Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

A Constituent Institution of Manipal University

VII SEMESTER B.TECH. (CHEMICAL ENGINEERING)

SEMESTER EXAMINATIONS, NOV- 2017

SUBJECT: PROCESS MODELLING AND SIMULATION[CHE 4101]

REVISED CREDIT SYSTEM
(16 /11/2017 AN)

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** questions.
- Missing data may be suitably assumed.
- Draw Information flow diagram wherever necessary.

1A. A 300 m^3 fuel storage tank that contains pure methane is to be switched to propane. Propane is fed to the tank at a rate of 5m^3 / min, and gas is withdrawn from the tank at the same rate. The contents in the tank may be considered uniform so that the composition of the outlet stream is that of the tank contents. All the gases are at 30^{o}C and 1 atmosphere. How long will it take to flush out 97% of methane originally in the tank? **03**

1B. Solve the following equation for f using Wegstein method

$$\frac{1}{\sqrt{f}} = -0.86\, ln\left[\frac{\frac{\varepsilon}{D}}{3.7} + \frac{2.51}{R_e\sqrt{f}}\right]$$

Where Ɛ/D = 10^{-4} and R_e = 10^5 . Use starting f value as 0.01 and perform two iterations. **05**

1C. Explain any four differences between Stochastic and Deterministic model. **02**

2. Develop a model for an enclosed tank where the following reversible reaction takes place:

A+B <=> C+D.

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 P_o(pressure in the gas space) and P_3. Derive equations for flow rate and pressure across the valve , and the temperature and volume . **10**

3A. Derive the center difference technique and develop the mathematical model for the dynamic response of an unsteady state counter current shell and tube heat exchanger for a change in inlet tube temperature. Briefly explain the solution procedure. **07**

3B. 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. **03**

4. Write the general modeling equations for a ternary equilibrium column of five stages including condenser and reboiler for a multi-component distillation column. Draw a neat information flow diagram for feed tray , reboiler and condensor. List out the assumptions used. **10**

5A. Develop the model equations for a first order reaction $A \xrightarrow{K} B$, in a tubular reactor, taking into consideration the existence of axial dispersion due to turbulent mixing effects in the reactor. The velocity profile is assumed to be plug flow. Briefly give the solution procedure. **05**

5B. Write down the benefits of process modeling and simulation. **03**

5C. Write a short notes on degree of freedom for non -reactive process. **02**

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