Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

II SEMESTER M.TECH(CHEMICAL) END SEMESTER EXAMINATIONS - July, 2023

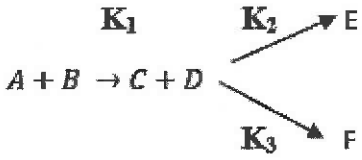
SUBJECT: PROCESS MODELLING ANALYSIS AND SIMULATION [CHE 5252]

(Make-Up Exam)

Time: 3 Hours **MAX. MARKS: 50**

Instructions to Candidates:

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

1.	Consider an enclosed tank where the following reaction takes place:  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. Derive (i) the relation between Flow rate and Pressure across one of the valve (ii) the relation between Temperature of compression and volume of the entrapped gas in the tank (iii) component balance for all components. **Draw a neat information flow diagram.**	**10**
2A.	A stream of CO_2 at 200K and 6.8 atm is fed to a process at the rate of 100 Kilomoles/hr. Using Wegstein method, estimate the volumetric flow rate of gas in this stream for **two** iteration using Soave modification of Redlich Kwong Equation, given by $P = \frac{RT}{(V-b)} - \frac{\alpha a}{V(V+b)}$ where $a = 0.370\ m^6\ Pa/mol^2$ $b = 2.97 * 10^{-5}\ m^3/mole$ $\alpha = 1.34$ $R = 8.314$ J/mole K (1 atm = 1.013×10^5 Pa)	**06**
2B.	With the help of a neat diagram, explain the step by step modelling of any process.	**04**
3A.	Write down the benefits of process modeling and simulation	**05**
3B.	A stirred tank is fitted with an electrical coil to heat 100 kg of solvent with a heat capacity of 2.5 J/g°C. The electrical coil delivers 2.0 KJ/s of power to the tank; the shaft work of the stirrer is 560 W . The solvent is initially at 25°c. The heat lost from the walls of the tank is 200 J/s. How long will the solution take to reach 70 °C	**05**

4.	Develop a mathematical model for dynamic response of the unsteady state one dimensional heat conduction through a rod. Derive the finite difference equations to determine the temperature distribution in the rod. List all the assumptions. Briefly write the solution procedure	**10**
5A.	It is desired to produce substance B from raw material A in a CSTR of effective volume of V(m^3), If q_o(m^3/min) of solution of A of concentration Co , is fed to the empty reactor and the chemical reaction in which all the reactions are first order. $A \underset{K_2}{\overset{K_1}{\leftrightarrow}} B \xrightarrow{K_3} C$ Prove that the number of moles of B in the initial discharge from the reactor is given by the solution of differential equation. $\frac{d^2N_B}{dt^2} + P\frac{dN_B}{dt} + R\,N_B = C$ Where $P = K_1 + K_2 + K_3$; $R = K_1 \times K_3$; $C = q_o C_o K_1$	**05**
5B.	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	**05**

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