Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

V SEMESTER B.TECH(CHEMICAL) END SEMESTER EXAMINATIONS - March, 2021

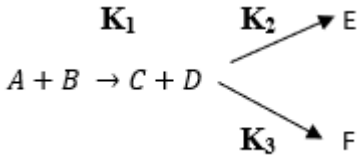
SUBJECT: PROCESS MODELLING AND SIMULATION [CHE 3153]

(18/01/2021, AN)

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**
2.	Solve the following system of equations using Newton – Raphson method $a^2 - 2a + b^2 - c = -1$ $ab^2 - a - 3b + bc = -2$ $ac^2 - 3c + bc^2 + ab = 0$ The initial value is a =1, b =2, c =3 Perform 3 iterations.	**10**
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^{o}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^{o}c. The heat lost from the walls of the tank is 200 J/s. How long will the solution take to reach 70 ^{o}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.	Consider the series reaction taking place in a constant volume batch reactor $A \xrightarrow{K_1} B \xrightarrow{K_2} C \xrightarrow{K_3} D$ Prove that $\frac{d^3C_c}{dt^3} + (K_1 + K_2 + K_3)\frac{d^2C_c}{dt^2} + (K_1K_2 + K_1K_3 + K_2K_3)\frac{dC_C}{dt} + K_1K_2K_3\,C_C = 0$	**06**
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	**04**

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