

# Question Paper

Exam Date & Time: 04-Jan-2023 (02:30 PM - 05:30 PM)



## MANIPAL ACADEMY OF HIGHER EDUCATION

V Semester Make-Up Examination, Jan, 2023 Process Modelling and Simulation (CHE-3153)

### PROCESS MODELLING AND SIMULATION [CHE 3153]

Marks: 50

Duration: 180 mins.

#### Descriptive Questions

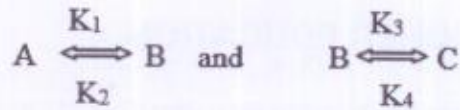
Answer all the questions.

Section Duration: 180 mins

Missing Data, if any, may be suitably assumed.

- 1) A tank contains 10 kg of a salt solution at a concentration of 2% by weight. Fresh solution enters the tank at a rate of 2 kg/min at a salt concentration of 3% by weight. The contents are stirred well and the mixture leaves the tank at a rate of 1.5 kg/min. Determine the salt concentration in the tank in weight % at 3.78 minutes (4)
- A)
- B) Solve the following system of equations using Newton- Raphson method (4)
- $$x^3 - 5x^2 + 2x - y + 13 = 0$$
- $$x^3 + x^2 - 14x - y - 19 = 0$$
- Take  $x_0 = 8$  and  $y_0 = 10$ . Perform 2 iteration.
- C) Explain the empirical model with an example. (2)
- 2) List the step by step procedure for modeling any process in chemical engineering. (4)
- A)
- B) Develop steady state tray composition for a 6 plate absorption column. A linear equilibrium relation holds between liquid  $x_m$  and vapor  $y_m$  on each plate and is given by  $y_m = ax_m + b$ . The inlet compositions to the column along with liquid and gas flow rate are known. Briefly give the solution procedure. (4)
- C) Compare Rigid and Probabilistic models(any 4 points). (2)
- 3) Develop the mathematical model of the steady state counter current flow heat exchange in a double pipe heat exchanger. Give brief solution procedure. (4)
- A)
- B) Water flows from a conical tank at a rate of  $0.02(2+h)^2$  m<sup>3</sup>/min. The diameter and height of the conical tank is 8m and 5m respectively. If the tank is initially full, Estimate the time taken for 40% of water to flow out of the tank. What is the flow rate at that time.? (4)
- C) List any four assumptions in modelling a ternary component distillation process. (2)
- 4) Develop the mathematical model for the dynamic response of an unsteady state counter current plug flow heat exchanger (4)
- A)
- B) Derive Finite difference equation and substitute in Heat equation (4)

- C) Derive the heat equation (2)
- 5) Derive Rachford-Rice equation (4)
- A)
- B) Consider a set of reversible reaction: (4)



Where  $N_A, N_B, N_C$  be the moles of A, B, C respectively present at any time  $t$ . Since the reaction is constant volume,  $N_A, N_B, N_C$  are proportional to concentration. Derive

$$\frac{d^2 N_A}{dt^2} + (K_1 + K_2 + K_3 + K_4) \frac{dN_A}{dt} + ((K_1 + K_3) + (K_2 + K_4) + (K_1 + K_4))N_A - (K_2 + K_4) = 0$$

- C) Write briefly about boiling of multicomponent( say A, B, C) mixture (2)

-----End-----