CODE NO: NR420805 NR

2006 JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY

IV B.TECH II SEMESTER SUPPLEMENTARY EXAMINATIONS
OPTIMIZATION OF CHEMICAL PROCESSES
(CHEMICAL ENGINEERING)

APR/MAY 2006

TIME - 3 HOUR
MARK – 80

Answer any FIVE Questions
All Questions carry equal marks

1. (a) Discuss the problem of optimization of economic insulation thickness. 6]

(b) Assume that the bare surface of a vessel is at 7000F with an ambient temperature of 700F The surface heat loss is 4000 Btu/(h) (ft2). Add one inch of calcium silicate insulation and the loss will drop to 250 Btu/(h)(ft2) At an installed cost of $ 4/ (ft2) 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 Sv, yearly depreciation Dj, and a tax rate t. Compare NPV for tax rates of 0 and 50 percent, Sv, = 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 ≥ 3 - x1 + x2 ≥ 1 x1 unrestricted, x2 ≥ 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, CA= Rs.20/ft2 Value of power, incorporating necessary conversion factors to have a consistent set of units, CH= 1.76x10-5 Average overall heat transfer coefficient, U = 95Btu/(h)(oF)(ft2) 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, T2= 600oR Average hot fluid temperature,Ts= 790oR Calculate the optimum value of the working fluid temperature, TH.
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 = C1D1.3L + 0.142(C0/η)m2.8μ0.2 -2.0D-4.8L where the cost coefficients are considered as C0= Rs. 0.59 and C1= Rs. 5.7. The mass flow rate of fluid m = 25 kg/s, density ρ = 1000kg/m3,μ = 1.08x10-3N/sm2, the pumping efficiency η = 0.60 and the pipe length L= 10 m. Find the optimal pipe diameter Dopt [16]

8. The steady state dependence of chemostat variables, namely, cell mass concentra- tion x and substrate concentration s are expressed by the following equations: x = yx/s hSf – DKs μmax-Di s = DKs μmax-D where D is the dilution rate. The parameter values are: maximum specific growth rate μmax= 1.0h-1,yield factor Yx/s= 0.5,substrate growth rate constant Ks=0.2 g/lit and substrate feed concentration sf= 10.0g/lit.. The rate of cell mass pro- duction per unit reactor volume is Dx. Show that the system exhibits washout condition at D =μmax ical fertilizer plant?` [16]