Code No: NR420805 **NR**

IV B.Tech II Semester Supplementary Examinations, Apr/May 2006
OPTIMIZATION OF CHEMICAL PROCESSES
(Chemical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks
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1. (a) Discuss the problem of optimization of economic insulation thickness. [6]
   (b) Assume that the bare surface of a vessel is at 700^0F with an ambient temperature of 70^0F The surface heat loss is 4000 Btu/(h) (ft^2). Add one inch of calcium silicate insulation and the loss will drop to 250 Btu/(h)(ft^2) At an installed cost of \$ 4/ (ft^2) and a cost of energy at \$ 5/106 Btu, a saving of \$ 164 per year (8760 hours of operation) per square foot would be realized. Calculate the pay back period and mention the approach to determine the optimum insulation thickness. [10]

2. Formulate net present value for a project lasting n years with an initial investment I0, interest rate of capital i, constant annual expense E, constant annual revenue A, salvage value S_v, yearly depreciation D_j, and a tax rate t. Compare NPV for tax rates of 0 and 50 percent, S_v, = 0, and straight-line depreciation. Use n = 10 and i = 0.15(r = 0.2). [16]

3. Explain the difference between uni model and multi model functions [16]

4. Use the simplex procedure with un restricted variables
   minimize f(x) = x1 + 4x2
   subject to x1 + x2 $\leq$ 3
   $-x1 + x2 \leq 1$
   x1 unrestricted, x2 $\geq$ 0
   find the optimal values of x1 and x2? [16]

5. For a waste heat recovery system the following data are given: Cost per unit area of exchanger, C_A= Rs.20/ft^2
   Value of power, incorporating necessary conversion factors to have a consistent set of units, C_H= 1.76x10^{-5}
   Average overall heat transfer coefficient, U = 95Btu/(h)(^{o}F)(ft^2)
   Number of hours per year of operation, y = 8760 h/year
   Annualization factor for capital investment, r = 0.365
   Efficiency of overall system, η= 0.7
   Condensing temperature, T_2= 600^{o}R
   Average hot fluid temperature,T_s= 790^{o}R
   Calculate the optimum value of the working fluid temperature, TH. [16]

6. Explain the procedure involved for determining the optimum reflux ratio for a staged distillation column applying the one dimensional search technique of optimization. [16]

7. The cost function C representing the annual costs of a pipe line transporting a fluid is given by
   $C = C_1 D^{1.3} L + 0.142(C_0/\eta) m^{2.8} \mu^{0.2} \rho^{-2.0} D^{-4.8} L$
   where the cost coefficients are considered as C_0= Rs. 0.59 and C_1= Rs. 5.7. The mass flow rate of fluid m = 25 kg/s, densityρ= 1000kg/m^3,μ= 1.08x10^{-3}N/sm^2, the pumping efficiency η= 0.60 and the pipe length L= 10 m. Find the optimal pipe diameter D_{opt} [16]

8. The steady state dependence of chemostat variables, namely, cell mass concentration x and substrate concentration s are expressed by the following equations:
   $x = y_{x/s}\left[S_f - \frac{DK_s}{\mu_{\max} - D}\right]$

   $s = \frac{DK_s}{\mu_{\max} - D}$
   where D is the dilution rate. The parameter values are: maximum specific growth rate $\mu_{\max}$= 1.0h^{-1},yield factor $Y_{x/s}$= 0.5,substrate growth rate constant Ks=0.2 g/lit and substrate feed concentration s_f= 10.0g/lit.. The rate of cell mass production per unit reactor volume is Dx. Show that the system exhibits washout condition at D =$\mu_{\max}$. [16]

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