Paper Code: CH-701	Roll No.										

B. Tech.

SEVENTH SEMESTER EXAMINATION, 2016-17

PROCESS MODELING AND SIMULATION

[Time: 3 Hours] [Total Marks: 100]

Note: Attempt ***ALL*** questions. Assume suitable data, if required. All question carry equal marks.

1. Attempt any *four* parts of the following: - **(5x4=20)**

(a) Explain in detail the use of mathematical models.
(b) Write the component continuity equations for a perfectly mixed batch reactor (no inflow or outflow) with first-order isothermal reversible reactions.
(c) Describe the degree of freedom of flash distillation column with a neat sketch.
(d) Write the short note on equation of motion.
(e) Derive the mass balance equations for interacting and non-interacting tanks.
(f) Explain the terms- lumped parameter system and distributed parameter system.

2. Attempt any *two* parts of the following: - **(10x2=20)**

(a) Water is flowing into a cylindrical tank at the constant rate of 0.3 m^3/s and flowing out at the rate given by F= 0.12 $h^{1/2}$ where F is the flow rate of water in m^3/s and h is the depth of water in the tank in meter. The cross section area of tank is 0.9 m^2. Calculate depth of water at 25 sec if the initial depth of water is 3 m. Use fourth order Runge-Kutta method.

(b) Air at 25^0C and 1atm flow though a 4 mm diameter tube with an average velocity of 50 m/s. The roughness is ε = 0.0015mm. Using Newton Raphson method, calculate the friction factor using the Colebrook equation

$$\frac{1}{\sqrt{f}} = -2.0log\left(\frac{\varepsilon/D}{3.7} + \frac{2.51}{Re\sqrt{f}}\right)$$

Determine the pressure drop in a 1m section of tube using the relation

$$\Delta P = (fL\bar{V}^2\rho)/2D$$

Density of air at 25^0C and 1atm is 1.23 kg/m^3 and viscosity is 1.79 X 10^{-5} kg/m-s.

(c) With a neat diagram**,** develop a equation describing the dynamic changes in series of isothermal constant – holdup CSTRs.

3. Attempt any *two* parts of the following:- **(10x2=20)**

(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, h_{ow} to the 1.5 power. The weir height is h_w. The cross-sectional area of the tank is A. Assume constant density. A first-order consecutive reaction takes place in the tank. Reactant A goes to B at a specific reaction rate k_1, but B can react at a specific reaction rate k_2 to form third component C: $A \overset{k_1}{\rightarrow} B \overset{k_2}{\rightarrow} C$
Derive the equations describing the system and also draw neat diagram.

(b) An irreversible exothermic reaction is carried out in a single perfectly mixed CSTR. $A \overset{k}{\rightarrow} B$ The reaction is first order in reactant A and has a heat lost of reaction λ (kJ/kmol of A reacted). Assume negligible heat losses and constant densities. To remove the heat of reaction a cooling jacket surrounds the reactor. Cooling water is added to the jacket at a volumetric flow rate F_J and with an inlet temperature of T_{JO}. The volume of water in jacket V_J is constant. The mass of the metal walls are assumed negligible.

(i) Develop the mathematical model for perfect mixed cooling jacket with neat diagram and

(ii) Define above model specified, underspecified or over specified.

(c) Solve the following equations by Gauss-Jordan method

10x+y+z=12, 2x+10y+z=13, x+y+5z=7

4. Attempt any *two* parts of the following:- **(10x2=20)**

(a) Solve the equation $\frac{dy}{dx} = \frac{1}{x^2} - \frac{y}{x}$ given y(1)=1, y(1.1)=0.996, y(1.2)=0.986, y(1.3)=0.972 find the value of y(1.4) and y(1.5) using Milne's Predicator and Corrector method.

(b) Develop a mathematical model for ideal binary distillation column.

(c) Write the model equations involved in a Batch reactor when it is in the heating phase with a neat diagram

5. Write short note on any *four* parts of the following: - **(5x4=20)**

(a) Continuity balance and component Continuity balance
(b) Sequential modular approach
(c) Chemical potential
(d) Simulation software
(e) Scope of process simulation
(f) Equation of state