MANIPAL INSTITUTE OF TECHNOLOGY

VII SEMESTER B.TECH. (CHEMICAL ENGINEERING) SEMESTER EXAMINATIONS, DEC 2016

Reg. No.

SUBJECT: PROCESS MODELLING AND SIMULATION [CHE 403]

REVISED CREDIT SYSTEM MAKE UP EXAM

(28 /12/2016)

Time: 3 Hours

A Constituent Institution of Manipal University

MAX. MARKS: 100

Instructions to Candidates:

- ✤ Answer ANY FIVE FULL questions.
- Missing data may be suitably assumed.
- ✤ Draw Information flow diagram wherever necessary.
- 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.
- **2.** Develop a model for an enclosed tank where the following reversible reaction takes place:

 $A+B \iff C+D.$

 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 Po(pressure in the gas space) and P_3 .

An agitated 2m³ tank is initially filled with water at 25 °C. A steam coil with an area of 0.5 m² heats the water using steam condensing at 120°C. The heat transfer coefficient for heating is 1140 J/s.m².K. The tank losses heat to the surrounding through the walls which have an area of 9 m². The heat transfer coefficient for heat losses is 10 J/s.m².K and the surrounding temperature is 25°C. How long will it take to heat the water to boiling point. Neglect the heat capacity of the tank walls. (Take water Cp=4187J/Kg.K)

3B. Determine the dynamic response of components in a continuous stirred tank reactor when the volume of the tank is V, the inlet and outlet total volumetric flow rate is F_o and F, the inlet concentration of A is C_{Ao}, for the following two cases Case 1: A gives B and C with rate constants K₁ & K₂ respectively.(parallel reaction)

Case 2: $A \rightarrow B \rightarrow C$ with reaction rate K_1 and K_2 respectively(series reaction)

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4A.	Solve the following system of equations using Newton- Raphson method
	$x^2 - 1.732xy + 2y^2 = 10$
	$4x^2 + 5.197xy + y = 22$
	Take $x_0=1$ and $y_0=0.5$. Perform 2 iteration

- **4B.** Derive using the method of Newton –Raphson , the bubble point temperature for Vapor liquid equilibrium calculation for multi component mixture.
- 5. 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. Suppose that gas A permeates through the wall of the glass tube much faster than gas B, 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

6A	Write down the benefits of process modeling and simulation	10
6B.	Briefly explain about (i) Mechanistic model (ii) Empirical model (iii) Stochastic	10
	model (iv) Probabilistic model with examples.	10

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