Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME – SEMESTER IV (NEW) – • EXAMINATION – SUMMER 2016

Subject Code: 2743004 **Date:04/05/2016**

Subject Name: Bioprocess &Biochemical Engineering

Time:10:30 am to 01:00 pm **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Starting from the basic equation between enzyme and substrate derive the Michaelis-Menten equation for the enzyme catalyzed reaction. State the assumptions clearly. How do you determine the kinetic parameters of the above equation? **07**

(b) Discuss primary, secondary and tertiary structure of proteins with schematic. What is protein denaturation. State the biological functions of proteins. **07**

Q.2 **(a)** Derive the design equations for continuous stirred tank fermenter with recycle of biomass. Draw the schematic and state the assumptions. What are the conditions that must be fulfilled for a settler thickener system to operate satisfactorily? **07**

(b) Anaerobic fermentation typically produces a variety of partially oxygenated compounds in addition to cell mass. In the cell molecular formula is given by $C_6H_{10}O_3N$, calculate the unknown coefficients for the following typical equation where coefficients are given as mole quantities and not in mass. **07**

5.56 (Glucose) + α (NH_3)

$\rightarrow$ β (cell mass) + γ (Butanol) + ξ (Succinic acid) +

2.20 (glycerol) + 3.40 (H_2O) + 3.75 (CO_2) + 1.08 (Ethanol)

OR

(b) Aerobic degradation of an organic compound by a mixed culture of organisms in waste water can be represented by the following reaction: **07**

$$C_3H_6O_3 + aO_2 + bNH_3 \rightarrow cC_5H_7NO_2 + d\,H_2O + e\,CO_2$$

i) Determine a, b, c, d and e, if $Y_{x/s} = 0.4$ g X/g S.

ii) Determine the yield coefficient s $Y_{x/O2}$ and $Y_{x/NH3}$

Q.3 **(a)** State and explain the principle of centrifugation for cell separation in fermentation. Explain with a diagram and example how various organelles of eukaryotic cells can be separated by differential centrifugation. **07**

(b) In a fermentation process producing baker's yeast, the biomass is separated using a continuous centrifuge, operating at 4000 rpm, with a feed rate of 80 l/min. The solid particles may be assumed to have an average diameter of 0.05 mm. The density of the biomass is 1010 kg/m^3. The fluid may be assumed to have properties of water. Find the sigma factor for the centrifuge. **07**

OR

Q.3 **(a)** Discuss thermal death rate kinetics during sterilization of microbial cells. **07**

(b) A liquid medium in a batch fermenter having working volume 1000L is sterilized in situ at 122°C. The initial concentration of bacterial spores in the medium was found to be 5×10^5 ml^{-1}. The sterility level after the holding cycle of sterilization is desired not to exceed 10^{-3} ml^{-1}. Initial temperature of the medium is 32°C and during heating cycle 10% of microorganism is expected to be destroyed. Calculate the holding time. Additional data given (Thermal death rate constant $\alpha = 8.0 \times 10^{38}$ min^{-1}; $E = 29 \times 10^7$ J/kmol **07**

Q.4 **(a)** Discuss various correlations dimensionless numbers with mass transfer coefficients for bubble and bubble swarms in freely rising or falling bodies. **07**

(b) Distinguish between prokaryotic and eukaryotic cells. Explain the salient features of different types of eukaryotes and proakryotes with more elaboration. **07**

OR

Q.4 **(a)** Enlist various gas-liquid mass transfer resistances in cellular system. **07**

(b) State various methods of determination of volumetric mass transfer coefficient and explain any one. State the factors affecting volumetric mass transfer coefficient. **07**

Q.5 **(a)** A new microorganism has been discovered which at each cell division yields three daughters. From the growth rate data given below calculate the mean time between successive cell divisions. **07**

t, h	Cell dry wt, g/L
0	0.10
0.5	0.15
1.0	0.23
1.5	0.34
2.0	0.51

(b) Briefly describe various methods of product separation and purification operations in bioprocess industries. **07**

OR

Q.5 **(a)** What are the advantages of enzyme immobilization? Explain with neat diagram various methods of immobilization. **07**

(b) When a pilot scale fermenter is run in a continuous mode with a fresh feed flow rate of 65 l/h, the effluent from the fermenter contains 12 mg/l of the original substrate. The same fermenter is then connected to a settler thickener which has the ability to concentrate the biomass in the effluent from the tank by a factor of 3.2 and from this a recycle stream of concentrated biomass is set up. The flow rate of this stream is 40 l/h and the fresh feed flow rate is at the same time increased to 100 l/h. Assuming that the system follows Monod kinetics, calculate the concentration of the final clarified liquid effluent from the system (μ_m = 0.15 h^{-1}, and K_s = 95 mg/l) **07**

****