Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

II SEMESTER M.TECH(CHEMICAL) END SEMESTER EXAMINATIONS APRIL, 2019

SUBJECT: PROCESS MODELLING ANALYSIS AND SIMULATION [CHE5202]

REVISED CREDIT SYSTEM
(26/04/2019)

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.

1A.	Consider the mixing of pollutant in a river of constant cross section, flowing downstream. Assume the pollutant disappears via first order reaction and presence of axial dispersion only. Develop a model for the distribution of pollutant in river. List all the assumptions and normalize the final equation using dimensionless parameter.	**05**
1B.	Develop a micro level model of a simple packed bed tubular catalytic reactor by considering a balance volume small enough to encapsulate only molecular level process. Take the part of the catalyst surface where the reaction A→P with K as reaction rate constant. List the assumptions used.	**05**
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 or the dynamics response of an unsteady state counter current plug flow heat exchanger. Give briefly the solution procedure.	**07**
3B.	Write down the benefits of process modeling and simulation	**03**

4A.	A 18% Na_2SO_4 solution is fed at a rate of 12kg/min into a mixer that initially holds 150 kg of a 50-50 mixture of Na_2SO_4 and water. The exit solution leaves at the rate of 10 kg/min. Assume uniform mixing, what is the concentration of Na_2SO_4 in the mixer at the end of 12 minute? Ignore any volume changes on mixing.	**05**
4B.	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 $$1/f^{0.5} = -0.40 + 4.0 \log10(N_{Re} * f^{0.5})$$ Compute f for $N_{Re} = 10^5$ using Wegstein's method with initial value of 0.01 for two iterations.	**05**
5A.	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.	**07**
5B.	Differentiate between lumped and Distributed parameter model with examples	**03**

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