(3 Hours) **Marks : 80**

NB:

(1) Question **No. 1** is **compulsory**.
(2) Solve **any three** questions out of remaining **five** questions
(3) **Draw figures wherever needed**
(4) Assume **suitable** data wherever **necessary** but justify the same.

Q1 Explain **any four** **20**

a) Baffles and Tie rods
b) Multiple Effect Evaporator
c) Tray support
d) Multishell and Shrink fit construction for High pressure vessel
e) Growth crystalizer

Q 2 (a) Design a Fixed tubesheet heat exchanger for the following data **10**

Design pressure	= 0.6 N/mm^2
Permissible stress for shell material, Carbon steel	= 100 N/mm^2
Standard torispherical head with knuckle radius as 10 % of crown radius	
25 % cut segmental baffles are provided	
Number of tubes	= 60
Tube outside diameter	= 20
Design Pressure for tube side fluid	= 21 N/mm^2
Permissible stress of tube material	= 120 N/mm^2
Tube pitch = Square	
Flange material of construction – carbon steel	
Permissible stress for flange material	
Permissible stress for bolt material	= 140 N/mm^2
Mean Gasket Diameter	= 428 mm
Gasket width	= 24 mm
Gasket Factor	= 3.75
Gasket seating stress	= 53.4 N/mm^2

Design

1. Shell Diameter and Shell Thickness
2. Flange thickness

(b) Explain in detail any two types of shell and tube type of heat exchanger in view of differential thermal expansion between the shell and tubes. **10**

Q3 (a) A thick cylinder with internal diameter of 40 mm and outside diameter as 80 mm is subjected to an internal pressure of 80 N/mm^2. Plot the stress distribution **10**

(b) Discuss design procedure of making high pressure vessel based on various theories of failure **10**

Q 4 (a) Determine the wall thickness of the shell of a tall column with the following data **20**

Shell outside diameter	= 1500 mm
Vessel Height	= 15 m
Skirt height	= 3m
Design pressure	= 0.5 N/mm^2
Corrosion allowance	= 2 mm
Tray spacing	= 0.6 m
Top disengaging spacing	= 1m
Bottom separator Space	= 2 m
Specific gravity of carbon steel	= 7.7
Insulation Thickness	= 50 mm
Density of Insulation	= 780 Kg/m^3
Head 2:1 elliptical	
Weight of each head	= 5 kN
Wind velocity	= 125km/hr
Weight of liquid and trays	= 700 N/m^2
Permissible stress for shell wall material	= 100 N/mm^2

Q5 (a) Design a standard vertical short tube evaporator of calendria type for the following data **20**

External pressure on evaporator drum	= 0.10 N/mm^2
Amount of water to be evaporated	= 25000 N/hr
Heating surface required	= 225 m^2
Steam pressure	= 0.15 N/mm^2
Density of liquid	= 9850 N/m^3
Density of vapor	= 0.84 N/m^3
Materials used for the evaporator	= low carbon steel

structure

Central down take	= 40 % of total cross sectional area
Entrainment separator value Rd	= 1.3
Vertical tube outer diameter	= 100 mm
Tube thickness	= 1.5 mm
Effective length of the tube	= 1200 mm
Pitch of tubes (triangular)	= 125 mm
Permissible stress for low carbon steel	= 98 N/mm^2
Modulus of elasticity for low carbon steel	= 20×10^4 N/mm^2
Modulus of elasticity for brass	= 9.6×10^4 N/mm^2
Bottom head cone angle	= 120^0
Number of bolts	= 112
Size of bolts	= M18
Factor of safety	= 4
Poisson ratio	= 0.33
Height of drum	= 3000 mm

Design

i) Calendria (Diameter and Thickness)

ii) Vapor drum (Diameter and Thickness)

Q 6 (a) Explain process flow diagram and piping and instrumentation diagram in detail. **10**

(b) Draw symbols for **05**

i) Fixed bed reactor

ii) Pressure filter

iii) Drum drier

iv) Butterfly valve

v) Centrifugal pump

(c) Short note on Rotary Drum Filter. **05**
