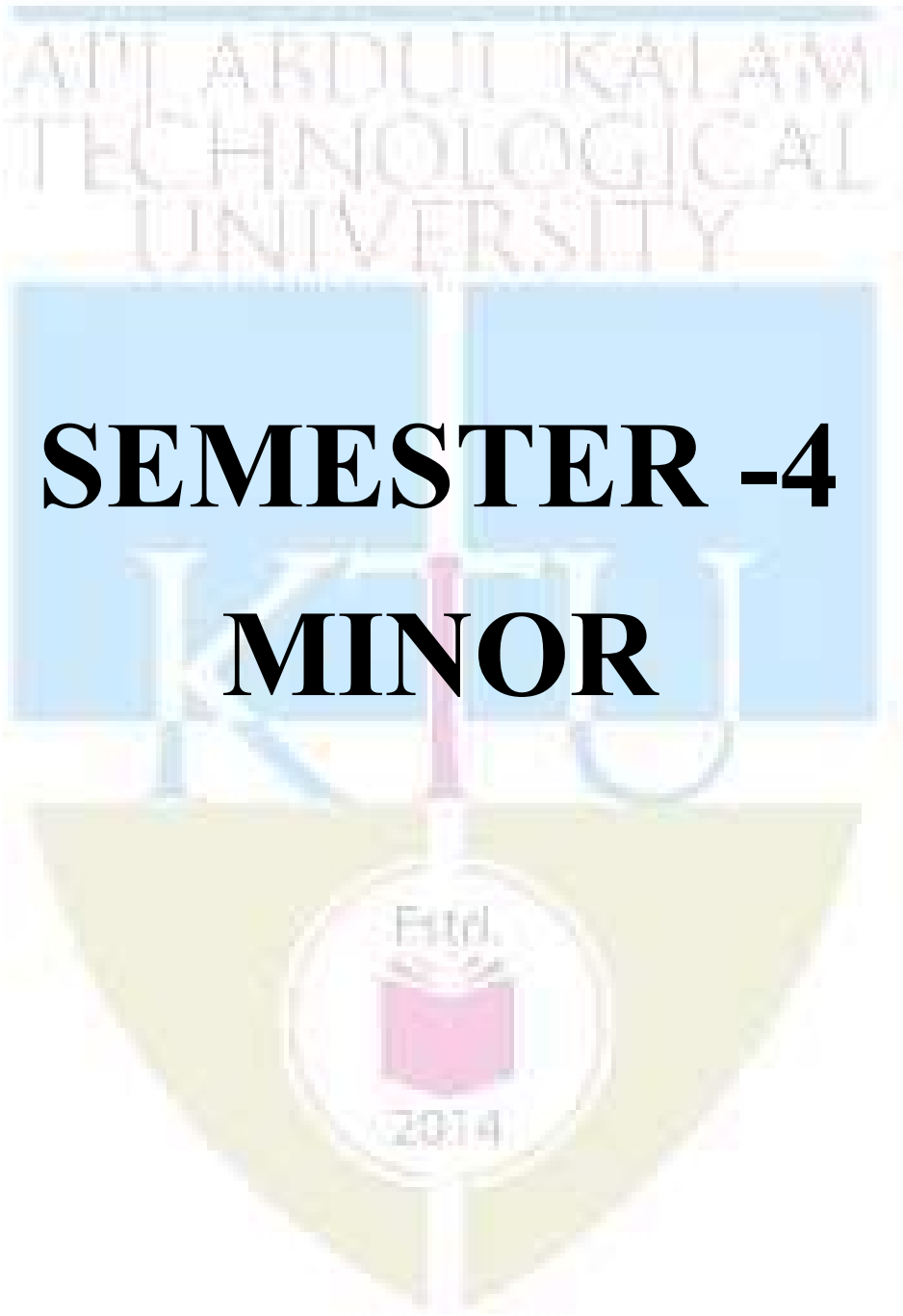
Reference Books

1. Rodney and Boyer, Modern Experimental Biochemistry, Pearson education, India.
2. Alexander J. Ninfa and David P. Ballou, Fundamental Laboratory Approaches for Biochemistry and Biotechnology, Fitzgerald Science Press Inc, USA.
3. David T. Plummer –An introduction to Practical Biochemistry, McGraw- Hill.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	Atomic absorption spectroscopy-Precision and validity of an experiment using absorption spectroscopy.	1
2	Colorimetry and spectrophotometry - Validate Beer-Lambert's law.	2
3	Determination of absorption maxima of the given sample.	3
4	UV spectra of Nucleic Acids	3
5	Paper chromatography -Separation of amino acids by paper chromatography & Determination of Rf value.	3
6	Thin Layer chromatography - Extraction of lipids and separation using thin layer chromatography.	3
7	Column chromatography - Determination of molecular weight of macromolecules	3
8	Separation and identification of protein on gel electrophoresis	3
9	Separation & identification of nucleic acids on gel electrophoresis.	3

10	PCR	3
11	Mass Spectrometry	3
12	IR Spectroscopy	
13	HPLC	3
14	NMR	3
15	Estimation of Thiamine and Riboflavin by Fluorimetry	3



SEMESTER -4

MINOR

BTT282	FERMENTATION TECHNOLOGY	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble: A basic knowhow on the various processes in fermentation for the development of biologically relevant products

Prerequisite: Basics in Bioprocess engineering

Course Outcomes: After the completion of the course the student will be able to

CO 1	Illustrate the introduction to fermentation, design of fermenter and factors affecting fermentation process
CO 2	Analyse microbial growth kinetics, comparison of batch and continuous culture processes and preservation of industrially important microorganism
CO 3	Formulate media for industrial fermentation and understand medium optimization process
CO 4	Understand the product development, product recovery and various purification strategy for fermentative products
CO 5	Practice the basics of Industrial production of primary metabolites and secondary metabolites and packing and labelling through good manufacturing practices

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	-	3	-	-	--	-	2	-	3	-	
CO 2	-	-	-	-	-	-	-	-	-	3	-	3
CO 3	-	-	-	-	-	-	-	-	-	3	-	3
CO 4	-	-	3	-	-	-	-	3	-	3	-	3
CO 5	-	-	-	-	-	3	-	3	-	3	-	3

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	20
Apply	20	20	70
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Illustrate the introduction to fermentation, design of fermenter and factors affecting fermentation process

1. Illustrate the working of an airlift fermenter

2. Brief about the factors affecting fermentation process

3. Outline the different types of fermentation processes.

Course Outcome 2 (CO2) : Analyse microbial growth kinetics, comparison of batch and continuous culture processes and preservation of industrially important microorganism

1 Draw a microbial growth curve and explain the different phases.

2. Explain the kinetics of continuous culture.

3. Write note on the preservation methods used for microbial cultures

Course Outcome 3(CO3): Formulate media for industrial fermentation and understand medium optimization process

1 Brief about the factors to be considered during the selection of carbon and nitrogen sources in the media.

2. Write a short note on animal cell media.

3. Describe the optimisation of fermentation media.

Course Outcome 4 (CO4): Understand the product development, product recovery and various purification strategy for fermentative products

1. Discuss about the methods for the removal of cells and solid matters.

2. Explain the principle of HPLC.

3. Outline the physical and chemical cell disruption methods.

Course Outcome 5 (CO5): Practice the basics of Industrial production of primary metabolites and secondary metabolites and packing and labelling through good manufacturing practices

1. With a neat sketch outline the production of any one intracellular enzyme.

2. Explain the production of organic acid.

3. List any four criteria to be followed during the production process.

Model Question paper

			Total Pages:
Reg No.:_____		Name:_____	
APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY THIRD SEMESTER B. TECH DEGREE EXAMINATION _____ ____ 20__			
Course Code: BTT 282			
Course Name: FERMENTATION TECHNOLOGY			
Max. Marks: 100			Duration: 3 Hours
PART A			
		Answer all questions, each carries 3 marks.	
1	a)	Write a short note on Cyclone column	
	b)	Discuss about fed batch fermentation process	
	c)	Explain the importance of preservation of microorganism	
	d)	Explain the isolation process of antibiotic producing organisms.	
	e	Explain about medium formulation in a fermentation process	

	)		
	f)	Discuss in detail about Non-nutritional media supplement	
	g)	Elaborate on any one physical method of Cell disruption	
	h)	Explain the principle of centrifugation.	
	i)	Enumerate the factors need to be considered for industrial production of Primary metabolites	
	j)	List out the different biosafety levels	
PART B			
Answer any one full question from each module. Each carries 14 marks.			
2		Illustrate the design and working of airlift fermenter and cyclone column	(14)
		OR	
3		Describe the different physical, chemical and biological factors affecting fermentation process	(14)
4		Discuss the different methods for the isolation and preservation of industrially important microorganisms.	(14)
		OR	
5		Explain the kinetics of batch and continuous cultures.	(14)
6		Describe Placket and Burman method of media optimisation. What are the requirements of a good production media?	(14)
		OR	
7		Explain the different types of media and the role of each component in animal cell culture.	(14)
8		Write notes on i) Adsorption chromatography ii) Ion exchange chromatography	(14)
		OR	
9		What is the theory of Filtration process? Explain about types of filters-batch-continuous filters	(14)
10		Discuss on the production of butanol in a fermentation process industry	(14)
		OR	

11		What are the forms of IPR and the process of patenting?	(14)
****			

Syllabus

Module 1

Introduction to fermentation-Design of fermenter-body construction-aeration system-agitation system-baffles- sensors. Type of fermenters- Waldhof, Tower, Deep jet, Cyclone column, packed tower and airlift fermenter Different types of fermentation process-batch, continuous, fed batch.Factors affecting fermentation process- physical, chemical and biological factors.

Module 2

Microbial Growth Kinetics: Batch culture-continuous culture-fed batch system-biomass productivity-metabolite productivity-continuous brewing-comparison of batch and continuous culture. Isolation and preservation of industrially important microorganisms.Preservation of industrially important microorganisms.

Module 3

Media for industrial fermentation- introduction-typical media-medium formulation-water-energy sources-carbon sources-factors affecting the selection of carbon source-carbohydrates, oils and fats, nitrogen source, minerals, growth factors, chelators, buffers, antifoam agents, pH.Medium optimization-animal cell media-serum-serum free media-protein free media. Non-nutritional media supplement.

Module 4

Product development and product recovery-cell.Introduction to purification of fermentative products-removal of microbial cells and other solid matters.Cell disruption-physical-mechanical-chemical-enzymatic methods.Product recovery-chromatography-adsorption-ion-exchange-HPLC. Filtration- types of filters-batch-continuous filters centrifugation. Liquid/liquid extraction and dialysis.

Module 5

Introduction to fermentative production technology: Industrial production of Primary metabolites and secondary metabolites. Introduction to enzyme production – Intracellular and Extracellular Enzymes- Production of Proteases.Fermentative production of ethanol-

acetone- butanol, Organic acids- citric acid.Amino acids- lysine and phenylalanine, Vitamins- riboflavin and ascorbic acid.Antibiotics-penicillinSCP production.

Packing and labelling. Good Manufacturing Practices, Biosafety- laws and concerns at different levels- individual, institution and society. Forms of IPR and process of patenting.

Text Books

1.Peter F. Stanbury Allan Whitaker Stephen Hall, *Principles of Fermentation Technology*,2nd Edition, Butterworth-Heinemann 1995

2.Michael L Shuler, FikretKargi, Bioprocess Engineering Basic Concepts, Prentice Hall, 1992.

3.WulfCruger and AnnelieseCrueger, Biotechnology: *A Textbook of Industrial Microbiology*, 2nd Edition, Panima Publishing Corporation, 2004.

Reference Books

1.Michael C Flickinge (Ed.), *Upstream Industrial Biotechnology*, Volumes 1 & 2, Wiley 2013

2. Brian McNeil, Linda Harvey (Eds.), *Practical Fermentation Technology*, Wiley, 2008.

3. J E Bailey, D F Ollis, *Biochemical Engineering Fundamentals*, 2/e, McGraw-Hill Chemical Engineering Series, 1986.

4. Bioprocess Technology, P.T. Kalichelvan and I Arul Pandi, 2009,MJP Publishers, Chennai.

5. Bioprocess Technology- Kinetics and reactors, Antan Moser and Philip Manor,.1998, Springer

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**INTRODUCTION TO FERMENTATION**	
1.1	Design of fermenter-body construction-aeration system-agitation system-baffles- sensors	3
1.2	Type of fermenters- Waldhof, Tower, Deep jet, Cyclone column, packed tower and airlift fermenter	3
1.3	Different types of fermentation process-batch, continuous, fed batch.	2
1.4	Factors affecting fermentation process- physical, chemical and biological factors.	1
2	**MICROBIAL GROWTH KINETICS**	

2.1	Batch culture-continuous culture-fed batch system	3
2.2	Biomass productivity-metabolite productivity-continuous brewing-comparison of batch and continuous culture.	3
2.3	Isolation and preservation of industrially important microorganisms.	2
3	**MEDIA FOR INDUSTRIAL FERMENTATION**	
3.1	Introduction -typical media-medium formulation-water-energy sources-carbon sources-factors affecting the selection of carbon source-carbohydrates, oils and fats, nitrogen source, minerals, growth factors, chelators, buffers, antifoam agents, pH.	3
3.2	Medium optimization-animal cell media,	2
3.3	serum free media-protein free media	1
3.4	Non-nutritional media supplement.	1
4	**PRODUCT DEVELOPMENT AND PRODUCT RECOVERY**	
4.1	Introduction to purification of fermentative products-removal of microbial cells and other solid matters.	2
4.2	Cell disruption-physical-mechanical-chemical-enzymatic methods.	2
4.3	Product recovery-chromatography-adsorption-ion-exchange-HPLC.	3
4.4	Filtration- types of filters-batch-continuous filters centrifugation.	2
4.5	Liquid/liquid extraction and dialysis.	2
5	**INTRODUCTION TO FERMENTATIVE PRODUCTION TECHNOLOGY**	
5.1	Industrial production of Primary metabolites and secondary metabolites. Introduction to enzyme production – Intracellular and Extracellular Enzymes- Production of Proteases.	2
5.2	Fermentative production of ethanol-acetone- butanol, Organic acids- citric acid.	3
5.3	Amino acids- lysine and phenylalanine, Vitamins-riboflavin and ascorbic acid. Antibiotics-penicillinSCP production.	2
5.4	Packing and labelling. Good Manufacturing Practices, Biosafety-laws and concerns at different levels- individual, institution and society.	2
5.5	Forms of IPR and process of patenting.	1

BTT284	INTRODUCTION TO MOLECULAR BIOLOGY	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble: Understand the DNA, its functions and methods of manipulation

Prerequisite: Basic Biology (+2)

Course Outcomes: After the completion of the course the student will be able to

CO 1	Lays out the groundwork for understanding the fundamental aspects of life through molecular studies
CO 2	Prioritize, Recognize and Undertake advanced courses based on Molecular Biology interactions of life systems and cellular biology
CO 3	Judge molecular level mechanisms in the biological processes
CO 4	Appraise the theoretical aspects of cellular activities and functioning

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	-	2	-	-	-	-	-	-	-	-	2
CO 2	-	-	2	-	-	-	-	2	-	2	-	-
CO 3	3	-	3	-	-	-	-	-	-	-	2	-
CO 4	-	-	2	-		2	-	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	20
Apply	20	20	70
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. State the components of DNA.

2. List the enzymes used in Molecular Biology.

3. Characterize the sequence of cellular events through Central dogma .

Course Outcome 2 (CO2)

1. Illustrate the Molecular techniques used in Modern Virology

2. PCR is a mandatory requirement in emerging disease diagnosis. Justify.

3. Signify the replication process through eukaryotic replication

Course Outcome 3(CO3):

1. Assess the role of Transcription factors in the synthesis of protein

2. Give reasons and prove that transcription is the key factor in cellular activities

3. Describe the process of RNA biosynthesis

Course Outcome 4 (CO4):

1. Define and judge the Genetic code as a basic component of hereditary features

2. Generate reasons to prove that Wobble hypothesis is error prone. Judge the hypothesis as a mandatory requirement for cellular function.

3. State the importance of DNA replication. Signify the reasons to have semi conservative mode of replication in living cells

Model Question paper

			Total Pages:
Reg No.:_____		Name:_____	
APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY THIRD SEMESTER B. TECH DEGREE EXAMINATION _____ ____ 20__			
Course Code: BTT 284			
Course Name: INTRODUCTION TO MOLECULAR BIOLOGY			
Max. Marks: 100			Duration: 3 Hours
PART A			
		Answer all questions, each carries 3 marks.	
1	a)	.Brief up the enzymatic requirements for cutting and pasting DNA in gene cloning	
	b)	Discuss in detail the historical events that lead to development of Molecular Biology	
	c)	Define Origin of replication. How is it important in the process of replication	
	d)	Signify semi conservative replication in living cells	
	e)	Define Transcription. Comment on the significance of Transcription bubble and explain the process of Transcription	
	f)	Comment on collinearity of genes and proteins	
	g)	Define codon. Detail the functions of the genetic code	
	h)	Propose Wobble hypothesis as essential subject in genetic level cellular interactions	
	i)	Discuss on the features of any one plasmid vector	
	j)	Point out the steps involved in Molecular cloning	
PART B			
Answer any one full question from each module. Each carries 14 marks.			

2	a)	Appraise the types of DNA with reference to its functions	(8)
	b)	Discuss in detail the importance of Central Dogma in cellular system	(6)
		OR	
3		Discuss in detail the types of RNA and its functions	(14)
4		Categorize the events in replication with the aid of neat and labelled diagram	(14)
		OR	
5		Generate reasons to prove that DNA Polymerases is necessary for cellular functions. Explain in detail the process involved in polymerisation	(14)
6	a)	Sketch and explain mRNA processing	(6)
	b)	Signify the process of RNA biosynthesis	(8)
		OR	
7		Define Transcription. Comment on the significance of Transcription bubble and explain the process of Transcription	14)
8		Outline translation representing it through diagrams and stepwise events	(14)
		OR	
9		Discuss in detail the importance of post translational modifications in cellular system	(14)
10		Define PCR. Summarize the role of PCR as diagnostic tool in detecting emerging infections	(14)
		OR	
11		Shortlist the applications of Molecular Biology	(14)
		****	

Syllabus

Basics of Molecular Biology (structure & function), Structure of DNA and RNA and their types, Significance of the flow of genetic information through central dogma, replication, Expression of genetic information, Transcription, Post Transcriptional modifications, Genetic code, Translation, Post translational modifications, Application of Molecular Biology and use of molecular approaches in Modern science

Module 1: Introduction: Historical perspective, composition of RNA and DNA. Structure of RNA and DNA, Types of RNA. Central dogma of molecular biology, Enzymes in Molecular Biology: Nucleases, RibonucleaseSetc

Module 2:Replication of DNA: Semi conservative nature,replication origin and site, and structure and DNA. Replication of double stranded DNA, direction of replication, discontinuous replication, Okazaki Fragments. DNA polymerase I II and III, DNA ligase, DNA topoisomerases.Significance of Replication.

Module 3: Transcription: Colinearity of genes and proteins, RNA polymerase I, II and III. RNA biosynthesis in prokaryotes and eukaryotes; initiation, elongation and termination. Processing of mRNA, cap addition, poly A tail addition.Significance of Transcription.

Module 4: Translation: Genetic code, triplet codon, universality, features of the genetic code, assignment of codons, degeneracy, wobble hypothesis, Steps involved in Translation. Post translational modifications. Significance of Translation

Module 5: Application of Molecular Biology: Cloning vectors, Plasmid and Viral vectors, Molecular Cloning, Polymerase Chain Reaction, DNA fingerprinting, RFLP. Use of molecular techniques in evolutionary biology such as population genetics and phylogenetics etc.

Text Books

1. Alberts, B., Bray, D. and Hopkin, K. (2004). Essential Cell Biology.3rd edition. Garland Science, U.S.A
2. Cox, M., Michael.,Nelson,L.D. (2008). Principles of Biochemistry.5th edition.W.H.Freeman and company, Newyork.

Reference Books

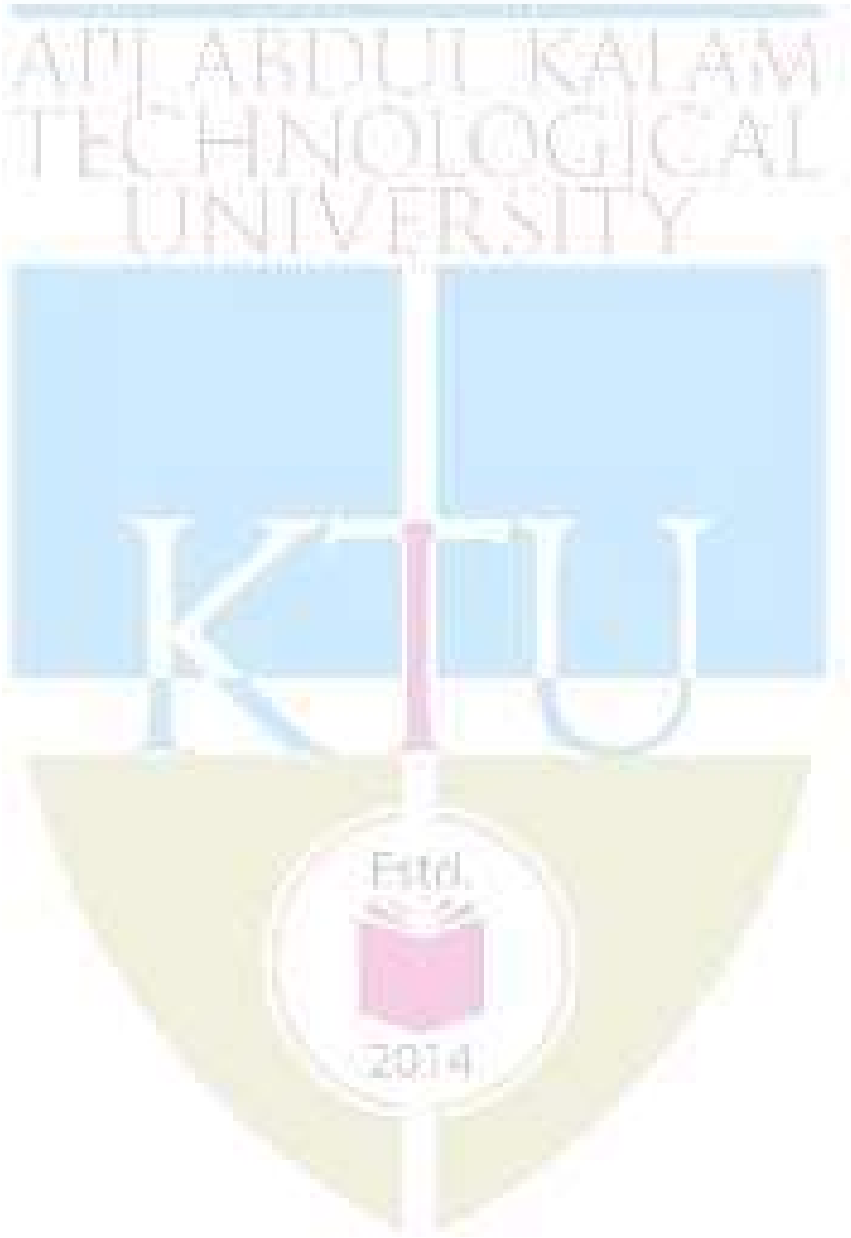
1. Dale,W.J. and Schontz, V.M.(2007). From Genes to Genomes. John Wiley &Sons ltd., England.
2. David. A. Micklos, Greg.A. Freyer and David A. Crotty, (2003). DNA Science A First Course, 2nd edition, Cold SpringHarbor Laboratory Press, New York.
3. Flint. S.J, L.W. Enquist, R.M. Krug, V.R. Racaniello and A.M. Skalka, (2000) Principles of Virology, ASM Press, Washington D.C
4. Gerald Karp (1996). Cell and Molecular Biology – Concepts and Experiments. John Wiley and Sons, Inc., New York.
5. Griffiths AJF, H.J. Muller., D.T. Suzuki, R.C. Lewontin and W.M. Gelbart (2000). An introduction to genetic analysis. W.H. Freeman , New York

6. Harvey Lodish, Arnold Berk, Paul Matsudaira, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, S. Lawrence Zipursky and James Darnell. (2003). Molecular Cell Biology, W.H. Freeman and Company, New York.
7. Kieleczawa,J. (2006). DNA Sequencing II.Jones and Bartlett Publishers, Canada.
8. Koenberg, A.and Baker, A.T. (2005). DNA Replication.2nd edition. University Science Book, California.
9. Nickoloff,A.J. and Hoekstra,F.M. (1998). DNA Damage and repair.Volume II. Humana Press Inc., New Jersey.
10. Watson, Baker, Bell, Gann, Levine and Losick. (2006). Molecular Biology of the Gene, 5 th edition, Pearson Education.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	Introduction to Molecular Biology	
1.1	Historical perspective, composition of RNA and DNA.	3
1.2	Structure of RNA and DNA, Types of RNA. Central dogma of molecular biology,	3
1.3	Enzymes in Molecular Biology: Nucleases, Ribonucleaseetc	3
2	Replication of DNA	
2.1	Semi conservative nature,replication origin and site, and structure and DNA.	3
2.2	Replication of double stranded DNA, direction of replication, discontinuous replication, Okazaki Fragments	3
2.3	DNA polymerase I II and III, DNA ligase, DNA topoisomerases. Significance of Replication.	3
3	Transcription	
3.1	Collinearity of genes and proteins, RNA polymerase I, II and III. RNA biosynthesis in prokaryotes and eukaryotes	3
3.2	Initiation, elongation and termination.	3
3.3	Processing of mRNA, cap addition, poly A tail addition. Significance of Transcription	3
4	Translation	
4.1	Genetic code, triplet codon, universality, features of the genetic code	3
4.2	Assignment of codons, degeneracy, wobble hypothesis.	3
4.3	Steps involved in Translation. Post translational modifications. Significance of Translation	3
5	Application of Molecular Biology	

5.1	Cloning vectors: Plasmid and Viral vectors, Molecular Cloning	3
5.2	Principle and application of Molecular Biology techniques such as Polymerase Chain Reaction, DNA fingerprinting, RFLP.	3
5.3	Use of molecular techniques in evolutionary biology such as population genetics and phylogeneticsetc	3



BTT286	PROCESS SAFETY	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble: To gain knowledge on the safety procedures in a biochemical industry

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO 1	Outline the methods for analysis of hazards, risks and accidents in process industries
CO 2	Explain the concept and philosophy of industrial safety.
CO 3	Outline the policies, legislations and conventions for safety in industrial practice
CO 4	Highlight the means and measures for ensuring personal safety in process industries.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	-	-	-	-	3	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	2	-	-	-	-
CO3	3	-	-	-	-	-	-	2	-	-	-	-
CO4	3	-	-	-	-	3	-	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	20
Apply	20	20	70
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

- **Course Outcome 1 (CO1):** Outline the methods for analysis of hazards, risks and accidents in process industries.

1. Illustrate hazard identification techniques
2. Differentiate between FTA and ETA
3. What are the common errors that may lead to accidents in process industries?

- **Course Outcome 2 (CO2) :** Explain the concept and philosophy of industrial safety

1. Write the role of industrial safety officer
2. What is the significance of safety audits
3. What are the benefits of industrial safety?

- **Course Outcome 3(CO3):** Outline the policies, legislations and conventions for safety in industrial practice

1. Exemplify the Factories Act 1948.
2. How can we ensure safety industries?
3. On what basis industrial safety policies are set?

Course Outcome 4 (CO4): Highlight the means and measures for ensuring personal safety in process industries.

1. Write about personal safety in industries
2. Classify personal protective equipment?
3. How can we ensure personal safety in process industries?

Model Question paper

			Total Pages:
Reg No.:_____		Name:_____	

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B. TECH DEGREE EXAMINATION _____ ____ 20__

Course Code: BTT 286

Course Name: PROCESS SAFETY

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions, each carries 3 marks.

1	a)	Define hazard, write any two examples
	b)	Explain FMEA
	c)	What are the duties and responsibilities of a supervisor
	d)	Explain the preparation and assessment of safety audit
	e)	Explain fire triangle
	f)	How fire is classified?
	g)	Write examples for electrical hazard
	h)	How can we ensure electrical safety in industries?
	i)	Explain about onsite emergency planning
	j)	Briefly explain material storage in industries

PART B

Answer any one full question from each module. Each carries 14 marks.

2	a)	Explain HAZOP with example	(6)
	b)	Compare and contrast fault tree and event tree analysis methods for hazard analysis.	(8)

		OR	
3		Illustrate hazard identification techniques	(14)
4		Explain about ILO Convention	(14)
		OR	
5	a)	Specify the elements of safety audit.	(8)
	b)	What are the duties and responsibilities of a plant worker?	(6)
6		Demonstrate the classification of fire and extinguishers	(14)
		OR	
7	a)	Explain the resuscitation and first aid.	(6)
	b)	What are the different types of explosion?	(8)
8		Exemplify the electrical safety considerations	(14)
		OR	
9		Explain the precautions in processes and operations involving explosives	(14)
10		Explain the general considerations and types of storage of chemicals	(14)
		OR	
11		Demonstrate the chemical accident prevention and explain any two case studies	(14)
****			

Syllabus

Module 1: Hazard, Risk and Accident

HAZARD: Introduction to hazard, causes, identification, evaluation & control of hazard. HAZOP analysis, Sources for information on hazard evaluation.

OCCUPATIONAL HAZARDS & DANGEROUS CHEMICALS: Introduction to occupational health hazards & dangerous properties of chemicals, dust, gases, fumes, mist, vapours, smoke and aerosols, concepts of threshold limit values, classification of hazards.

RISK ANALYSIS: Definition of risk, risk analysis, introduction to Failure Mode & Effect Analysis (FMEA), Fault Tree Analysis (FTA), and Event Tree Analysis (ETA).

ACCIDENT: Definition of accidents, classification of accidents, need for the analysis of accidents, methods adopted for reducing accidents, investigation of accidents, safety slogans, principles of accident(Heinrich theory), accident ratio study, identification of unsafe mechanical/ physical conditions, identification of unsafe acts. Frequency rate, prevention methods.

Module 2: Industrial Safety

SAFETY CONCEPT : Introduction to safety management, safety policy, safety committee, safety review, responsibility of management, safety officers duties & responsibilities, safety targets, objectives, standards, practices and performances. Motivation & communication as part of a safety programme. Duties & responsibility of an owner, duties and responsibilities of a worker, role of a supervisor, role of a safety engineer.

ILO CONVENTION: Introduction of ILO and conventions.

FACTORIES ACT 1948 (Amended): Health - cleanliness, disposal of waste, ventilation and temperatures, dust & fumes, drinking water, lighting, latrines & urinals. safety - fencing of machineries, work on or near machinery in motion, hoists and lifts, pressure plants, floors, stairs and means of escape, protection against fumes & gases, safety offers. Welfare - washing facilities in dry clothing, storing, sitting, first aid appliances, canteen, and shelters for rest & lunch, crèches, welfare offers, rights & obligations of workers.

PREPARATION & ASSESSMENT OF SAFETY AUDIT : Introduction to safety checklist, plant safety inspection, safety precautions adopted in the plant, safety tag system, safety audit report objective of safety audit, type of audit, audit team, elements of safety audit, method of audit, audit steps, concept and layout of audit report.

WELFARE & TRAINING: General provision, drinking water, sanitary & washing, cloakrooms, facilities for food & drink, shelters & living accommodation, information & training.

Module 3: Fire Hazard

BASIC PHYSICS AND CHEMISTRY RELATED TO FIRE: Definition of matter and energy, physical properties of matter like density, specific gravity, relative density, vapour density, melting & boiling point, flammable limits, latent heat, etc, effects of density on behaviour of gases, basics of oxidizing and reducing agents, acids. Flammable liquids -classification and types of tanks, dust and explosion, liquid and gas fires, LPG. UCVE, BLEVE, slope over, boil over, gas laws, P-V-T relation for perfect gas.

ANATOMY OF FIRE: Definition of combustion, elements of combustion, products of combustion, heat of reaction and calorific value, flash point, fire point, ignition temperature and spontaneous combustion. fire triangle, fire tetrahedron, fire pyramid, source of heat(chemical, mechanical, electrical, nuclear etc.), classification of fire and method of fire extinguishment, oxygen and its effects on combustion, mode of heat transfer(conduction, convection & radiation).

CLASSIFICATION OF FIRE & EXTINGUISHERS: Classification of fire and types of extinguishers, maintenance, method of operation, halon and its detrimental effect on environment. Alternatives of halon.Types of fire extinguishing agents, rating system for portable fire extinguishers, limitation of fire extinguishers, inspection requirement.

HOSE & PUMPS, WATER TENDER: fire service hose & hose fittings, fixed fire Fighting installations ropes & lines, practical firemanship, small & special gears, water tender. Types of fire hoses, its construction, causes of decay care & maintenance. Types of hose fittings, identification and use of hose fittings.Types of FFF installations -testing care & maintenance.

HYDRANT, DETECTORS & LADDERS: Introduction to hydrant & hydrant fittings, water supply requirements for fire fighting, introductions to pump & primers, detectors & ladders.
BREATHING SETS: Classification and selection of respiratory personal protective devices, instruction & training in the use, maintenance and care of self containing breathing apparatus.
RESUSCITATION & FIRST AID: Burns, fractures, toxic ingestion, bleeding, wounds and bandaging, artificial respiration, techniques of resuscitation.

Module 4: Electrical & Chemical safety

BASIC PHILOSOPHY OF SAFETY: Peculiarities & parameters governing the safety in construction e.g. site planning, layout, safe access / egress.
Construction Industry: General safety precautions related to construction industry, safety in the use of construction machinery. Industrial lighting: Introduction to lighting, ventilation, heat stress, cold Stress, noise & vibration.
ELECTRICAL SAFETY: Electrical hazards, static electricity. Identification and zoning of hazardous areas, classification of products.
EXCAVATIONS, DEMOLITIONS & STRUCTURAL FRAMES: Safety related to excavation, demolitions, framework & concrete Work, pile driving and work over water.
SAFETY IN MELTING, BOILERS: Hazards in process of melting (furnaces), casting, and forging. Automatic manufacturing activity - machining, chipping, grinding, safety precautions in use of Boilers.
PRECAUTIONS IN PROCESSES: Precautions in processes and operations involving explosive, toxic substances, dusts, gases, vapour, clouds formation and combating, workplace exposure limit, control measures.
SAFETY IN THE ENGINEERING INDUSTRY: Introduction to machine operations & guarding, safety in the use of machines, safety precautions while using hand tools & power tools, selection, maintenance & care of hand and power tools.

Module 5: Transportation and storage of chemicals in industries

CHEMICAL COMPATIBILITY & TRANSPORTATION: Chemicals compatibility considerations, transportation of chemicals, toxic / flammable / explosive / radioactive substances by all modes - safety precautions, use of material Safety Data Sheets.
PERSONAL PROTECTIVE EQUIPMENT: Need for personal protection equipment, selection, use, care & maintenance of respiratory and non-respiratory personal protective equipment, non-respiratory protective devices, head protection, ear protection, face and eye protection, hand protection, foot protection, body protection.
BULK STORAGE: General considerations, types of storage, layout of storages with specific reference to LPG, CNG, chlorine, ammonia.
CHEMICALS ACCIDENT PREVENTION & MAJOR CASE STUDIES: Major industrial accidents due to chemicals (Bhopal gas tragedy) - emergency planning, major industrial disaster case studies.

Text Books

1. **Wills, G.L,** *Safety in Process Plant Design*, John Wiley and Sons

2. **Frank P. Less,** *Loss Prevention in Process Industries, Volume I and II,* Butterworth Heinemann, 1980.

Reference Books

1. **Crowl, D.A and Louvar, J.F,** *Chemical Process Safety: Fundamentals with Applications,* Prentice Hall, Inc.
2. **Pandey, C.G,** *Hazards in Chemical Units: a Study*, Oxford IBH Publishing Co., New Delhi.
3. **Fawcett H.H and Wood W.S,** *Safety and Accident Prevention in Chemical Operation,* 2 Ed, Wiley *Interscience, 1982.*
4. Industrial Safety and Laws*, 1993, by Indian School of Labour Education, Madras.*
5. **Raghavan K. V and Khan A A,** *Methodologies in Hazard Identification and Risk Assessment, Manual by CLRI, 1990.*
6. **Marshal V. C,** *Major Chemical Hazards, Ellis Horwood Ltd., Chichester, United Kingdom, 1987.*
7. *A Guide to Hazard Operability Studies, Chemical Industry Safety and Health Council of the Chemical Industries Association (London , 1977.*

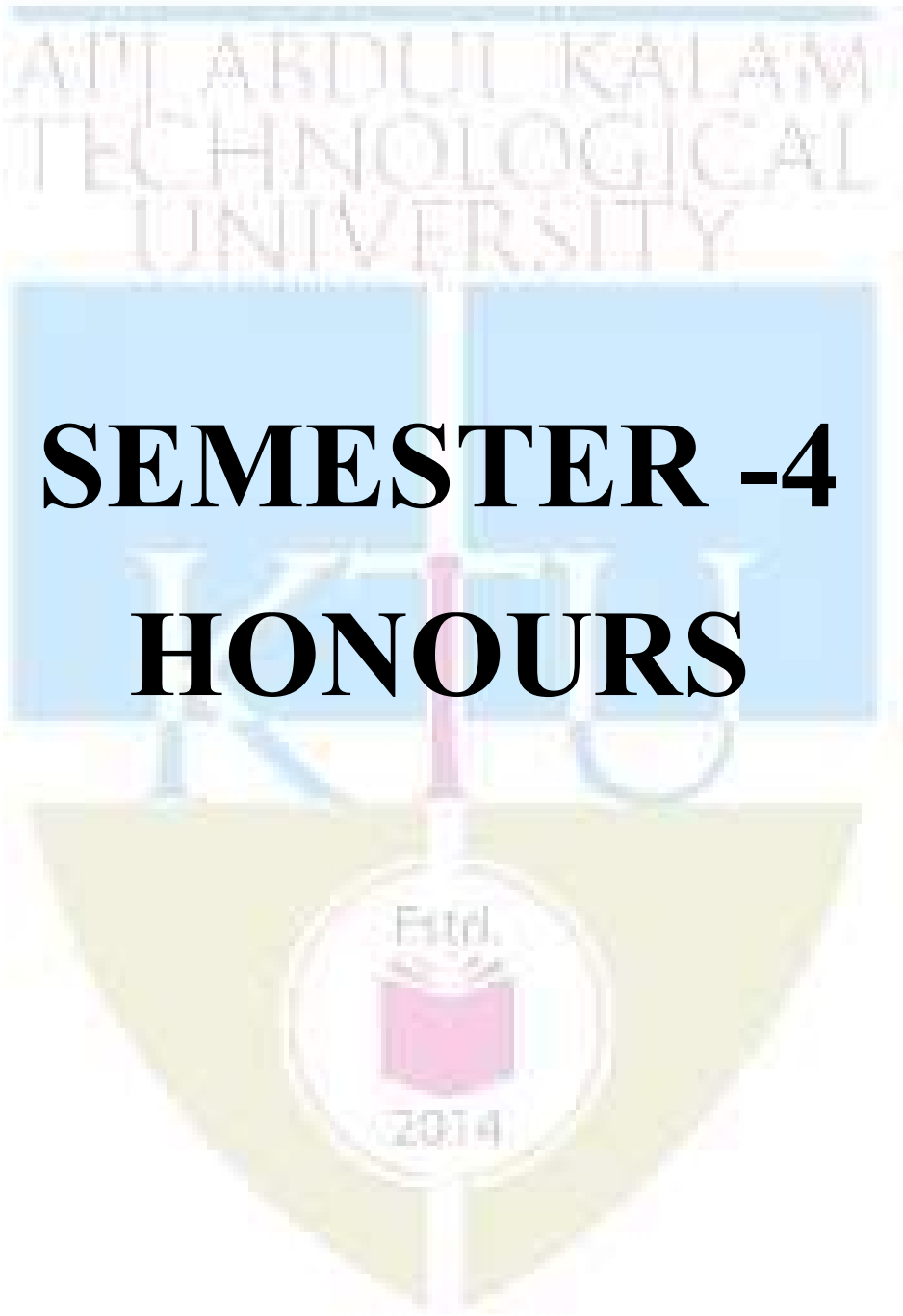
Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Hazard, Risk and Accident (10 hrs)**	
1.1	**HAZARD**: Introduction to hazard, causes, identification, evaluation & control of hazard. HAZOP analysis, Sources for information on hazard evaluation.	2
1.2	**OCCUPATIONAL HAZARDS & DANGEROUS CHEMICALS**: Introduction to occupational health hazards & dangerous properties of chemicals, dust, gases, fumes, mist, vapours, smoke and aerosols, concepts of threshold limit values, classification of hazards.	2
1.3	**RISK ANALYSIS**: Definition of risk, risk analysis, introduction to Failure Mode & Effect Analysis (FMEA), Fault Tree Analysis (FTA), and Event Tree Analysis (ETA).	2
1.4	**ACCIDENT**: Definition of accidents, classification of accidents, need for the analysis of accidents, methods adopted for reducing accidents, investigation of accidents, safety slogans, principles of accident(Heinrich theory), accident ratio study, identification of unsafe mechanical/ physical conditions, identification of unsafe acts. Frequency rate, prevention methods.	3
2	**Industrial Safety (10 hrs)**	
2.1	**SAFETY CONCEPT** : Introduction to safety management, safety policy, safety committee, safety review, responsibility of management, safety officers duties & responsibilities, safety targets, objectives, standards, practices and performances. Motivation & communication as part of a safety programme. Duties & responsibility of an owner, duties and responsibilities of a worker, role of a supervisor, role of a safety engineer.	2

2.2	**ILO CONVENTION**: Introduction of ILO and conventions. **FACTORIES ACT 1948 (Amended)**: Health - cleanliness, disposal of waste, ventilation and temperatures, dust & fumes, drinking water, lighting, latrines & urinals. safety - fencing of machineries, work on or near machinery in motion, hoists and lifts, pressure plants, floors, stairs and means of escape, protection against fumes & gases, safety offers. Welfare - washing facilities in dry clothing, storing, sitting, first aid appliances, canteen, and shelters for rest & lunch, crèches, welfare offers, rights & obligations of workers.	3
2.3	**PREPARATION & ASSESSMENT OF SAFETY AUDIT** : Introduction to safety checklist, plant safety inspection, safety precautions adopted in the plant, safety tag system, safety audit report objective of safety audit, type of audit, audit team, elements of safety audit, method of audit, audit steps, concept and layout of audit report.	2
2.4	**WELFARE & TRAINING**: General provision, drinking water, sanitary & washing, cloakrooms, facilities for food & drink, shelters & living accommodation, information & training.	2
3	**Fire Hazard (10 hrs)**	
3.1	**BASIC PHYSICS AND CHEMISTRY RELATED TO FIRE**: Definition of matter and energy, physical properties of matter like density, specific gravity, relative density, vapour density, melting & boiling point, flammable limits, latent heat, etc, effects of density on behaviour of gases, basics of oxidizing and reducing agents, acids. Flammable liquids -classification and types of tanks, dust and explosion, liquid and gas fires, LPG. UCVE, BLEVE, slope over, boil over, gas laws, P-V-T relation for perfect gas.	2
3.2	**ANATOMY OF FIRE**: Definition of combustion, elements of combustion, products of combustion, heat of reaction and calorific value, flash point, fire point, ignition temperature and spontaneous combustion. fire triangle, fire tetrahedron, fire pyramid, source of heat(chemical, mechanical, electrical, nuclear etc.), classification of fire and method of fire extinguishment, oxygen and its effects on combustion, mode of heat transfer(conduction, convection & radiation).	2
3.3	**CLASSIFICATION OF FIRE & EXTINGUISHERS**: Classification of fire and types of extinguishers, maintenance, method of operation, halon and its detrimental effect on environment. Alternatives of halon. Types of fire extinguishing agents, rating system for portable fire extinguishers, limitation of fire extinguishers, inspection requirement.	2
3.4	**HOSE & PUMPS, WATER TENDER**: fire service hose & hose fittings, fixed fire Fighting installations ropes & lines, practical firemanship, small & special gears, water tender. Types of fire hoses, its construction, caused by decay care & maintenance.	2

	Types of hose fittings, identification and use of hose fittings. Types of FFF installations -testing care & maintenance	
3.5	**HYDRANT, DETECTORS & LADDERS**: Introduction to hydrant & hydrant fittings, water supply requirements for fire fighting, introductions to pump & primers, detectors & ladders. **BREATHING SETS**: Classification and selection of respiratory personal protective devices, instruction & training in the use, maintenance and care of self containing breathing apparatus. **RESUSCITATION & FIRST AID**: Burns, fractures, toxic ingestion, bleeding, wounds and bandaging, artificial respiration, techniques of resuscitation.	2
4	**Electrical & Chemical safety (10 hrs)**	
4.1	**BASIC PHILOSOPHY OF SAFETY**: Peculiarities & parameters governing the safety in construction e.g. site planning, layout, safe access / egress. Construction Industry: General safety precautions related to construction industry, safety in the use of construction machinery. Industrial lighting: Introduction to lighting, ventilation, heat stress, cold Stress, noise & vibration.	2
4.2	**ELECTRICAL SAFETY**: Electrical hazards, static electricity. Identification and zoning of hazardous areas, classification of products. **EXCAVATIONS, DEMOLITIONS & STRUCTURAL FRAMES**: Safety related to excavation, demolitions, framework & concrete Work, pile driving and work over water.	2
4.3	**EXCAVATIONS, DEMOLITIONS & STRUCTURAL FRAMES**: Safety related to excavation, demolitions, framework & concrete Work, pile driving and work over water. **SAFETY IN MELTING, BOILERS**: Hazards in process of melting (furnaces), casting, and forging. Automatic manufacturing activity - machining, chipping, grinding, safety precautions in use of Boilers.	3
4.4	**PRECAUTIONS IN PROCESSES**: Precautions in processes and operations involving explosive, toxic substances, dusts, gases, vapour, clouds formation and combating, workplace exposure limit, control measures. **SAFETY IN THE ENGINEERING INDUSTRY**: Introduction to machine operations & guarding, safety in the use of machines, safety precautions while using hand tools & power tools, selection, maintenance & care of hand and power tools.	2
5	**Transportation and storage of chemicals in industries (8 hrs)**	
5.1	**CHEMICAL COMPATIBILITY & TRANSPORTATION**: Chemicals compatibility considerations, transportation of chemicals, toxic / flammable / explosive / radioactive substances by all modes - safety precautions, use of material Safety Data Sheets.	2

5.2	**PERSONAL PROTECTIVE EQUIPMENT**: Need for personal protection equipment, selection, use, care & maintenance of respiratory and non-respiratory personal protective equipment, non-respiratory protective devices, head protection, ear protection, face and eye protection, hand protection, foot protection, body protection.	2
5.3	**BULK STORAGE**: General considerations, types of storage, layout of storages with specific reference to LPG, CNG, chlorine, ammonia.	2
5.4	**CHEMICALS ACCIDENT PREVENTION & MAJOR CASE STUDIES**: Major industrial accidents due to chemicals (Bhopal gas tragedy) - emergency planning, major industrial disaster case studies.	2



SEMESTER -4

HONOURS

BTT292	CELL SIGNALLING	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble: Understand the process of cell signalling in normal physiological process and its variation during pathological processes

Prerequisite: A basic background in Biochemistry and cellular biology

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand the components, principles and properties of major cell signaling pathways.
CO 2	Describe how cells exploit signaling components to assemble the specific signalingpathways, which they require to communicate which each other or to adapt to changes of external environment.
CO 3	Contemplate on the role of signaling pathways in control of gene expression (transcription and translation) and cellular metabolism.
CO 4	Clinical Significance of Cell signalling

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	-	-	2	-	-	-	-	-	2	-	2
CO 2	2	-	-	-	-	-	-	-	-	2	-	2
CO 3	-	3	-	2	-	-	-	-	-	2	-	2
CO 4	-	3	-	2	-	-	-	3	-	2	-	2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	20
Apply	20	20	70
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Describe the role of integrins in cell communication?

2. How do second massagers play a role in cell signalling?

3. Describe the phosphorylation processes in G protein receptor?

Course Outcome 2 (CO2)

1. Describe the role of transcription factors in the JAK-STA pathway with two specific examples ?

2. Illustrate the activation of protein kinases in glycogen metabolism with a neat diagram?

3. How does ECM affect cell signalling? Illustrate this with one specific example?

Course Outcome 3(CO3):

1. Bring out the key transcription factors and its role in Wnt signalling?

2. Describe the RTK gene and the various domains in general?

3. MAP kinases and their signalling pathways are crucial in pathological conditions. Justify the statement

Course Outcome 4 (CO4):

1. Demonstrate the memory segmentation for x86 architecture.

2. Give an example for generating physical addresses for accessing data segments.

3. Describe the functionality of the pipeline mechanism in X86

Model Question paper

			Total Pages:
Reg No.:_____		Name:_____	
APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY THIRD SEMESTER B. TECH DEGREE EXAMINATION _____ ____ 20__			
Course Code: BTT 292			
Course Name: CELL SIGNALLING			
Max. Marks: 100			Duration: 3 Hours
PART A			
		Answer all questions, each carries 3 marks.	
1	a)	Interpret the reasons to have protein and membrane trafficking in cellular system	
	b)	Define Apoptosis. Comment on the negative role it play in cellular system	
	c)	Brief up the basic principles of cell signalling	
	d)	Critically evaluate the concept integration and amplification of signals.	
	e)	Draw conclusions to prove that response of GPCR is important to trigger the production of second messengers	
	f)	Sketch and explain signal attenuation process	
	g)	Comment on the impact of G protein effectors in protein signalling	
	h)	Analyze signals with long term consequences with reference to proteases	
	i)	Distinguish nuclear receptor cell cycle control system from other components in regulation giving reasons	
	j)	Exemplify physiological roles giving attention to cardiovascular diseases	
PART B			

Answer any one full question from each module. Each carries 14 marks.			
2	a)	Discuss in detail the cytoskeletal organization and dynamics	(14)
		OR	
3		Define cell cycle. Detail the stages in cell cycle with the aid of a neat and labelled diagram	(14)
4	a)	Characterize and analyse the components of signalling	(8)
	b)	Signify the components giving reasons wherever necessary	(6)
		OR	
5	a)	Classify membrane receptors	(8)
	b)	Appraise the functions and importance of receptors in cellular system	(6)
6		Correlate *Ras* to MAPK pathways. Add a note on its importance	(14)
		OR	
7		Relate growth factor/RTS and *Wnt*receptors in cellular system	(14)
8		Detail signal transduction process through Ion channels	(14)
		OR	
9		Critically evaluate the structure and functions of GPCR's in protein signalling	(14)
10		Define Chromatin. Examine chromatin remodelling as a essential component in regulation	(14)
		OR	
11		Outline the topic signalling defects. Relate it to human diseases with examples	(14)
****			

Syllabus

Module 1

Introduction to Advanced cell biology: Protein targeting and membrane trafficking.Cytoskeletal organization and dynamics. Cell adhesion and extracellular matrix, Cell division cycle, Cell cycle and death

Module 2

Signalling pathways in prokaryotes.Two-component system (TCS).Evolution and TCS in eukaryotes.Basic principles of cell signalling. Characterization of signalling components: signalling molecules, receptors, second messengers, effectors, signalling complexes. Integration and amplification of signals.Basic classification and characterization of membrane receptors.

Module 3

Principles of Cell SignalingSystems : General Introduction and Introduction to G Protein-Coupled Receptor (GPCR) Signaling. Growth Factor/ Receptor Tyrosine Kinases (RTKs) and Wnt Receptors.Ras to Mitogen-Activated Protein Kinase (MAPK) Pathways.Protein Kinases.Protein Phosphatases. Domains in RTKs: Structural Aspects

Module 4

G Protein Signaling: Structure of GPCRs, G proteins, and GTPases, GPCRs and Their Modulation, G Protein Effectors. **Signal Transduction Through Ion Channels:** Ligand-Gated Channels, Regulation of Ion Channels by G Proteins, Transient Receptor Protein (TRP) Channels. **Signals with Long-Term Consequences:** Proteases and Signaling, Apoptosis, Cytokine Receptors

Module 5

Regulation of Transcription and Translation: Nuclear Transactivators and Repressors, Chromatin Remodeling , Nuclear Receptors Cell cycle control. Signalling defects.

Examples of physiological roles (apoptosis, cell cycle regulation, gene transcription) and clinical significance (cancer, cardiovascular disease, learning and memory, immune responses).

Text Books

1. Cell Biology by Rastogi : New Age international Publishers
2. Textbook of Cell Signalling in Cancer by Jacques Robert :Springer

Reference Books

1. 1. Molecular and Cellular Signaling. Beckerman , MUSA: Springer

2. Molecular Biology of the Cell; Alberts et al,

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Introduction to Advanced cell biology:**	
1.1	Protein targeting and membrane trafficking.	2
1.2	Cytoskeletal organization and dynamics.	3
1.3	Cell adhesion and extracellular matrix, Cell division cycle, Cell cycle and death	3
2	**Signalling pathways in prokaryotes**	
2.1	Two-component system (TCS). Evolution and TCS in eukaryotes. Basic principles of cell signalling.	3
2.2	Characterization of signalling components: signalling molecules, receptors, second messengers, effectors, signalling complexes. Integration and amplification of signals.	3
2.3	Basic classification and characterization of membrane receptors.	3
3	**Principles of Cell Signalling Systems** :	
3.1	General Introduction and Introduction to G Protein-Coupled Receptor (GPCR) Signalling.	3
3.2	Growth Factor/ Receptor Tyrosine Kinases (RTKs) and Wnt Receptors.	3
3.3	Ras to Mitogen-Activated Protein Kinase (MAPK) Pathways. Protein Kinases. Protein Phosphatases.	3
3.4	Domains in RTKs: Structural Aspects	3
4	**G Protein Signalling**:	
4.1	Structure of GPCRs, G proteins, and GTPases, GPCRs and Their Modulation, G Protein Effectors.	3
4.2	**Signal Transduction Through Ion Channels:** Ligand-Gated Channels, Regulation of Ion Channels by G Proteins, Transient Receptor Protein (TRP) Channels.	3
4.3	**Signals with Long-Term Consequences:** Proteases and Signalling, Apoptosis, Cytokine Receptors	3
5	**Regulation of Transcription and Translation:**	
5.1	Nuclear Transactivators and Repressors, Chromatin Remodelling,	3

	Nuclear Receptors Cell cycle control. Signalling defects.	
5.2	Examples of physiological roles (apoptosis, cell cycle regulation, gene transcription)	2
5.3	Clinical significance (cancer, cardiovascular disease, learning and memory, immune responses).	2

BTT294	BIORESOURCE TECHNOLOGY	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble: Understand the various sources of bioenergy and conversions to a useful form

Prerequisite: Knowledge in Basic Sciences

Course Outcomes: After the completion of the course the student will be able to

CO 1	Disseminate and inculcate knowledge in all the related areas of bioenergy, biotransformation and bio resource systems and technologies associated with conversion or production.
CO 2	Analysis of leading scientific topics for sustainable living based on waste management system.
CO 3	Judge biological mechanisms laying out the fundamental knowledge to undertake better and more efficient scientific and technological advancements in the field of bio resource technology and engineering.
CO 4	Appraise the theoretical aspects of Bio resource technology

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	-	-	2	2	-	-	2	-	-	-	-	1
CO 2	-	-	3	2	-	2	1	2	2	-	-	-
CO 3	-	1	2	2	-	-	2	2	2	-	-	-
CO 4	-	1	3	2	-	-	1	-	-	-	-	1

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	20
Apply	20	20	70
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. State the uses of cellulosic waste for bioconversion.
2. List the feed stock materials used for biogas production.
3. Elaborate the process of enzymatic deinking.

Course Outcome 2 (CO2)

1. Justify the role of microbes in bioethanol production.
2. Exemplify the significance of renewable energy
3. Recall the oxygen sensitivity problems in hydrogenases during biohydrogen production.

Course Outcome 3(CO3):

1. Demonstrate the mechanism of transesterification.
2. List out the factors affecting methane formation
3. Describe the advantages of microbial ethanol production

Course Outcome 4 (CO4):

1. Demonstrate the role of various oils in biofuel production.
2. Give example for pre-treatment technologies used in bioconversion.
3. Describe the role of microbes in biofuel production.

Model Question paper

			Total Pages:
Reg No.:_____		Name:_____	
APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY THIRD SEMESTER B. TECH DEGREE EXAMINATION _____ ____ 20__			
Course Code: BTT 294			
Course Name: BIORESOURCE TECHNOLOGY			
Max. Marks: 100			Duration: 3 Hours
PART A			
		Answer all questions, each carries 3 marks.	
1	a)	What are the different sources of renewable energy sources?	
	b)	Explain the significance of cellulosic materials.	
	c)	Explain the role of chemically reacting lipids in biodiesel production.	
	d)	What are the factors affecting methane formation?	
	e)	List out the applications of biodiesel	
	f)	Name three microorganisms used for bioethanol production.	
	g)	Give a note on Butanol fuel mixtures	
	h)	Which are the common feedstock materials used in biogas production?	
	i)	Give a note on autohydrolysis.	

	j)	Brief about cellulose saccharification.	
PART B			
Answer any one full question from each module. Each carries 14 marks.			
2		Explain bioethanol and biopropanol production.	(14)
		OR	
3	a)	What are the methods employed for ethanol recovery?	(7)
	b)	Explain Octane rating and air fuel ratio.	(7)
4		Explain in detail about different extraction techniques used to separate oil from algae for biodiesel production.	(14)
		OR	
5	a)	What are the different constraints in Biodiesel production?	(7)
	b)	Explain the applications of biodiesel in terms of environmental benefits and concerns?	(7)
6		Explain the bioconversion of lignocellulosic material to value added products using an appropriate flow diagram.	(14)
		OR	
7	a)	What are the different types of feedstocks for the production of biofuel? Explain.	(8)
	b)	Exemplify fuel-related advanced carbon materials and by-products.	(6)
8		With the help of a neat diagram explain in detail the design of a biogas plant. Critically examine the role of microbes in biogas production	(14)
		OR	
9	a)	Explain the factors affecting methane production.	(7)
	b)	Brief about the oxygen sensitivity problems in hydrogenases during biohydrogen production.	(7)
10		Explain the significance of renewable energy.	(14)
		OR	
11	a)	Exemplify the term bioenergy crops.	(7)

	b)	What do you mean by feed stocks? Explain their significance	(7)
****			

Syllabus

Module 1

RENEWABLE ENERGY SOURCE

Hydropower, geothermal power, solar power, wind power. Value added chemicals and production of Biofuel -Biomass - Feed stocks (agricultural crops, bioenergy crops, agricultural waste residues, wood residues, waste stream)

Module 2

FUEL TECHNOLOGY AND BIOCONVERSION

History - Definition of biofuel, applications of Biofuel. Scientific and technological aspects of converting fossil and renewable resources to clean fuels.*Fuel*-related advanced carbon materials and by-products. Significance of Lignocellulosic and cellulosic waste for Bioconversion.Bioconversion of lignocellulosics, cellulose saccharification, pre-treatment technologies (air separation process, mechanical size reduction, autohydrolysis) - Pulping and bleaching – Enzymatic deinking.

Module 3

BIOGAS

Biogas-definition, Biogas plant, feedstock materials, organic matter, such as food scraps and animal waste for biogas production, factors affecting methane formation - Role of microbes – Biohydrogen production - Oxygen sensitivity problems in hydrogenases

Module 4

BIO ETHANOL AND BUTANOL

Role of microbes in Bioethanol and Butanol production, Advantages of ethanol through microbial and enzymatic process, production of ethanol from cellulosic materials, ethanol recovery - Biobutanol production, energy content and effects on fuel economy - Octane rating, air fuel ratio, specific energy, viscosity, heat of vaporization -Butanol fuel mixtures

Module 5

BIODIESEL

Biodiesel definition,Transesterification, Production of biodiesel, Constraints in Biodiesel production and use.Role of chemically reacting lipids (e.g., vegetable oil, soybean oil, animal fat in Biodiesel production.Role of Algae in Biodiesel production, oil extraction from algae by chemical solvents, enzymatic, expeller press - Osmotic shock and ultrasonic assisted extraction - Applications of biodiesel, environmental benefits and concerns.

Text Books

1. Alain A.V., Biomass to biofuels strategies for global Industries, John Wiley &sons ltd, 1st Edition, 2010.
2. Twidell., J & Weir., T., Renewable energy resources, Taylor & Francis 2nd Edition, 2006.

Reference Books

1. Luque, R., Camp, J., Hand book of biofuel production processes and technologies, Woodhead publishing ltd., 1st Edition, 2011.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**RENEWABLE ENERGY SOURCE**	
1.1	Hydropower, geothermal power, solar power, wind power	2
1.2	Value added chemicals and production of biofuel, biomass	2
1.3	Feed stocks -agricultural crops, bioenergy crops	3
1.4	Feed stocks- agricultural waste residues, wood residues, waste stream	2
2	**FUEL TECHNOLOGY AND BIOCONVERSION**	
2.1	History - Definition of biofuel, applications of Biofuel. Scientific and technological aspects of converting fossil and renewable resources to clean fuels.	2
2.2	*Fuel*-related advanced carbon materials and by-products.	1
2.3	Significance of Lignocellulosic and cellulosic waste for Bioconversion. Bioconversion of lignocellulosics, cellulose saccharification	2
2.4	Pre-treatment technologies - air separation process, mechanical size reduction, autohydrolysis.	2
2.5	Pulping and bleaching – Enzymatic deinking.	2

3	**BIOGAS**	
3.1	Biogas-definition, Biogas plant, feedstock materials, organic matter, such as food scraps and animal waste for biogas production	3
3.2	factors affecting methane formation, Role of microbes	2
3.3	Biohydrogen production	3
3.4	Oxygen sensitivity problems in hydrogenases	2
4	**BIO ETHANOL AND BUTANOL**	
4.1	Role of microbes in Bioethanol and Butanol production, Advantages of ethanol through microbial and enzymatic process,	2
4.2	Production of ethanol from cellulosic materials, ethanol recovery	2
4.3	Biobutanol production, energy content and effects on fuel economy	3
4.4	Octane rating, air fuel ratio, specific energy, viscosity, heat of vaporization -Butanol fuel mixtures	2
5	**BIODIESEL**	
5.1	Biodieseldefinition, Transesterification, Production of biodiesel, Constraints in Biodiesel production and use.	2
5.2	Role of chemically reacting lipids (e.g., vegetable oil, soybean oil, animal fat in Biodiesel production. Role of Algae in Biodiesel production	2
5.3	Oil extraction from algae by chemical solvents, enzymatic, expeller press - Osmotic shock and ultrasonic assisted extraction	2
5.4	Applications of biodiesel, environmental benefits and concerns.	2

BTT 296	BIOPROCESS INSTRUMENTATION	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble: An advanced knowledge in process instrumentations and applications

Prerequisite: Knowledge on Bioprocess Calculations

Course Outcomes: After the completion of the course the student will be able to

CO 1	Outline the various elements and characteristics of measuring instruments
CO 2	Explain the working principle of various industrial instruments.
CO 3	Explain various types of biosensors for measurement.
CO 4	Select suitable instruments for measuring process variables.
CO 5	Explain the working principle of analytical instruments.
CO 6	Understand the application of digital computers in fermentation processes and data analysis

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	1	-	-	-	-	-	-	-	-	-	2
CO 2	2	-	-	2	-	-	-	-	-	-	-	-
CO 3	2	-	-	2	-	-	-	-	-	-	-	-
CO 4	3	-	3	-	-	-	-	-	-	-	-	-
CO 5	3	-	-	3	-	-	-	-	-	-	-	-
CO 6	3	2	-	2	-	-	-	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	20
Apply	20	20	70
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Outline the various elements and characteristics of measuring instruments

1. Differentiate between secondary and manipulating elements?
2. Name any two piezoelectric materials used in piezoelectric transducer
3. Discuss the static and dynamics characteristics of measuring instruments

Course Outcome 2 (CO2) : Explain the working principle of various industrial instruments

1. Explain the principle behind the working of Knudsen gauge.
2. Name any two types of positive displacement flow meters
3. List any four biomedical applications of transducers with example.

Course Outcome 3(CO3): Explain various types of biosensors for measurement

1. Explain the basic principle and components of a biosensor.
2. State the role of BOD biosensor in environmental biotechnology
3. Discuss about the on-line sensors for cell properties

Course Outcome 4 (CO4): Select suitable instruments for measuring process variables

1. Discuss the working principle behind manometers.
2. Elaborate the static and dynamics characteristics of measuring instruments

3. Explain the principle of resistance thermometer

Course Outcome 5 (CO5): Explain the working principle of analytical instruments.

1. Comment on the working principle of electrophoretic technique.
2. With a neat sketch, illustrate the working of gas chromatography.
3. Illustrate the instrumentation and working of HPLC with a neat diagram.

Course Outcome 6 (CO6): Understand the application of digital computers in fermentation processes and data analysis

1. List some strategies used for programmed batch bioreaction
2. Discuss data smoothing and interpolation with an example
3. Explain in detail on various elements of digital computers

Model Question paper

			Total Pages:
Reg No.:_____		Name:_____	
APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY THIRD SEMESTER B. TECH DEGREE EXAMINATION _____ ____ 20__			
Course Code: BTT 296			
Course Name: BIOPROCESS INSTRUMENTATION			
Max. Marks: 100			Duration: 3 Hours
PART A			
		Answer all questions, each carries 3 marks.	
1	a)	Differentiate between secondary and manipulating elements?	
	b)	Name any three piezoelectric materials used in piezoelectric transducer	
	c)	Explain the importance of P& I diagrams	
	d)	List any three flow measuring devices	
	e)	Concisely explain any two detectors used in gas chromatography?	
	f)	Define isotachophoresis	
	g)	State the role of BOD biosensor in environmental biotechnology.	
	h	List any three biomedical applications of transducers with example	

	)		
	i)	Discuss Fermentation software system	
	j)	List out various elements of digital computers	
PART B			
Answer any one full question from each module. Each carries 14 marks.			
2		Elaborate the static and dynamics characteristics of measuring instruments	(14)
		OR	
3		Explain the different types of transducers in bioprocess applications	(14)
4	a)	Detail the working of head flow meters.	(7)
	b)	Discuss the working principle behind manometers.	(7)
		OR	
5	a)	What are the precautions to be taken in temperature measuring instruments	(4)
	b)	Explain the principle and working of any two types of temperature measuring instruments with neat sketch	(10)
6	a)	With a neat sketch, illustrate the working of gas chromatography.	(10)
	b)	Differentiate stationary phase and mobile phase with an example?	(4)
		OR	
7	a)	Illustrate the instrumentation and working of HPLC with a neat diagram.	(10)
	b)	Explain the Principle of NMR	(4)
8	a)	With a neat sketch, explain different components of a biosensor.	(7)
	b)	Discuss about the on-line sensors for cell properties	(7)
		OR	
9		Describe any two off line sensors for cell properties with neat sketch	(14)
10	a)	List some strategies used for programmed batch bioreaction.	(7)
	b)	Explain in detail on various elements of digital computers	(7)
		OR	
11	a)	Discuss data smoothing and interpolation with an example	(7)
	b)	Elaborate state and parameter estimation.	(7)
****			

Syllabus

Module 1

Principles of measurement. Error Analysis, Classification, methods of measurements - Direct and indirect measurements, various elements in a measuring instrument , Static and dynamic characteristics of measuring instrument, accuracy, reproducibility, sensitivity, static error, dead zone, dynamic error, fidelity lag, speed of response etc.
Different types of sensors and transducers in bioprocess applications– their classification, principle and working, Recording, indicating and signaling instruments, Transmission methods.

Module 2

Instruments for measuring process variables: Temperature measurement: Filled system Thermometer, Thermocouples- ranges of different types of temperature measuring instruments, resistance thermometers, radiation and optical pyrometers. Sources of errors and precautions to be taken in temperature measurements
Pressure measurement: Principles of working of manometers, various types of manometers - McLeod gauge, Knudsen gauge, Bourdon gauge, bellows, diaphragm, electrical pressure transducers piezoelectric manometers, thermal conductivity gauges- ionisation gauge high pressure measuring instrument
Flow measurement: Head flow meters, area flow meters, positive displacement flow meters, mass and magnetic flow meters and strain gauges. A brief overview of P and I diagrams.
Level measurement: Direct and inferential type.
Miscellaneous measurement: Measurement of density and specific gravity, humidity, viscosity and composition.

Module 3

Monitoring of bioprocess: different types of fermentation-common measurements and control systems, additional sensors, redox, airflow, weight, pressure.Online data analysis for measurement of important physico-chemical and biochemical parameters.
Analytical instruments: Chromatography: GC, HPLC, Spectroscopy: Mass spectroscopy, NMR, autoradiography, Electrophoresis, schematic summary of biochemical reactor instrumentation

Module 4

Biosensors: Various components of biosensors - On-line sensors for cell properties - off-line analytical methods - potentiometric biosensors - Transducers, calorimetric, optical, potentiometric/amperometric, conductometric/resistometric biosensors, Biosensors for glucose, alcohol, carbon dioxide, cell population, BOD

Module 5

Elements of Digital computers; Computer Interfaces and peripheral devices-Data Analysis-Data smoothing and interpolation- State and parameter estimation. Components of a computer linked system-Programmed batch bioreactor-Design and operation strategies for batch plants-Fermentation software system

Text Books

1. Eckman D P, *Industrial Instrumentation*, Wiley Eastern Ltd (1975).
2. Patranabis, Principles of industrial Instrumentation, Tata McGraw Hill
3. Shuler M. L. and Kargi F, Bioprocess Engineering, 2nd Edition, Prentice Hall of India, New Delhi. 2002.
4. Bailey J.E and Ollis D.F, Biochemical Engineering Fundamentals, 2nd Ed., McGraw-Hill Publishing Co.

Reference Books

1. Stanbury P, Whitakar A and Hall S.J, Principles of Fermentation Technology 2nd Ed., Elsevier Pergamon Press, 1999.
2. T.K.Ghose (Ed.) Process Computations in Biotechnology (1994), Tata McGraw Hill.
3. A.Fischer (Ed.), Advances in Biochemical Engineering, Vol. 13, 1973,Springer Verlag, Germany
4. Aiba, Humphry and Millis, Biochemical Engineering , 2nd Ed., (1973),Academic press
5. McNeil and Harvey, Fermentation - A Practical Approach (1990). IRL Press, U.K.
6. Scragg, Bioreactors in Biotechnology - A Practical Approach (1991), Ellis Horwood Ltd., U.K.
7. Kerk F W, Rimboi W, and Tarapore R, Instrumentation, Wiley and Sons, 1983.
8. Considine D N, Process Instruments and Controls Handbook, McGraw Hill, 2001.
9. Andrew W G, Applied instrumentation in the Process Industries Vols I,II,III Gulf Publishing Company, 1987.
10. Ashok Mulchandani and Kim R. Rogers, Enzyme and Microbial Biosensors: Techniques and Protocols- (Eds); Humana Press, Totowa, NJ, 1998.

11. Ashok Mulchandani and Kim R. Rogers, (Eds).;Affinity Biosensors: Techniques and Protocols, Humana Press, Totowa, NJ, 1998.

12. Yang, V.C. and T.T. Ngo, Biosensors and Their Applications, Kluwer Academic/Plenum Publishers, 2000.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Principles of measurement.**	
1.1	Error Analysis, Classification, methods of measurements - Direct and indirect measurements,	2
1.2	various elements in a measuring instrument ,	1
1.3	Static and dynamic characteristics of measuring instrument, accuracy, reproducibility, sensitivity, static error, dead zone, dynamic error, fidelity lag, speed of response etc.	2
1.4	Different types of sensors in bioprocess applications– their classification, principle and working,	2
1.5	Different types of transducers in bioprocess applications– their classification, principle and working,	1
1.6	Recording instruments	1
1.7	indicating and signaling instruments, Transmission methods.	1
2	**Instruments for measuring process variables:**	
2.1	Temperature measurement: Filled system Thermometer, Thermocouples- ranges of different types of temperature measuring instruments,	1
2.2	resistance thermometers, radiation and optical pyrometers.	1
2.3	Sources of errors and precautions to be taken in temperature measurements	1
2.4	Pressure measurement: Principles of working of manometers,	1
2.5	various types of manometers - McLeod gauge, Knudsen gauge, Bourdon gauge,	1
2.6	bellows, diaphragm, electrical pressure transducers piezoelectric manometers	1
2.7	thermal conductivity gauges- ionisation gauge high pressure measuring instrument	1
2.8	Flow measurement: Head flow meters, area flow meters,	1
2.9	Positive displacement flow meters, mass and magnetic flow meters and strain gauges.	1
2.10	A brief overview of P and I diagrams.	1
2.11	Level measurement: Direct and inferential type.	1
2.12	Miscellaneous measurement: Measurement of density and specific gravity	1

2.13	humidity, viscosity and composition	1
3	**Monitoring of bioprocess:**	
3.1	Different types of fermentation-common measurements and control systems, additional sensors, redox, airflow, weight, pressure.	1
3.2	Online data analysis for measurement of important physico-chemical and biochemical parameters.	1
3.3	Chromatography: GC,	1
3.4	HPLC	1
3.5	Spectroscopy: Mass spectroscopy,	1
3.6	NMR,	1
3.7	autoradiography,	1
3.8	Electrophoresis	1
3.9	schematic summary of biochemical reactor instrumentation	1
4	**Biosensors**:	
4.1	Various components of biosensors	1
4.2	On-line sensors for cell properties	1
4.3	off-line analytical methods - potentiometric biosensors -	1
4.4	Transducers, calorimetric biosensors	1
4.5	optical, potentiometric/amperometric biosensors	1
4.6	conductometric/resistometric biosensors	1
4.7	Biosensors for glucose, alcohol,	1
4.8	Biosensors carbon dioxide, cell population, BOD	1
5	**Elements of Digital computers;**	
5.1	Computer Interfaces and peripheral devices	1
5.2	Data Analysis-Data smoothing and interpolation- State and parameter estimation.	1
5.3	Components of a computer linked system-	1
5.4	Programmed batch bioreactor-Design and operation strategies for batch plants	1
5.5	Fermentation software system	1