Enrollment No./Seat No.:

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering - SEMESTER - VII EXAMINATION - WINTER 2025

Subject Code: 3170502 **Date: 26-11-2025**

Subject Name: Process Equipment Design

Time: 10:30 AM TO 01:00 PM **Total Marks: 70**

Instructions

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

			Marks
Q.1	**(a)**	Differentiate between NPSHA and NPSHR.	**03**
	(b)	Discuss about non-destructive test for determination of welding joint efficiency in brief.	**04**
	(c)	Describe step wise procedure to calculate overall heat transfer coefficient in a shell and tube heat exchanger, employed to transfer the heat without phase change.	**07**
Q.2	**(a)**	In a ABC private limited, management has decided to increase the production capacity of a existing plant. Being a Chemical Engineer, you need to suggest ways to maintain the purity of top and bottom without altering physical dimensions of a column. Support your answer with appropriate reasons.	**03**
	(b)	Describe the effect of reflux ratio on fixed, operating and total cost of distillation column.	**04**
	(c)	Estimate minimum reflux ratio for the feed defined by the compositions given in table below.The desired recovery of the light key component O in the distillation is 94.48%. The recovery of heavy key component P in the bottoms is 95.39%. Feed is at its bubble point. Total feed flow rate is 100 kmol/hr. Assume components lighter than the light key do not appear in bottom and components heavier than the heavy key do not appear in distillate.	**07**

Component	Feed mole fractions	Average relative volatility, αi
M	0.10	2.30
N	0.13	1.75
O (LK)	0.25	1.45
P (HK)	0.23	1.00
Q	0.15	0.90
R	0.08	0.83
S	0.06	0.65

OR

(c) Lube-oil (flowrate 450 L/min) is to be cooled from 65 ºC to 45 ºC with the cooling water. Calculate, **07**

(i) flow rate of cooling water.

(ii) tube side heat transfer coefficient.

Use following data for calculation purpose.

4-1 pass shell and tube heat exchanger

Shell side fluid = lube-oil, Tube side fluid = cooling water

Cooling water inlet temperature = 35 ºC

Cooling water outlet temperature = 39 ºC

Assume value of overall heat transfer coefficient of 400 W/m2.ºC.

Tube length = 10 ft

Tube outside diameter = 15.875 mm

Tube inside diameter = 13.3858 mm

LMTD correction factor = 0.95

Property	Lube-oil	Cooling water
Density, kg/m3	869	993.328
Viscosity, cP	15	0.73
Specific heat, kJ/kg.ºC	2.1413	4.1868
Thermal conductivity, W/m.ºC	0.13	0.628

Q.3 **(a)** Describe function of following parts in a shell and tube heat exchanger: 1) Tube side pass partition plate, 2) Shell side pass partition plate, and 3) Tie rods. **03**

(b) Discuss merits and demerits of air cooled heat exchanger over water cooled heat exchanger. **04**

(c) Describe step wise design procedure for vertical thermosyphon reboiler. **07**

OR

(a) Describe the function of baffles in a shell and tube heat excahnger. Also list various types of baffles used in a shell and tube heat exchanger. **03**

(b) Discuss merits and demerits of U-tube heat exchanger over fixed tube sheet heat exchanger. **04**

(c) Describe step wise design procedure for kettle type reboiler. **07**

Q.4 **(a)** Define following terms: 1) Heavy key component, 2) Minimum reflux ratio, and 3) Weeping **03**

(b) Describe merits and demerits of distillation columns operated under vacuum. **04**

(c) Explain step wise procedure to calculate pressure drop in a sieve tray distillation column. **07**

OR

(a) Explain the function of weir in a sieve tray tower. Also suggest the effect of weir height on separation efficiency and pressure drop. **03**

(b) Explain the following terms: 1) Jet flooding and 2) Downcomer flooding **04**

	(c)	Explain step wise procedure to calculate tower diameter in a sieve tray distillation column.	**07**
Q.5	**(a)**	Differentiate between Internal Design Pressure and External Design Pressure from mechanical design prespective.	**03**
	(b)	Describe selection criteria between tray tower and packed tower for absorption.	**04**
	(c)	Describe step wise procedure to calculate minimum solvent rate for a packed absorption column. Consider physical absorption of dilute gas mixture in an isothermal condition.	**07**

OR

	(a)	Explain about stress-strain curve with a neat figure.	**03**
	(b)	Describe the function of liquid distributor and liquid redistributor in a absorber. Also list various types of liquid distributors and liquid redistributors.	**04**
	(c)	Describe step wise procedure for the design of a torispherical head.	**07**

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