Name: **Enrolment No:**	UPES UNIVERSITY WITH A PURPOSE

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, December 2019

Course: B.Tech Chemical R&P **Semester:**

Program: Chemical Process Equipment Design & Drawing **Time 03 hrs.**

Course Code: 40001790 **Max. Marks: 100**

Nos. of page(s) : 03

Instructions: Closed Book Exam. Data set Allowed

SECTION A

S. No.		**Marks**	**CO**
Q 1	Define Elastic Limit, Yield stress and Ultimate stress with proper diagram.	**1+1+1 +2= 5**	**CO1**
Q 2	Derive the thickness equation for the following stresses 1. Longitudinal stress in sphere 2. Circumferential stress in sphere For same vessel configuration and operating condition, thickness for sphere will be more than the thickness for the cylinder. **TRUE** or **FLASE**.	**2+2+1 =5**	**CO2**
Q 3	An agitator vessel is designed with ID = 5 m, H = 5 m. The flow rate (pumping capacity) is 10 m^3/sec. The speed of rotation of the impeller is 200 rpm. Calculate the flow number for the agitator.	**5**	**CO3**

SECTION B

Q 4	Name different types of heads (covers) used in pressure vessels and mention their usage criteria.	**5**	**CO2**
Q 5	Consider a quarter ($1/4^{th}$) filled horizontal vessel with ID = 3 m & L/D ratio = 2. No insulation is provided over the vessel surface. Consider the latent heat of vaporization of the stored material as 90 kJ/kg. Calculate the Relief Rate for Fire case scenario. Consider adequate drainage and fire-fighting is available.	**10**	**CO3**

SECTION-C

Q	44000 lb/hr of a 42^0API kerosene leaves the bottom of a distillation column at 390 ^{0}F and will be cooled to 200 ^{0}F by 34 ^{0}API Mid-continent crude coming from storage at 100 ^{0}F and heated to 170 ^{0}F. A 10 psi pressure drop is permissible on both streams, and a combined dirt factor of 0.003 should be provided. Available for this service is a 21 ¼” ID exchanger having 156 1” OD, 13 BWG tubes 16’0” long and laid out on 1 ¼” square pitch. The bundle is arranged for four passes, and baffles are spaced 5” apart.	**5+35= 40**	**CO4**

Calculate

1. Flow rate of the cold fluid **5 (CO4)**
2. Will the exchanger be suitable? **35 (CO4)**

Q 9

Acetone is to be recovered from an aqueous waste stream by continuous distillation. The feed will contain 15 per cent w/w acetone. Acetone of at least 97 per cent purity is wanted, and the aqueous effluent must not contain more than 60 ppm acetone. The feed will be at 20^0C. Total number of ideal stages 18.

Other details are given as:

Feed rate = 15,000 kg/hr. $MW_{acetone}$= 58, MW_{water} =18. Slope of the Operating line at bottom & Top are 5.0 & 0.57 respectively. Composition at the top is 98 w/w%. mol. % (i.e. 98 w/w %). Bottom composition is essentially water. Reflux ratio = 1.30

Component	Temp (ºC)	ρ_v (kg/m^3)	ρ_l (kg/m^3)	Surface Tension (N/m)
Steam	106	0.72	954	57×10^{-3}
Acetone (98 w/w %)	57	2.05	753	23×10^{-3}

Assume following parameters as per design standard for the design of the column

a) Velocity (% flooding) at maximum flow rate
b) Down comer area (as % of the total area)
c) Tray spacing.

1. Estimate pressure at bottom of the column. Assume 60% column efficiency. **5 (CO5)**
2. Calculate Column diameter at Top & bottom respectively. **25 (CO5)**

Refer to figure for necessary information and data

OR

A storage tank for a particular fluid will be constructed from SS to resist corrosion. The tank is to have an inside diameter of 20 m and a height of 24 m. Allowable design stress for SS is 85 MN/m^2 and specific gravity of the stored fluid is 1.20.

Design a storage tank calculating (1) Number of courses (2) Dimension of each course (length, thickness & width).

Refer the tables given below as applicable. Consider Internal Diameter as Nominal Diameter of the tank. **30 (CO1)**

30

CO5 or CO1

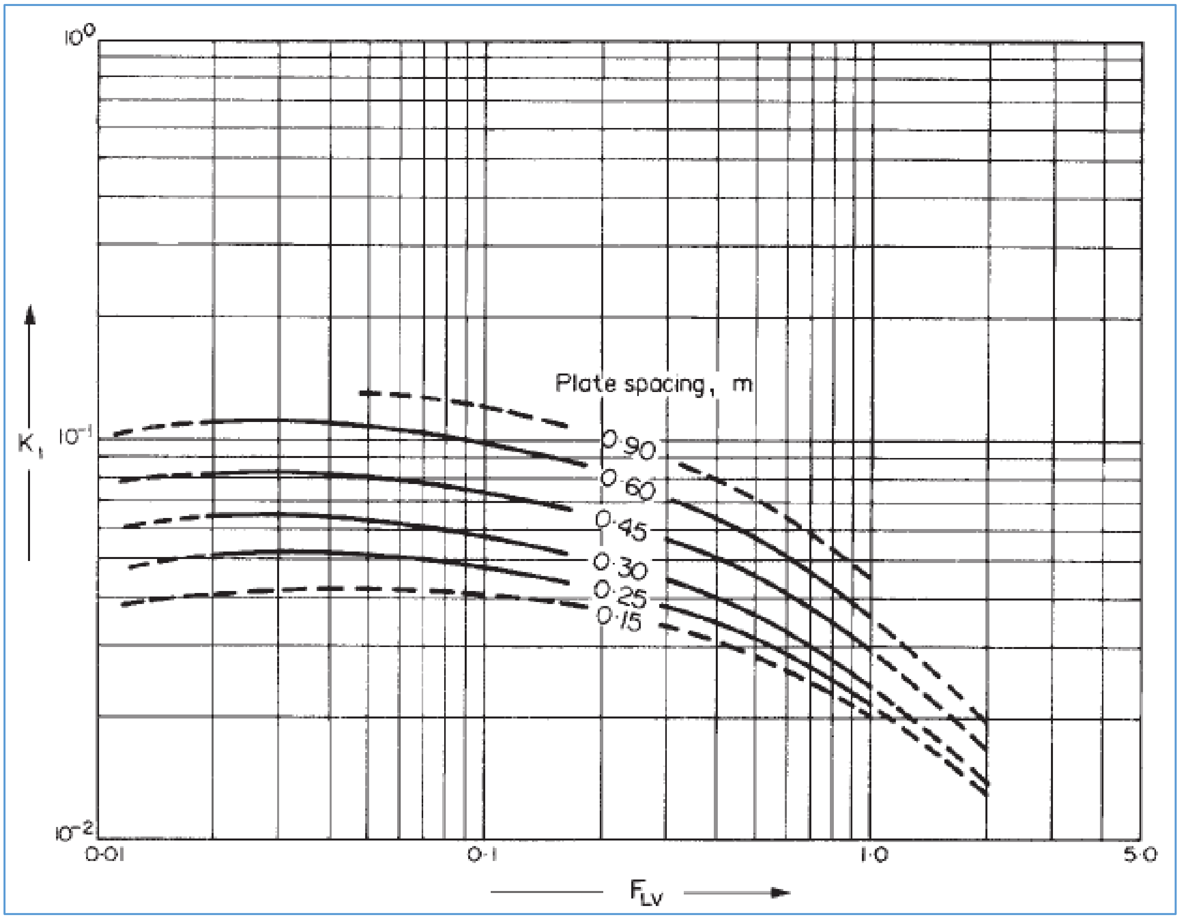
Table 1: Standard Nominal Thickness of Plates in mm

5.0	10.0	18.0	28.0	45.0
6.0	12.0	20.0	32.0	50.0
7.0	14.0	22.0	36.0	56.0
8.0	16.0	25.0	40.0	63.0

Table 2: Minimum Nominal thickness (mm)

Nominal Tank Diameter (m)	Minimum Nominal Thickness (mm)
Smaller than 15	5.0
Over 15 upto and including 36	6.0
Over 36 upto and including 60	8.0
Over 60	10.0

Figure 1: K_1 for Flooding Velocity, Sieve Plate



10⁰
10⁻¹
10⁻²
K₁
Plate spacing, m
0·90
0·60
0·45
0·30
0·25
0·15
0·01
0·1
1·0
5·0
F_LV