13/05/2025 CHEMICAL SEM-VIII C-SCHEME MSO QP CODE: 10083432

(3 hours) **[Total marks: 80]**

N.B.: 1. Question-1 is compulsory. Answer any three questions from remaining
2. Assume data if necessary and specify the assumptions clearly
3. Draw neat sketches wherever required
4. Answer to the sub-questions of an individual question should be grouped and written together i.e. one below the other

Q1.a) Discuss advantages and disadvantages of ANN **5**

Q1.b) Explain classification of mathematical models. **5**

Q1.c) List out the various methods of optimization and explain in brief. **5**

Q1.d) Explain sequential based approach for solving flowsheet **5**

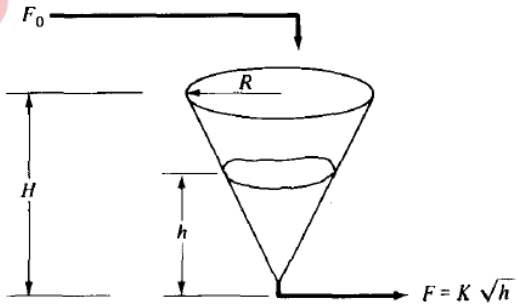
Q2.a) An isothermal, irreversible reaction takes place $A \xrightarrow{k} B$ in the liquid phase in a constant volume reactor. The mixing is not perfect. Observation of flow patterns indicates that a two-tank system with back mixing, as shown in figure below, should approximate the imperfect mixing. Assuming F and F_R are constant. Write equations that can describe the system **10**

Q2.b) Write the component continuity equations for a perfectly mixed batch reactor of constant volume with first order isothermal reactions: **10**

a) Consecutive: $A \xrightarrow{k1} B \xrightarrow{k2} C$

b) Simultaneous: $A \xrightarrow{k1} B$, $A \xrightarrow{k2} C$

Q3.a) A fluid of constant density $\boldsymbol{\rho}$ is pumped into a cone-shaped tank of total volume $H\pi R^2/3$. The flow out of the bottom of the tank is proportional to the square root of the height $\boldsymbol{h}$ of liquid in the tank. Derive the equations describing the system. **10**



Q3.b) 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 $x_1 = 0.8$ *and* $x_2 = 0.8$

Q4.a) Consider a reaction $A \xrightarrow{k} B$, carried out in a constant volume batch reactor. The differential equation of the species A is $\frac{dC_A}{dt} = -kC_A$.The initial condition is: at t=0, C_A=1 mol/m^3.The rate constant of the reaction is 0.1s^{-1}. Using the Runge-Kutta fourth order method, determine the concentration of A at 10s. Take the step size in time as 5 s **10**

Q4.b) Maximize $8x-3x^2+x^3-2x^4-x^6$ start with range (0, 1.2) using one dimensional search method. Also find the optimal solution with Ɛ=0.01 **10**

Q5.a) Write mathematical model of ANN? How an artificial neuron model can be compared with biological neuron model with neat diagram **10**

Q5 b) Determine solution for the following equation using Armijo line search method take α has 1and initial guess has x=[2, 1] ? **10**

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

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

Q6.a) Feed stream with pure species A and B are mixed with recycle stream enter CSTR, where following reactions take place **15**

$A + B \rightarrow C$

$C + B \rightarrow P + E$

$P + C \rightarrow G$

$k_1 = 5.9755 \times 10^9 \exp\left(-12000 / T\right)$

$k_2 = 2.5962 \times 10^{12} \exp\left(-15000 / T\right)$

$k_3 = 9.6283 \times 10^{15} \exp\left(-20000 / T\right)$

Here, C is an intermediate, P is main product, E is by product and G is oily waste. The plant consist of reactor, a heat exchanger to cool reactor effluent, a decanter to separate waste product G from reactants and other products and a distillation column to separate product P. Due to formation of an azeotrope some of product (equivalent to 10 wt% of mass flow rate of component E) 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.

Q6.b) Explain partitioning, precedence ordering and tearing in flow sheet simulation **5**