Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

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

SUBJECT: PROCESS MODELLING AND SIMULATION [CHE 3153]

(28/01/2021, AN)

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

Instructions to Candidates:

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

1A. One hundred kgmol /hr of bubble point liquid feed containing 30% n-butane , 40% n-pentane and 30% n-hexane are available at 148^{o}C and 17.5 atm. total pressure. The mixture is throttled adiabatically to give vapor- liquid product at 7 atm. Write down the model equations (then substitute the given values) and draw flow diagram to find the product temperature and the vapor liquid split. **08**

1B. Write about the Phenomenological model with an example. **02**

2A. A pure liquid is boiling in a steam jacketed vessel. The pressure of steam in the jacket is kept constant. Liquid flows into the vessel at a rate of m_1 and temperature T_1. The vapor leaves through a valve at an exit pressure P_o. The opening of the valve on the exit line is kept constant. Write model equations to calculate the mass flow rate of vapor m_v, as function of time. The feed flow rate and temperature may vary with time. Construct the information flow diagram for the model. **08**

2B. Explain the empirical model with an example. **02**

3A. Derive the model equation for steady state counter current double pipe, liquid- liquid heat exchanger. The known input conditions are the two inlet temperature T_{Si} and T_{Ti}, the two flow rates F_S and F_T, the dimensions of the pipe and the heat transfer coefficient. The exit temperature T_{Sa} and T_{To} are unknown. Derive the model equations and discuss the solution strategy. List the assumptions. **05**

3B. A tank has a cross-sectional area of $1m^2$ and normal discharge of $10m^3$/hr . What is the time required to attain a height of 4m, if the flow to the tank is suddenly increased to 25 m^3/hr. The exit flow rate, F_2 is related to h by $F_2= 10*h^{0.5}$. **05**

4 A fluid at a velocity V is flowing through the unsteady state shell and tube heat exchanger of diameter D. The heat exchanger is steam heated. Neglect the wall resistance. Derive the explicit centered difference equations and develop a dynamic response for such exchangers. Briefly write the solution procedure. **10**

5A. Derive the model equations for temperature effects in CSTR for decomposition of Hydrogen peroxide to water. Briefly explain the energy balance around the jacket. **05**

5B. For a turbulent flow of fluid in a hydraulically smooth pipe, the friction factor f is related to Reynolds number N_{Re} according to the following relation

$$\frac{1}{f^{0.5}} = -0.40 + 4.0\ log_{10}(N_{Re} \times f^{0.5}) \quad \textbf{05}$$

Compute f for $N_{Re} = 10^5$ using Wegstein's method with initial value of 0.01

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