大葉大學九十二學年度碩士班甄試試題紙					
所　別	組別	考試科目（中文名稱）	考試日期	考試時間	備註 共2頁
生物產業科技	甲組	生化工程	12月9日	9:00-10:30	可攜帶計算機

註：詳列計算步驟否則一概不計分。

1. Please describe the following technical terms in biochemical engineering:
   (a) What is Biochemical Engineering? What is Biotechnology?
   (b) What is the growth pattern of microorganism in batch cultures?
   (c) What is the typical chemical process? (20 points)

2. Derive the Michaelis-Menten equation for the following enzyme-catalyzed reaction by using an equilibrium assumption for the enzyme-substrate (ES) complex forming step and by using in terms of the substrate (S), the water (W), the enzyme (E), the total enzyme (E_o), the product (P), and the specific reaction rates k_1, k_2, and k_3.

$$E + S \xrightarrow{k_1} ES$$
$$ES \xrightarrow{k_2} E + S$$
$$ES + W \xrightarrow{k_3} P + E$$

(20 points)

3. (a) Milk is pasteurized if it is heated to 63°C for 30 min, but if it is heated to 74°C it only need 15 sec for the same result. Find the temperature to heat 1 min to have the same result in this sterilization process. (Arrhenius' equation: $k = k_o \exp(-E/RT)$; R=8.314 J/gmol^{-1}K^{-1}) (15 points)
   (b) For high temperature and short time sterilization process, a liquid of culture broth flows at a rate of 5.0 kg/s through a sterilized tube having an inside diameter of 0.04 m. The sterilized tube wall is maintained at constant temperature of 400 K and constant heat flux is maintained. The culture broth enters at 300 K and is heated to 380 K in the tube. Calculate the heat-transfer coefficient, h_L, and the required tube length.
   The average physical properties are as follows: $\mu=7.0\times10^{-4}$kg/m·s, $\rho=7500$kg/m^3, $C_p=120$J/kg·K, k=10W/m·K. For constant wall temperatures, $N_{Nu}=h_L D/k = 5.0+0.025N_{Pe}^{0.8}$ for L/D>60 and $N_{Pe}>100$ where $N_{Pe}=N_{Re}N_{Pr}$, $N_{Re}=D G/\mu$, $N_{Pr}=C_p \mu/k$, and G is mass velocity or mass flux in kg/s·m^2. (20 points)

4. Calculate the maximum rate of absorption of O_2 in a fermenter from air bubbles at 1 atm abs pressure having diameters (D_p) of 100 μm at 37°C into broth liquid having a zero concentration of dissolved O_2. The solubility of O_2 from air in broth at 37°C is 2.26 x 10^{-4}gmol O_2/m^3 broth. The diffusivity (D_{AB}) of O_2 in broth at 37°C is 3.25 x 10^{-9} m^2/s. Agitation is used to produce the air bubbles. Assume the viscosity (μ_c) of broth is 6.947 x 10^{-4} kg/m s and the density (ρ_c) of broth is 994 kg/m^3 at 37°C. Assume the density (ρ_p) of air bubbles is 1.13 kg/m^3.
   The following equation is shown to predict mass-transfer coefficients (k_L) from small gas bubbles such as O_2 to liquid phase.

$$k_L = 2D_{AB}/D_p + 0.31N_{Sc}^{-2/3}(\Delta\rho\,\mu_c\,g/\rho_c^2)^{1/3}$$

   where D_{AB} is the diffusivity of the air bubble A in broth liquid B in m^2/s, D_p is the diameter of air bubbles and g = 9.806 m/s^2, $\Delta\rho = \rho_c - \rho_p$, $N_{Sc} = \mu_c/(\rho_c D_{AB})$
   The following equation is shown to predict the maximum rate of absorption of O_2.

$$N_A = k_L (C_{A1} - C_{A2})$$

(25 points)