Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL

VII SEMESTER B.TECH. (CHEMICAL ENGINEERING)

MAKEUP EXAMINATIONS, DEC 2017

SUBJECT: DESIGN AND DRAWING OF CHEMICAL EQUIPMENTS

[CHE 4102]

REVISED CREDIT SYSTEM
(26/12/2017)

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitable assumed.

1.A	Calculate the thickness of vessel and a. Flanged flat cover b. Conical head apex angle 60° c. Torispherical head d. 2:1 Ellipsoidal head Given data: Maximum operating pressure : 400 kN/m^2 Nominal diameter of the vessel : 1 m Material of construction : IS-2002-1962-grade 2A Corrosion allowance : 2 mm Joint efficiency 0.85 Constant z = 1.35 (for conical head)	**5**
1.B	Estimate the size of hydrocyclone needed to separate 80% of particles with a diameter greater than 0.04 mm, from a dilute slurry with a flow rate of 1000 m^3/day. The density of liquid is 1000 kg/m^3 and that of the solid is 3300 kg/m^3, viscosity 1 mNs/m^2.	**5**
2.	The mechanical design of a standard (calendria) vertical short tube evaporator, with the help of the following data calculate thickness of a. Flange b. Tube sheet c. Head (top and bottom) d. Calendia and Drum Evaporator drum: 0.1 N/mm^2 Amount of water evaporated : 2500 kg/hr Heat transfer area : 220 m^2 Steam pressure : 0.15 N/mm^2 Density of liquid : 1000 kg/m^3 Material of construction (MOC) : Evaporator : carbon steel IS- 2062 Tubes : brass Permissible stress for carbon steel : 98 N/mm^2 Modulus of elasticity : **Calendria with vertical tubes** **Tubes and tube lay out :** Tube diameter (outside) : 100 mm Tube thickness : 1.5 mm Tube length : 1220 mm The effective tube length : 1165 mm Tube lay out : triangular pitch : 125 mm **Bottom flange of the calendria** Flange material – IS-2004-1962 Class 2 Bolting material : 5% Cr Mo Steel	**10**

	Carbon steel : 19.0 x 10^4 N/mm^2 Brass : 9.5 x 10^4 N/mm^2 Conical head bottom : cone angle 120^o Torispherical head at top : (100-10) Length of drum – 4000 mm Operating temperature – 120^{o}C Top head connected with drum : Flange (IS-2004-1962 Class -2) Gasket material : asbestos composition (1.6mm thickness) Out side diameter : 3894 mm Pitch circle diameter : 3825 mm Number of bolts : 112 Flange joint : Lap joint	
3.	20,000 kg/hr of kerosene is to be cooled from 200 ^{o}C to 95 ^{o}C. Crude oil is available at 40 ^{o}C and the output is preferred at 80 ^{o}C. Design a STHE to handle this mix. Calculate up to overall heat transfer coefficient. **DATA:** Assume initial trial U value as 300 W/m^2 K.Use $Q_h = Q_c$ without any extra allowance	**10**
4.	Check if down-comer flooding occurs in this design of a sieve plate tower (for absorption) **DATA:** A_h = 0.03 m^2, A_a = 0.54 m^2, t_R = 3 mm, t_S = 400 mm, d_h = 5 mm, ρ_g = 1.41 kg/m^3, G = 0.624 m^3/s, L = 0.02 m^3/s, L_w = 80 cm, ρ_L = 1000 kg/m^3, σ = 59.1 dynes/cm, h_w = 50 mm, h_{ow} = 20 mm, h_D = 40 mm liquid.	**10**
5.	The mechanical design of shell and tube heat exchanger, with the help of following data calculate the thickness of a. Shell and Head b. Flange c. Tube sheet d. Nozzles (Both side)	**10**

Shell side	**Tube side**
MOC: carbon steel	Tube and tube sheet material : stainless steel (SS 304)
Number of shell : 1	Number of tubes – 54
Number of passes : 1	Outside diameter – 18 mm
Fluid : liquid	Length (maximum U) – 12 m
Working pressure : 0.33 N/mm^2	Pitch (square) – 25 mm
Design pressure : 0.50 N/mm^2	Fluid – gas
Temperature inlet : 30^o C	Working pressure – 19 N/mm^2
Temperature outlet : 50^{o}C	Design pressure – 21.5 N/mm^2
Segmental baffles (25% cut) with tie rods spacers	Inlet temperature – 150^{o}C
Head	Outlet temperature – 55^{o}C
Crown radius : 400 mm	Permissible stress – 100.6 N/mm^2
Knuckle radius : 40 mm	
Shell flange : female facing	**Channel and channel cover**
Gasket : flat metal – jacketed asbestos filled	Material – carbon steel (IS-2062)
Bolts – steel	Joint with tube sheet – ring facing
Nozzles – inlet and outlet – 75 mm	Gasket – steel jacked asbestos
Permissible stress for carbon steel 95 N/mm^2	Permissible stress – 95 N/mm^2
Permissible stress for bolt material–140.6 N/mm^2	