

Time: 3 Hours

Total marks: 80

- N.B.:** (1) Question No 1 is compulsory
(2) Attempt any three questions out of remaining five questions
(3) Assume suitable data if necessary and indicate it clearly.
(4) Figures to the right indicate full marks.

- Q.1. Solve any four questions of the following. 20
- (a) What are the various approaches to chemical process design and integration?
 - (b) Explain six tenth rule and its applications for cost estimation of equipment.
 - (c) Discuss Profitability and list out (write the names of) its different evaluation techniques
 - (d) Describe packed tower distillation column.
 - (e) What is Process Block Diagram? Explain its significance.
 - (f) Explain the various types of interest.
- Q.2. (a) Design an absorption column and calculate the number of theoretical stages for absorber separating mixture of 20 gmol/sec of methane & 70 gmol/sec of methanol using water as the solvent. Recovery of methanol is 95% at temperature of 350 K & column pressure of 10 bar. Also determine the solvent flowrate & absorption factors for the following components. 10

Component	Vapour Pressure (bar)
Methane	445.16
Methanol	1.62
Water	0.419

- (b) An asset has an initial value of Rs.50000, a service life of 10 years and zero salvage and scrap value. If, annual interest rate is 5%, by how much will depreciation cost be decreased if a sinking fund method were used instead of the straight-line method? 10
- Q.3. (a) What is Break Even analysis in project cost estimation? Explain with graphical representation. Also write and explain the equation for break-even point. 10
- (b) Explain working & applications of Short Path Distillation Unit (SPDU) with schematic diagram. 10
- Q.4. (a) A reactor which will contain corrosive liquids has been designed. The two alternatives are: 10

	Reactor A	Reactor B
Material	Mild steel	Stainless steel
Installation cost	Rs. 5000	Rs. 15000
Service life	3 years	?
Scrap value	0	0

On the basis of equal capitalized costs for both types of reactors, what should be the useful-life period for stainless steel reactor if money is worth 6% compounded annually?

- (b) A centrifugal pump draws benzene from an overhead tank. Operating pressure in the tank is 700 torr vacuum. Vertical distance between free surface of liquid in tank and centerline of pump is 12 m. Maximum operating temperature is 50 °C. Vapor pressure of benzene at 50 °C is 280 torr. Density of benzene at 50 °C is 870 kg/m³. Frictional loss in suction line of pump is 1 m of benzene column. Calculate the (NPSH)_A of centrifugal pump. **10**

- Q.5 (a) A bond has a maturity value of Rs. 1000 and is paying discrete compound interest of an effective annual rate of 4%. Determine the following at a time 4 years before the bond reaches maturity value. **10**
- Present worth
 - Discount
 - Discrete compound rate of effective interest which will be received by a purchaser if the bond were obtained for Rs. 600.

- (b) Find out area of heat exchanger according to the following specifications and calculate its total installed cost (Updated bare module cost) in year 2011. **10**

Heat Exchanger specifications:

Identification: Condenser; Function: to condense overhead vapor from methanol; Overall HTC, U= 851.7 w/m²k; Type: Horizontal fixed tube sheet; F_p = 0.2; Heat duty= 896 kW; Type of flow: counterflow

Tube side specifications: Fluid: Cooling water, T_{in}= 25°C, T_{out}= 35°C; Tube material: carbon steel

Shell side specifications: Fluid: Methanol, T=70°C (Constant); Shell material: carbon steel

Design Type	Kettle reboiler	U tube	Fixed tube sheet
F _d	1.35	0.85	0.80

Surface area (m ²)	Shell & Tube material, F _m	
	CS/CS	SS/SS
0-10	1.0	2.50
10-50	1.0	3.10

Equipment type	Co(Rs.)	So (m ²)	Range (S) m ²	α	MF
Heat exchanger	25x10 ⁴	37.18	10-900	0.65	3.29
	1.5x10 ⁴	0.51	0.1-10	0.024	183

Cost index(CI)	Year
420	2011
115	Base year

- Q.6. (a) Write a short note on: **10**
- Batch process vs Continuous process
 - FUG method for design of multicomponent distillation
- (b) A mining company estimates that it can increase its sales if it procures a new machine to cut more. The installed cost of the new machine is Rs. 3000000. The extra expenditure per year is Rs.1750000 and extra income is 75% of installed cost per year. The salvage value after 12 years is expected to be 12.5% of installed cost. What is rate of return? **10**
