Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

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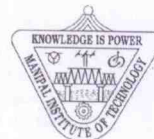
II SEMESTER M.TECH (IPC)

END SEMESTER EXAMINATIONS, MAY 2016

SUBJECT: **Modelling & Simulation of Environmental Systems [CHE 556]**

REVISED CREDIT SYSTEM

Time: 3 Hours

MAX. MARKS: 100

Instructions to Candidates:
- ❖ Answer **ANY FIVE FULL** questions.
- ❖ Missing data may be suitably assumed.

1A	Explain the fundamental difference between stochastic, empirical and mechanistic models. What are factors which make it easier or harder to develop such models?	10
1B	What are the major steps in building model of a process system?	10
2A	Develop a Newton-Raphson algorithm to solve nonlinear algebraic equation. Consider an example of heat capacity of the carbon monoxide is given as function of temperature as $Cp = 1.716 - 4.257 \times 10^{-6} T - \dfrac{15.04}{\sqrt{T}}$ Using Newton-Raphson algorithm to determine the temperature which yield a value of the heat capacity of 1 (kJ/kg K).	12
2B	Explain the difference between lumped parameter and distributed parameter models with an example.	08
3A	8 plate Scrubber is used to remove solute from the gas phase. The liquid and gas enters the column at the rate of (mole/time) are 66.7 and 40.8 moles /min respectively. It is assumed that a linear equilibrium relation holds between liquid (x_m) and vapor (y_m) on each plate is $y_m = a x_m + b$ The inlet composition to the column x_0 is zero and gas feed rate is 0.2 kg mole solute/kg mole inert. Develop a steady-state model to calculate steady-state composition for seven plate scrubber column and solution strategy for the above model equation.	12
3B	Discuss the fundamentals of hydrology and develop water budget equation.	08
4A	Discuss the stability classification of atmospheric condition.	06

4B	A power plant burns 5.45 tons of coal per hour and discharges the combustion product through a stack that has an effective stack height of 75 m. The coal has sulfur content of 4.2 % and wind velocity at top of stack is 6 m/s. The atmosphere condition are slightly unstable (condition C). Determine the max ground level concentration of SO_2. The maximum ground level concentration occurs where $\sigma_z = 0.707\ H$.	14
5A	Discuss *Reynolds transport theorem* for fluid flowing stream	06
5B	Sulis lake has a surface area of 7,08,000 m^2. Based on collected data, Okemos Brook flows into the lake at an average rate of 1.5 m^3/sec and Tamesis river flows out of sulis lake at an average rate of 1.25 m^3/sec during month of June. The evaporation rate was measured as 19.4 cm/month. Evapotranspiration can be ignored because there are few plants on the shore of lake. A total of 9.1 cm of precipitation fell this month. Seepage is negligible. Due to dense forest and gentle slope of the land surrounding the lake, run off is also negligible. The average depth of lake on June 1 was 19 m. What was the average depth on June 30th?	14
6A	Develop a Gaussian plume model and discuss its merits over other models.	10
6B	Explain the working principle of waste water treatment plant and develop a model equation for activated sludge process.	10