Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.TECH (CHE-NEW)/SEM-7/CHE-702/2010-11

2010-11
MODELLING, SIMULATION AND OPTIMIZATION

Time Allotted : 3 Hours *Full Marks* : 70

The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.

GROUP – A
(Multiple Choice Type Questions)

1. Choose the correct alternatives for the following : $10 \times 1 = 10$

   i) Sum Rate method is applicable when
      a) Boiling points of components are wide different
      b) Boiling points of components are very closed
      c) Boiling points of components are same
      d) None of these.

   ii) Bisection method is used to
      a) Find the roots of a polynomial
      b) Solve a set of linear equations
      c) Solve an ODE
      d) Solve a PDE.

   iii) The minimum value of the function $x^2 + 8x + 7$ is
      a) – 4 b) – 9
      c) 0 d) – 1/4.

iv) Lumped parameter model is represented by

a) ODE

b) PDE

c) a set of linear equation

d) none of these.

v) In $f = 24/N_{Re}$ the relation between Reynolds number and friction factor is

a) Linear b) Non-linear

c) either (a) or (b) d) none of these.

vi) The relationship, input = output is valid for systems at steady state

a) with chemical reaction

b) without chemical reaction

c) without chemical reaction and losses

d) none of these.

vii) CSTR is an example of

a) Lumped parameter model

b) Distributed parameter model

c) Either (a) or (b)

d) None of these.

viii) Optimization is not possible when degree of freedom is

a) 1 b) 0

c) 2 d) none of these.

ix) In a process if the observable changes are random and sometimes discontinuous

a) The process is called Deterministic process

b) The process is called Stochastic process

c) The process is called Steady state process

d) None of these.

x) Flow sheeting software normally deals with

a) Steady state process

b) Dynamic model

c) Both (a) and (b)

d) None of these.

xi) Multi-stage decision process is a part of

a) Dynamic Programming

b) Non-linear Programming

c) Geometric Programming

d) None of these.

xii) Steady state multiplicity in CSTR may be present under

a) Isothermal condition

b) Non-isothermal condition

c) Both (i) and (b)

d) None of these.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

2. Explain with proper example the term "Mathematical Consistency of a Model". 5
3. a) Distinguish between lumped parameter system and distributed parameter system. 3
   b) Define steady state and unsteady state systems. 2
4. Differentiate between Deterministic process and Stochastic process. 5
5. What do you mean by constrained and unconstrained optimization ? What are the advantages of optimization in chemical engineering process ? 5
6. Minimize $f(x) = x^2 + \frac{54}{x}$ with the help of Fibonacci Search Method. Explain why Golden Section Method is better than Fibonacci Search Method. 5

GROUP – C

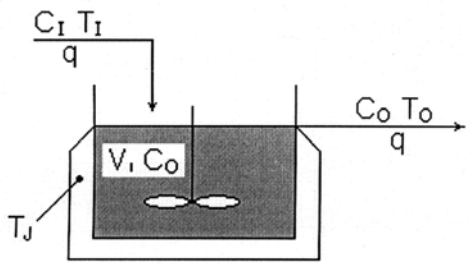
(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

7. a) A tank contains 20 m^3 of water. A stream of brine containing 2kg/m^3 of salt is fed into the tank at a rate of 8.33×10^{-4} m^3/sec. The liquid flows from the tank at a rate of 5.56×10^{-4} m^3/sec. If the tank is well agitated what is the concentration of salt in the tank when the tank contains 30m^3 material ?

b) In shell & tube heat exchanger usually hot or corrosive fluid are not passed through shell side. Why ? 12 + 3

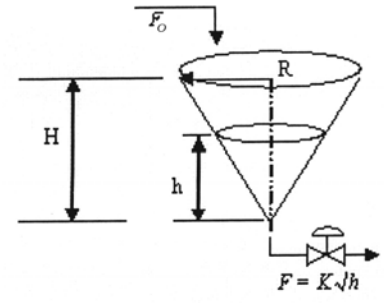
8. a) The reactor has an outside jacket that carries the cooling fluid. The feed flow rate and jacket liquid temperature may be assumed constant at q and T_J. The heat transfer occurs through an area = A and the overall heat transfer coefficient is U. The exit liquid concentration C_O and temperature T_O, are similar to that in the bulk liquid in the reactor. Develop dynamic relations between C_O and T_O with C_I and T_I.



b) Derive the condition for steady state. Discuss why multiplicities may occur for the above system. 9 + 6

9. a) A fluid of constant density ρ is pumped into a cone-shaped tank of total volume $\frac{1}{3}\pi R^2 H$. The flow out of the bottom of the tank is proportional to the square root of the height h of the liquid in the tank. Derive the model equations describing the system. Where, h is the liquid level in the tank and H is the height of the tank.

Where, F_0 and F are the inlet and outlet flow rates of fluid respectively.



b) Model one isothermal semi-batch reactor for a first order reaction A $\rightarrow$ B. Develop the concentratin profile with time. 7 + 8

10. a) Show that the percentage conversion for second order reaction in an Isothermal CSTR is $X = \frac{(1+2Da) - \sqrt{1+4Da}}{2Da}$, X = percentage conversion, Da = Damkohler No.

b) For a multi-component distillation unit present the model equations describing the system. Also write the steps to calculate the temperature, composition of each component in vapour and liquid, molar flow rate of vapour and liquid at each plate using Wang-Henke Bubble Point method. 5 + 10

11. a) What do you mean by feasible solution in optimization problem ?

b) What is the motivation of the simplex method ?

c) What is the significance of Hessian Matrix ?

d) Solve the following :

Maximize $F = X_1 + 2X_2 + X_3$

Subject to

$2X_1 + X_2 - X_3 \leq 2$

$- \quad 2X_1 + X_2 - 5X_3 \geq -6$

$4X_1 + X_2 + X_3 \leq 6$

$X_1 \geq 0, X_2 \geq 0, X_3 \geq 0.$ 2 + 3 + 2 + 8