Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

VII SEMESTER B.TECH(CHEMICAL) END SEMESTER EXAMINATIONS - NOV, 2018

SUBJECT: PROCESS MODELLING AND SIMULATION [CHE 4101]

REVISED CREDIT SYSTEM
(20/11/2018, AN)

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

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitably assumed.
- Draw **Information Flow Diagram** wherever necessary.

1. 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**

2A. 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

$$\frac{d^3C_c}{dt^3} + (K_1 + K_2 + K_3)\frac{d^2C_c}{dt^2} + (K_1K_2 + K_1K_3 + K_2K_4)\frac{dC_C}{dt} + K_1K_2K_3\,C_C = 0$$

05

2B. Write in detail the step by step procedure for modelling of any process. **05**

3A. A water tank 6m high and 3m in diameter is drained by an orifice at the bottom. The exit velocity is given by $V_2 = 0.61*(2gh)^{0.5}$ m/sec . The orifice is 100mm in diameter and the tank is initially full. a) How long will it take to drain the tank to three fourth of its capacity. b) If the water is filled at the top of the tank at a rate of 70 m^3/hr, what will be the time taken to drain to three fourth of its capacity. **05**

3B. One hundred kgmol /hr of bubble point liquid feed containing 30% n-butane , 40% n-pentane and 30% n-hexane are available at 148°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 to find the product temperature and the vapor liquid split. **05**

4A. A gaseous mixture of components A and B is separated by permeating this mixture through a semi-permeable material. The apparatus used for this operation consists of a thin walled glass tube enclosed in a larger tube, through which the gaseous mixture flows at a high pressure. Gas permeates from the shell side, flows through the wall of the inner tube and out, while the remaining gas on the shell side flows out at the other end . This arrangement allows the gases on the shell side and the tube side to flow counter-currently. The gas A permeates through the wall of the glass tube much faster than gas B and the gas flowing out of the inner tube will be greatly enriched in component A. Set up the model equations to compute the flow rates and pressure inside the tube **08**

4B. Write any four points about stochastic models with examples. **02**

5A. 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)

05

5B. Develop the mathematical model for the pure liquid boiling in a jacketed vessel (boiler). **05**

****