Duration: 3 hours **Total Marks: 80**

N. B. (i) Question number one is compulsory.
(ii) Answer any three questions from the rest.
(ii) Assume suitable data wherever necessary.

Q. 1 Write short note on any **four** 20

(a) Explain standards and codes. List out different standards.

(b) List and explain types of heads.

(c) List and explain types of jackets..

(d) Explain types of losses in storage vessels.

(e) List and Explain tall column internals.

(f) List and explain types of agitators.

Q.2 (a) Design a pressure vessel subjected to internal pressure for the following data: 12
Shell and head data: Design pressure = 0.6 N/mm2,
ID of the shell = 1200 mm
Permissible stress for head and shell material = 140 N/mm2, MoC = S S
Flange, gasket and bolt data: Gasket factor = 3.75,
Min gasket seating stress = 52 N/mm2
Flange material same as shell material. Permissible stress for bolt material = 140 N/mm2
Nozzle data: ID of nozzle = 150 mm. (Nozzle welded to head), MoC: SS
Design should include: Shell, flanged joint, nozzle and reinforcement.

Q.2(b) Explain with neat diagram constructional features of high-pressure vessel. 08

Q3 (a) Design a Standard Vertical Short Tube Evaporator for the following data- 12
Data – Evaporator drum under vacuum –
Amount of water to be evaporated = 24,000 N/hr
Heating surface area = 245m^2, Steam Pressure = 0.13 N/mm^2
Density of Liquid = 9800 N/mm^3, Density of Vapor = 0.86 N/mm^3
M.O.C. = Low Carbon Steel,
Permissible Stress for Low Carbon Steel = 100 N/mm^2
E for L.C.S. = 20 x 10^4 N/mm^2, E for Brass = 9.6 x 10^4 N/mm^2
Tube Material = Brass, O.D. of Tube = 80mm,
Tube Thickness = 2 mm Effective length of Tube = 1170 mm,
Conical heads at top and bottom cone angle = 120^0 Factor of safety = 2
Design should include- (a)Calendria diameter and tube sheet thickness,
(b) Evaporator drum thickness and diameter

Q.3(b) Explain classification of heat exchangers on the basis of different methods. Also explain Classification on the basis of TEMA. 08

Q 4 (a) A tall vertical column 2.5 m in outer diameter and 42 m in height is to be installed. The available specifications are: 10

Operating temperature and pressure – 160 C and 0.45 N/mm2. Skirt height – 3.0 m.
Tray spacing – 0.6 m. Top space disengagement – 1.2 m.
Weir height – 60 mm. Bottom space separation – 1.8 m
Tray loading with liquid – 110 kg/m2
Corrosion allowance – 1.5 mm Wind force acting over vent – 1100 N/m2
Design pressure – 0.5 N/mm2 Insulation thickness – 120 mm.
Permissible material stress of shell – 98 N/mm2 Welded joint efficiency – 0.80
Density of shell mtl. – 7600 kg/m3 . Density of insulation – 500 kg/m3 .
Over head vapor pressure line – 2280 mm Weight of ladder – 300 N/m.
Weight of 280 mm outer diameter pipe – 600 N/m

Q 4(b) Write difference between tray column and packed column. 08

Q 5(a) Design a U-tube heat exchanger for the following data- 10

(i)Shell Side:-
No. of shells and passes– 1, Fluid – Water,
Design Pressure – 0.45N/mm^2 M.O.C. – Carbon Steel,
Permissible stress for C.S. – 100N/mm^2
Standard torrispherical head,
M.O.C. for head and all flanges- Carbon steel,
Gasket on shell side – Flat metal jacketed asbestos
Gasket factor – 3.75,
Gasket seating stress -53N/mm^2
(ii)Tube Side:-
Tube and tube sheet material – S.S., No. of tubes – 60
Outside diameter – 20mm, Fluid – Carbon Dioxide,
Design Pressure – 1.5N/mm^2 Permissible stress for S.S. – 105N/mm^2
Design should include- (a) Shell, (b) Head, (c) Flange joint (shell and tube sheet)

Minimum Thickness (in mm)							
Nominal Diameter	Cast Iron	Carbon Steel (including Corrosion Allowance)	Copper and Copper Alloys	Aluminium and Aluminium Alloys	Austenitic Stainless Steel	Nickel	Monel Inconel
150	10	5	3.2	5	3.2	3.2	3.2
200	10	6.3	3.2	5	3.2	3.2	3.2
250	10	6.3	3.2	5	3.2	3.2	3.2
300	13	6.3	3.2	5	3.2	3.2	3.2
350	13	6.3	5	5	3.2	5	3.2
400	13	6.3	5	6.3	3.2	5	3.2
500	13	8	6.3	8	3.2	6.3	3.2
600	16	8	6.3	8	5	6.3	5
700	16	10	8.3	10	5	8	5
800	16	10	10	11.2	6.3	8	6.3
900	19	10	10	11.2	6.3	10	6.3
1000	19	19	11.2	12.5	6.3	11.2	6.3
1100	22	11.2	11.2	14	6.3	11.2	6.3

Q5 (b) Design storage tank for following data: (Shell with varied thickness) 08

Tank diameter = 24 m Tank ht = 16m Density of liquid = 980 kg/m^3

Superimposed load = 1200 N/m^2 MoC = CS Permissible stress = 165 N/mm^2

Density of MoC = 7800 kg/m^3 Corrossion allowance = 2 mm E = 2*10^5 N/mm^2

Table D1 : Plates

Thickness (mm)	Width (mm)	Length (mm)
5, 6, 7, 8, 10	900, 1000, 1100, 1250, 1400, 1500, 1600, 1800, 2000, 2200, 2500	4500, 5000, 5600, 6300, 8000, 10000
12, 14, 16, 18, 20, 22, 25, 28, 32	1500, 1600, 1800, 2000, 2200, 2500, 2800	4500, 5000, 5600, 6300, 7100, 8000, 9000, 10000
36, 40, 45, 50	1500, 1600, 1800, 2000, 2200, 2500, 2800, 3000, 3200	4500, 5000, 5600, 6300, 7100, 8000, 9000, 10000
56, 63, 75, 80	1500, 1600, 1800, 2000, 2200, 2500	4500, 5000, 5600, 6300, 7100, 8000
90, 100, 110, 120	1600, 1800, 2000	5000, 5600, 6300

Q.6 A high pressure compound cylinder consists of an inner cylinder of inner diameter 200 mm and outer diameter 250 mm. on it is shrunk fit a tube of external diameter of 300 mm. the shrink fit should be so done that the contact pressure of the two tube surfaces do not exceed 7.85 Mpa. the cylinder is then subjected to an internal pressure of 83 Mpa. 20

1.Calculate the original dimensions of the tubes (deformation) if the coeff of thermal expansion is 12 * 10^{-6} /^{0}C.

2.Calculate by what temperature the outer tube should be heated to achieve the necessary shrink fit (Assume E = 200 * 10^3 N/mm^2)

3.Also find the reduction in max stress by compounding when compared to a single tube of inner dia of 200 mm and outer dia of 300 mm.

4.plot the stress distribution.