

GUJARAT TECHNOLOGICAL UNIVERSITY**BE - SEMESTER-VII (NEW) EXAMINATION – WINTER 2021****Subject Code:3173617****Date:13/12/2021****Subject Name:Principles of 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) Define: (a) Tray Efficiency (b) Tie Rods (c) Equivalent length of Pipe (L_e)	03
(b) Explain the pressure drop in fittings and valves.	04
(c) Write a brief note on selection of heating media and cooling media in heat exchanger.	07
Q.2 (a) Write down the advantage and disadvantage of PFR over MFR.	03
(b) How reflux ratio affects distillation column design.	04
(c) State the various types of shell and tube heat exchanger. Discuss the advantages and disadvantages of different types of shell and tube heat exchanger with each other.	07
OR	
(c) Explain in detail about various steps for shell and tube Heat exchanger design.	07
Q.3 (a) Explain degree of completion of reaction.	03
(b) Discuss the effect of various parameters in design of equipment: 1. Baffle spacing in heat exchanger 2. Tray spacing in tray tower 3. Weir length in tray column	04
(c) Benzene at 40 °C is pumped through the system at a rate of 10 m ³ /h with the help of a centrifugal pump. The reservoir is at atmospheric pressure. Pressure at the end of discharge line is 350 kPa g. The discharge head is 3.05 m and the pump suction head is 1.1 m above the level of liquid reservoir. The friction loss in suction line 3.45 kPa and that in discharge line is 39 kPa. The mechanical efficiency of the pump is 0.65. The density of benzene is 870 kg/m ³ and its vapour pressure at 40 °C is 29 kPa. Calculate (a) (NPSH) _A and (b) power required by centrifugal pump.	07
OR	
Q.3 (a) Discuss the process design of kettle type reboiler.	03
(b) List important industrial application of reactors.	04
(c) Design a bubble column reactor with suitable rate equation.	07
Q.4 (a) Discuss in brief jet flooding and downcomer flooding	03
(b) How to select key components for multicomponent distillation.	04
(c) Explain McCabe-Thiele method for binary distillation.	07
OR	
Q.4 (a) Mention the selection criteria for heat exchanger.	03
(b) Discuss Tinker's flow model with neat figure.	04
(c) In vertical thermosyphon reboiler recirculation ratio is fixed by trial and error method. Discuss how to find or fix the recirculation ratio in the following conditions: (i) $\Delta P_{av} \approx \Delta P_t$ (ii) $\Delta P_{av} > \Delta P_t$ (iii) $\Delta P_{av} < \Delta P_t$	07

- Q.5** (a) Define (a) Weeping (b) Jet flooding (c) Down comer flooding **03**
 (b) Mention the different types of weirs & down comers of tray tower. **04**
 (c) 1-2 shell and tube heat exchanger is used to cool methanol condensate from 95 °C to 40°C. Flow rate of methanol is 100000 kg/h. Brackish water is used as coolant with temperature rise from 25 °C to 40 °C. Choose 20mm OD, 16 mm id, 4.88 m long cupro-nickle tubes with triangular pitch $Pt = 1.25 d_o$. Based on overall heat transfer coefficient 600 W/m² °C Calculate (1) Number of tubes (2) Shell Diameter K₁ and n₁ for tube bundle diameter: (For triangular pitch $Pt= 1.25dO$) **07**

No. of tube side passes	1	2	4	6	8
K ₁	0.319	0.249	0.175	0.0743	0.0365
n ₁	2.142	2.207	2.285	2.499	2.675

Property	Methanol	Brackish Water
Heat Capacity, kJ/kg °C	2.84	4.2
Density, kg/m ³	750	995
Viscosity, mN.s/m	0.34	0.8
Thermal conductivity, W/m °C	0.19	0.59

OR

- Q.5** (a) Explain in brief about liquid entrainment. **03**
 (b) Discuss the advantages and disadvantages of Vacuum distillation. **04**
 (c) Explain concept of NPSH in pumping system. Distinguish between (NPSH)_A and (NPSH)_R. If (NPSH)_A is less than (NPSH)_R, then suggest corrective action to make (NPSH)_A greater than (NPSH)_R. **07**
