Reg. No. | | | | | | | | | | | | | |

B.E / B.TECH. DEGREE EXAM1INATION, MAY 2023

Fifth Semester

BT18501- BIOPROCESS ENGINEERING

(Biotechnology)

(Regulation 2018)

TIME: 3 HOURS **MAX. MARKS: 100**

CO 1 Select different operation modes according to appropriate bioreactor configurations
CO 2 Examine the factors involved in oxygen mass transfer in bioreactors
CO 3 Apply selection criteria with respect to bioreactor consideration in enzyme systems
CO 4 Interpret the stoichiometry and energetics of product formation mediated by cell growth
CO 5 Accomplish knowledge about the fundamentals of modeling and simulations of bioprocess

PART- A (10 x 2 = 20 Marks)

(Answer all Questions)

		CO	RBT LEVEL
1.	Comment on the rheological properties of fermentation medium.	**1**	**2**
2.	During the operations of a microbial fermentations, a proteinaceous material released into the medium by the cells forming froth. How do you control the foam formation?	**1**	**2**
3.	Deduce the equation for studying specific growth rate of microbial cells..	**2**	**3**
4.	Calculate the respiratory quotient for the given equation: $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$	**2**	**5**
5.	List out the design considerations for the fluidised bed reactor.	**3**	**3**
6.	Outline the sterilization design criterion: Del factor.	**3**	**4**
7.	List the agitation parameter which acts as scale up factors and why is this important?	**4**	**2**
8.	Rate of oxygen consumption by the cells determines the rate of oxygen transfer from gas to broth. Mention few factors which influences the oxygen demand in aerobic fermentation process.	**4**	**2**
9.	Differentiate Structured and unstructured models	**5**	**2**
10.	Illustrate the model which helps to study the inhibition constants	**5**	**4**

PART- B (5 x 14 = 70 Marks)

			Marks	CO	RBT LEVEL
11. (a)	**(i)**	A continuous culture system is being constructed and fermentation tank is of 50000 L in size and the residence time is of 2 hrs. The unsterilized medium contains spores and the sterilization process is carried out for 4 weeks in continuous mode. The level of microorganism present in the reactor has to reduce to 10-fold from its initial level. Describe the sterilization procedure and categorize the organisms based on their viability temperature range.	**(7)**	**1**	**3**
	(ii)	Interpret the above process in terms of design equations and derive the expression for thermal cell death rate kinetics using graphical plots.	**(7)**	**1**	**3**
		(OR)			
(b)	**(i)**	In the food industry, it is important to reduce the number of microbes in products to ensure proper food safety. This is usually done by thermal processing and finding ways to reduce the number of bacteria in the product. How long it would take to reduce the bacterial population by 90% at a given state of the killing agent. To predict the above case: Outline the various phases of microorganisms and its changes in terms of cell number.	**(7)**	**1**	**3**
	(ii)	Deduce the constants for exponential increase in growth and the rapid death of microorganisms.	**(7)**	**1**	**3**
12. (a)	**(i)**	A genetically engineered strain is cultured in the reactor at 30°C for the production of heterologous protein. The oxygen requirement, solubility of the oxygen in the medium is monitored regularly during the process. Give a detailed description about the steps for the mass transfer of gas from the culture medium to the cells if the reactor is sparged with air approximately at 1 atm pressure.	**(7)**	**2**	**4**
	(ii)	Enlist different methods for the determination of KLa.	**(7)**	**2**	**4**
		(OR)			

(b)	**(i)**	During aerobic bioprocess, the oxygen is transferred from a rising gas bubble into a liquid phase and ultimately to the site of oxidative phosphorylation inside the cell. Explain the concept using film theory and justify the importance of oxygen in the bioprocesses.	**(7)**	**2**	**4**
	(ii)	What are the major resistances in oxygen transfer to the cells during the process?	**(7)**	**2**	**4**
13. (a)	**(i)**	It is a semi-batch operation in which nutrients are fed either intermittently or continuously during the course of otherwise batch operation. The culture broth is harvested only at the end of the operational period (full volume), either fully or partially. Derive the balance equation for the above process assume it occurs at quasi steady state conditions.	**(7)**	**3**	**2**
	(ii)	Derive the product formation kinetic equation for the above-mentioned process.	**(7)**	**3**	**2**
		(OR)			
(b)	**(i)**	After a batch fermentation process, the system is dismantled and approximately half of the cell mass suspended in the liquid phase (2L) is attached to the walls of the reactor as a thick film. The target product is associated with each such cell fractions. If the reactor is scaled up to 20000 L, what are the problems associated with it? (a)What would be the required conditions of the reactors based on oxygen transfer.	**(7)**	**3**	**2**
	(ii)	What would be the required conditions of the reactors based on power consumption and impeller tip speed.	**(7)**	**3**	**2**
14. (a)		Anaerobic digestion of volatile acids by methane bacteria is represented by the equation $CH_3COOH + NH_3 \rightarrow Biomass + CO_2 + H_2O + CH_4$ The composition of methane bacteria is approximated by the empirical formula $CH_{1.4}O_{0.40}N_{0.20}$. For each kg acetic acid consumed 0.67 kg CO_2 is evolved. How does the yield of methane under these conditions compare with the maximum possible yield?	**(14)**	**4**	**4**
		(OR)			

(b)		Production of recombinant protein by a genetically-engineered strain of *Escherichia coli* is proportional to cell growth. Ammonia is used as nitrogen source for aerobic respiration of glucose. The recombinant protein has an overall formula $CH_{1.55}O_{0.31}N_{0.25}$. The yield of biomass from glucose is measured at 0.48 gg^{-1}; the yield of recombinant protein from glucose is about 20% that for cells (a) How much ammonia is required? (b) What is the oxygen demand?	**(`14)**	**4**	**4**
15. (a)		Derive the equation for identifying the substrate utilization rate and saturation rate in the continuous stirred tank reactor using unstructured model.	**(14)**	**5**	**3**
		(OR)			
(b)		It is a 'closed system', whereby the substrate and producing microorganism are added to the system at time zero and are not removed until the fermentation is complete. Explain the above concept using logistic models based on leudeking piret equation.	**(14)**	**5**	**3**

PART- C (1 x 10 = 10 Marks)

(Q.No.16 is compulsory)

		Marks	CO	RBT LEVEL
16.	A researcher was carrying out the lipase production by *Aspergillus niger* using shea butter cake as the main substrate. She tries to identify the parameters which influence the lipase production so as to generate reliable and more manageable set of components, as well as indicating how each component affects the overall response. What type of model optimization method she can adopt in order to evaluate the parameters.	**(10)**	**5**	**5**

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