(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) Explain classification of mathematical methods **[05]**

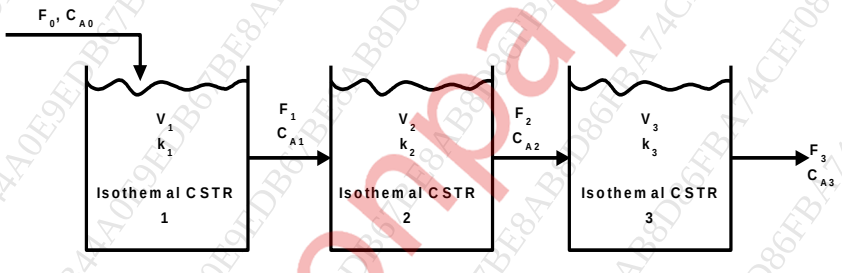
b) Write applications and limitation of ANNs in Chemical Engineering **[05]**

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

d) Differentiate between lumped and distributed parameter models **[05]**

Que.2

a) Three CSTR's are connected in a series of reaction $A \rightarrow B$ is taking place in each reactor by a first order reaction occurring in the liquid. Assume both temp and the liquid volume are constant (Isothermal and constant holdup). The rate constant in each reactor is k_1, k_2, and k_3. Volume of reactor is V_1, V_2, and V_3 respectively. A reactant A is fed to first reactor at a flow rate F_0 at concentration C_{A0}. Derive mathematical model for the above system. **[10]**



b) 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 reaction takes place in the tank:$A \xrightarrow{k} B$. Derive the equation describing the system **[10]**

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) Solve the fixed point problem given by **[10]**

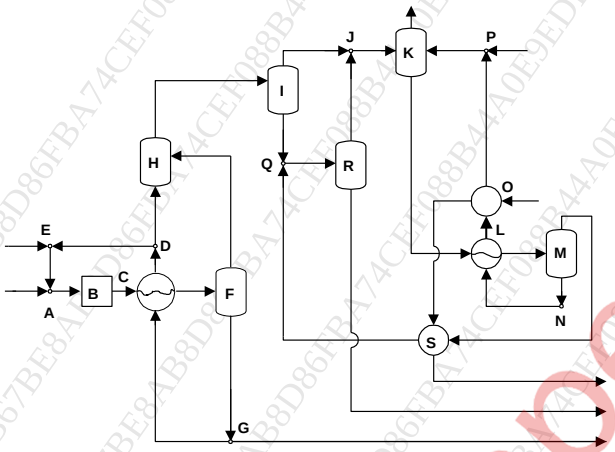
$$x_1 = 1 - 0.5\exp(0.7(1 - x_2))$$
$$x_2 = 2 - 0.3\exp(0.5(x_1 + x_2))$$

Using direct substitution method starting from x_1= -1 and x_2= -1.

b) Maximize $f(x)=12x-3x^4-2x^6$ using one dimensional search method (Bisection method) over a closed interval (0,2) with a tolerance level of ε=0.01 **[10]**

Que.5

a) For the flow diagram given below find the partitions and develop precedence order **[10]**



b) Find solution of the following equation using fixed point iteration (direct Substitution method) take initial guess as x_1=5 and x_2=5 and x_3=0 **[10]**

$$f_1(x) = x_1^2 + x_2 - 37 = 0$$
$$f_2(x) = x_1 - x_2^2 - 5 = 0$$
$$f_3(x) = x_1 + x_2 + x_3 - 3 = 0$$

Que.6 a) The model equation for three CSTR in series is given below, At t=0, CA0=1.8 kmol/m^3, CA1 (0)=0.4 kmol/m^3, CA2(0)=0.2 kmol/m^3,CA3(0)=0.1 kmol/m^3, τ=2, k1=k2=k3=0.5, find concentration in all the reactor at t=0.1 using Runge Kutta-4th order method, take the step size in time as 0.1? **[10]**

$$\frac{dC_{A1}}{dt} = \frac{1}{\tau}(C_{A0}) - \left(\frac{1}{\tau} + K_1\right)C_{A1}$$
$$\frac{dC_{A2}}{dt} = \frac{1}{\tau}(C_{A1}) - \left(\frac{1}{\tau} + K_2\right)C_{A2}$$
$$\frac{dC_{A3}}{dt} = \frac{1}{\tau}(C_{A2}) - \left(\frac{1}{\tau} + K_3\right)C_{A3}$$

Q 6 B Write short note on **[10]**

a) Explain partitioning, precedence ordering and tearing in flow sheet simulation

b) What are artificial neural networks? How an artificial neuron model can be compared with biological neuron model