Final Examination : Semester II   Academic Year : 2003
Date : 18 February 2004   Time : 13.30-16.30
Subject : 230-432 Chemical Engineering Room : R 300
          Plant Design

Student Name: ……………………………..   ID No : ……………..

Number of questions : 4

Time : 3 hours

Total marks : 100

Lecture notes are allowed

Calculators are allowed

Question	Full Marks	Marks Received
1	25	
2	25	
3	25	
4	25	
Total	100	

Question 1:

a)   Two mutually exclusive projects have the following cash flows.

Year	Project I	Project II
0	-$100,000	-$60,000
1	$60,000	$36,500
2	$60,000	$36,500

Which of these two projects should the company choose if the interest rate is 10% per year?

(10 marks)

b)   A pulp and paper company has two alternatives in buying an evaporator. Two types of evaporator have different installed and maintenance costs, salvage values and service lives, as shown below.

	Evaporator A	Evaporator B
Installed cost	$18,000	$25,000
Annual maintenance cost	$4,000	$3,000
Salvage value	$500	$1,500
Service life	2 year	3 year

Use the interest rate 10% to select an evaporator.

(15 marks)

Answer Q1

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Answer Q1 (continued)

Question 2:

A chemical plant is proposed with $90 millions fixed capital investment which is equally distributed during the 3-year construction period. The plant requires $40 millions of working capital at the beginning of first-year production. At 100% capacity the plant has sales revenues of $150 millions/year and the total cost of product excluding depreciation of $100 millions/year. The plant is projected to operate at 50% and 75% capacity during the first and second operating years. The number of operators is not reduced proportionally therefore the total cost of product is projected to reduce by 45% and 32% during the first and second operating years respectively. The depreciable capital depreciates in 6 years after beginning of operation with values 18.0, 28.8,17.28,10.37,10.37 and 5.18 $millions. Tax rate is 37%.

Write annual cash flow for 15-year project life. Calculate the net present value for an interest rate of 15% and the internal rate of return.

(25 marks)

Answer Q2

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Question 3:

a) A sieve-tray distillation column for separation of isobutene and n-butane mixture has flows and property profiles on tray number 4 as shown below. Assume that tray spacing is 24 inches, foaming factor is 1.0 and $A_h/A_a > 0.1$. Estimate the column diameter at this tray location.

Conditions at tray number 4:

	Liquid	Vapour
Mass flow (lb/hr)	215,000	244,000
Molecular Weight	58.12	58.12
Temperature (^{o}F)	130	132
Density (lb/ft^3)	32.4	1.095
Surface tension (dyne/cm)	7.1	----

Note: 1 ft = 0.3048 m

(15 marks)

b) If this tray column is made of carbon steel, 212 feet high and operates at a pressure of 110 psia or 6.75 bar(guage), estimate the cost of the column (without trays), C_{Notray}.

$$C_{Notray} = 1780L^{0.87}D^{1.23}[2.86+1.694F_M(10.01-7.408lnP+1.395(lnP)^2)]$$

where C_{Notray} = cost of the column (without trays) in $

   L = column height in meters

   D = column diameter in meters

   F_M = material factor = 1.0 for carbon steel

   P = design pressure in bar (guage)

(5 marks)

c) Specify parameters for choosing between a tray column and a packed column.

(5marks)

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Answer Q3

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Answer Q3 (continued)

Question 4:

a)   Explain the following terms in sieve tray design.

a.1 Trial tray lay-out

a.2 Weeping

a.3 Entrainment

a.4 Turndown ratio

(10 marks)

b) Discuss the use of "Glass lining" in chemical processing units. What are the applications and limitations of this technique?

(3 marks)

c) What is dust explosion? How does it occur? How to prevent it?

(3 marks)

d) Describe the method for determination of optimum conditions such as minimum total cost when there are two independent variables x and y.

(5 marks)

e)   For inherent safety plant design, discuss the "Attenuation" approach.

(4 marks)

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Answer Q4

Student Name : …………………………..   ID No : ……………..

Answer Q4(continued)

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