

Scheme of Evaluation

Reg. No.



MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

VII SEMESTER B.TECH(CHEMICAL) END SEMESTER EXAMINATIONS - DEC, 2020

SUBJECT: PROCESS MODELLING AND SIMULATION [CHE 4101]

REVISED CREDIT SYSTEM

(23/12/2020, AN)

Time: 3 Hours

MAX. MARKS: 50

Instructions to Candidates:

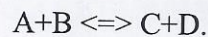
- ❖ Answer ALL questions.
- ❖ Missing data may be suitably assumed.

- 1A** Write the general modeling equations for a ternary equilibrium column of five stages including condenser and reboiler for a multi-component distillation column. List all the assumptions. **05**
- 1B.** Draw a neat information flow diagram for feed tray , reboiler and Condenser for a ternary equilibrium column of five stages including condenser and reboiler for a multi-component distillation column **05**
- 2A.** Determine the dynamic response of component A in a continuous stirred tank reactor when the volume of the tank is V , the inlet and outlet total volumetric flow rate is F , the inlet concentration is constant at C_0 , and the initial concentration of component A in the tank is zero. Component A undergoes a first-order reaction in the tank and the rate constant K varies with temperature i.e $K = K_0 - at^2$ (sec^{-1}) **05**
- 2B.** An electric heating coil is immersed in a stirred tank. Solvent at $15^\circ C$ with heat capacity $2.1 \text{ kJ kg}^{-1} ^\circ C^{-1}$ is fed into the tank at a rate of 15 kg h^{-1} . Heated solvent is discharged at the same flow rate. The tank is filled initially with 125 kg of cold solvent at $10^\circ C$. The rate of heating by the electric coil is 800 W . Calculate the time required for the temperature of the solvent to reach $60^\circ C$. **05**
- 3A.** Solve the following system of equations using Newton- Raphson method
 $x^3 - 5x^2 + 2x - y + 13 = 0$
 $x^3 + x^2 - 14x - y - 19 = 0$
Take $x_0=8$ and $y_0=10$. Perform 2 iteration **05**
- 3B.** Write down the step by step procedure for modeling any process in chemical engineering. **05**
- 4A.** Derive Finite difference method for solving Heat equation. **05**

- 4B. Develop the mathematical model of the steady state counter current and co-current flow heat exchange in a double pipe heat exchanger. Give brief solution procedure.

05

5. Consider an enclosed tank where the following reversible reaction takes place:



K_1 and K_2 are rate constant for forward and backward reaction respectively. The inflow F_1 passes through a fixed inlet valve from a pressure source P_1 and the pressure downstream side is P_2 . Whereas the pressure, upstream and downstream side of the outlet valve is P_2 and P_3 respectively with a flow rate of F_2 . The flow is influenced by level Z and the pressure.

- 5A. Derive the relation for flow rate and Pressure across one of the valve. 3
- 5B. Obtain a relation between temperature of compression and volume of the entrapped gas in the tank 3
- 5C. Write the component balance equations. 2
- 5C. Draw the information flow diagram. 2

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