(3 Hours) **Total Marks: 80**

N.B.

1. Question No. 1 is Compulsory.
2 Attempt any **Three** Questions from remaining **Five** Questions
3. Assume Suitable Data if needed and Justify the Same
4. Figures to the right indicate full marks.

Que.1

a) Discuss principles of formulation of process models [05]

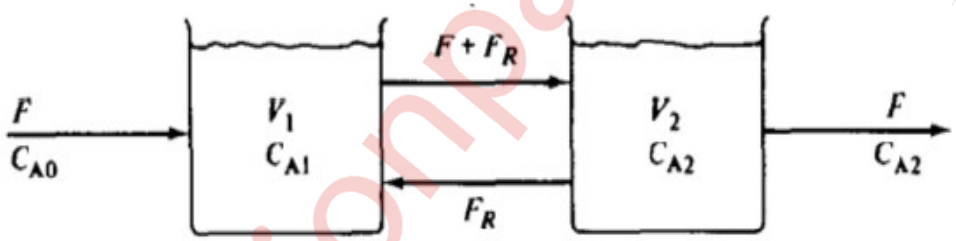
b) Write applications and limitation of ANNs in Chemical Engineering [05]

c) Give the Difference Sequential and Equation oriented Simulation [05]

d) Write total continuity equation,component continuity equation and energy balance equation for dynamic system [05]

Que.2

a) An isothermal, irreversible reaction $A \rightarrow B$ takes place in the liquid phase in a constant volume reactor. The mixing is not perfect. Observation of flow patterns indicates that a two-tank system with back mixing, as shown in figure below, should approximate the imperfect mixing. Assuming F and F_R are constant; Develop the equations that can describe the system? [10]



b) The flow rate F (m^3/s) of oil passing through two perfectly mixed tanks in series is constant. The density ρ (kg/m^3) of the oil is constant. The volume of tank 1 is V_1 and that of thank 2 is V_2. The temperature of oil entering the first tank is T_o. The temperatures in the two tanks are T_1 and T_2. A heating coil in the first tank uses steam to heat the coil. Let Q_1 be the heat addition rate in the first tank. [10]

a. Derive the mathematical model for this system
b. Perform DOF for this system

Que.3 Feed stream with pure species P and Q are mixed with recycle stream enter CSTR, where following reactions take place [20]

$$P + Q \rightarrow X$$
$$X + Q \rightarrow S + R$$
$$S + X \rightarrow Z$$

Here, X is an intermediate, S is main product, R is bi product and Z is oily waste. The plant consist of reactor, a heat exchanger to cool reactor effluent, a decanter to separate waste product Z from reactants and other products and a distillation column to separate product S. Due to formation of an azeotrope some of product (equivalent to 15 wt% of mass flow rate of component R) is retained in the column bottom. Most of the bottom product is recycled to reactor and rest is purged. Construct a Williams-otto flowsheet and develop the process equations.

Que.4

a) Determine solution for the following equation using Armijo line search method take α has 1and initial guess has x=[2, 1] ? [10]

$$f_1 = 2x_1^2 + x_2^2 - 6 = 0$$

$$f_2 = x_1 + 2x_2 - 3.5 = 0$$

b) The model equation for a three CSTR in series is given below, At t=0, CA_0=1.8 kmol/m^3, $CA_1(0)$=0.4 kmol/m^3, $CA_2(0)$=0.2 kmol/m^3,$CA_3(0)$=0.1 kmol/m^3, τ=2, $k_1=k_2=k_3$=0.5, find concentration in all the reactor at t=0.2 using Runge Kutta-4th order method take the step size in time as 0.1? [10]

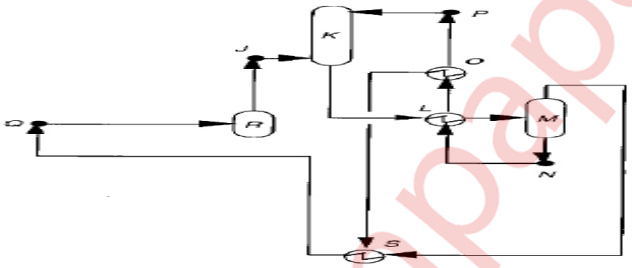
$$\frac{dC_{A1}}{dt} = \frac{1}{\tau}(C_{A0}) - \left(\frac{1}{\tau} + K_1\right)C_{A1}$$

$$\frac{dC_{A2}}{dt} = \frac{1}{\tau}(C_{A1}) - \left(\frac{1}{\tau} + K_2\right)C_{A2}$$

$$\frac{dC_{A3}}{dt} = \frac{1}{\tau}(C_{A2}) - \left(\frac{1}{\tau} + K_3\right)C_{A3}$$

Que.5

a) Determine the tear stream for the following flowsheet [10]



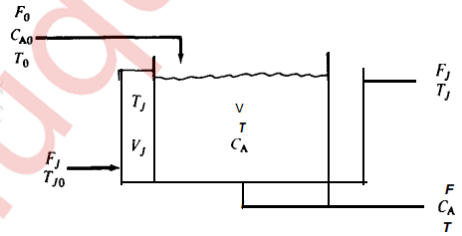
b) Write the component continuity equations describing the CSTR with [10]

1. Simultaneous reactions (first order, isothermal): $A \xrightarrow{k1} B$, $A \xrightarrow{k2} C$
2. Reversible (first order, isothermal) : $A \leftrightarrows B$ with k_1 and k_2 respective rate constants for forward and backward reactions

Q.6A Derive the mathematical model for the a non-isothermal CSTR with an irreversible exothermic reaction [10]

$$A \xrightarrow{k} B$$

The reaction is nth order in reactant A and a heat of reaction λ. Consider a perfectly mixed cooling jacket



Q 6 B [10]

i. Write short note on feed forward neural networks

ii. What are artificial neural networks? How an artificial neuron model can be compared with biological neuron model