B.E - VII Sem Biotech.

QP Code : 5925

Bioprocess Modeling & Simulation. BE/VII/CBGS/BT/BMS

(3 hours) (21) Total marks: 80

1) Question No.1 is compulsory.
2) Attempt any three questions from remaining five questions.
3) Assume suitable data if necessary and indicate it clearly.

Q.1. Explain any four of the following

(a) What is the difference between modelling and simulation? **(05)**

(b) State some applications of modelling and simulation in bio-processes. **(05)**

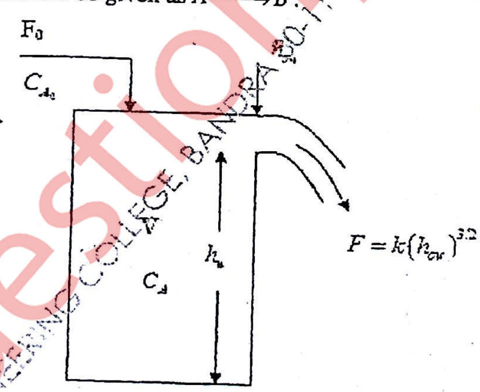
(c) Differentiate between modular and equation oriented approach of modelling. **(05)**

(d) Differentiate between linear and nonlinear model with one example. **(05)**

(e) State and explain various enzyme growth kinetic models. **(05)**

(f) State and explain various methods of sterilization. What is the importance of sterilization in bio-process operations? **(05)**

Q.2. (a) A perfectly mixed isothermal CSTR has an outlet weir. The flow rate over the weir is proportional to the height of liquid over the weir, how to the 1.5 power. The weir height is h_w. The cross sectional area of the tank is A. Assume reaction is first order with constant density. Reaction takes place in the tank that can be given as $A \xrightarrow{k} B$. **(10)**



(b) Write general forms of mass, energy and momentum balance equations based on conservation law. (10)

Q.3. (a) What is simulation and explain the types of process simulation problems? (05)

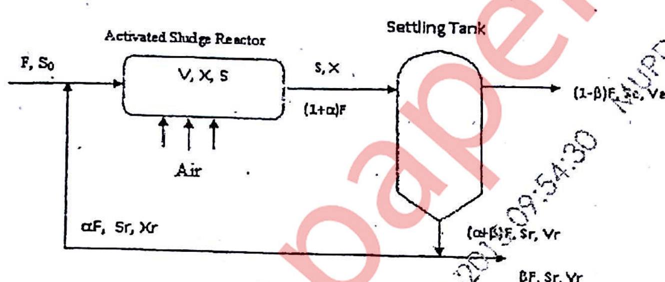
(b) Calculate the specific volume of superheated steam at pressure and temperature of 10 MPa and 623 K respectively using Newton Raphson method. Vander Walls equation is given as (15)

$$\left(P+\frac{a}{V^2}\right)(V-b)=RT$$

$$a=\frac{27R^2T_c^2}{64P_c}, b=\frac{RT_c}{8P_c}$$

$$P_c=22.076 MPa, T_c=647.11K$$

Q.4. (a) Develop a mathematical model for activated sludge process. (10)

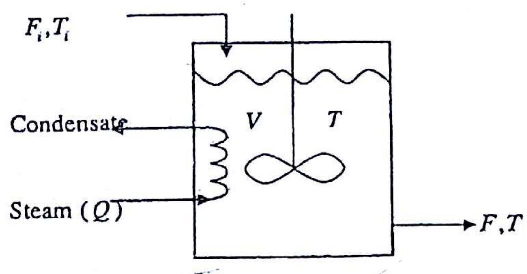


(b) Solve the following equations using Gauss Siedal iteration method (10)

$$10x_1-2x_2-x_3-x_4=3$$
$$-2x_1+10x_2-x_3-x_4=15$$
$$-x_1-x_2+10x_3-2x_4=27$$
$$-x_1-x_2-2x_3+10x_4=-9$$

Q.5. (a) Develop a mathematical model for ethanol fermentation process. (10)

(b) Consider a stirred heating tank as shown in figure below. Liquid at temperature T_i flowing into the tank at a volumetric flow rate F_i, is heated by steam flowing through the steam coil arrangement at a rate Q (mass/time). The heated fluid now at a temperature T, is withdrawn at the same volumetric flow rate F. The tank volume is V and the latent heat of vaporization of steam is λ. Consider constant density (ρ) and heat capacity (C_p) of the reacting material. Derive the overall mass and energy balance equations making appropriate assumptions. (10)



Q.6 (a) The reaction rate constant for the decomposition of a particular acid has been determined at various temperatures as given in table below (10)

T in Celsius	50	70.1	89.4	101
k in hr^{-1}	1.08×10^{-4}	7.34×10^{-4}	45.4×10^{-4}	138×10^{-4}

Use the method of least squares to determine the activation energy E in the equation $k = Ae^{-E/RT}$ where T is measured in Kelvin.

(b) Develop the mathematical model of thermal death kinetics for batch sterilization Micro-organism. (10)