Seat No.: _____ **Enrolment No._____**

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VI (NEW) - EXAMINATION – SUMMER 2016

Subject Code:2160503 **Date:09/05/2016**

Subject Name: Process Equipment Design -I

Time: 10:30 AM to 01:30 PM **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Discuss the criteria for the selection of different types of absorption column in industries **07**

(b) A three stage reciprocating compressor is used to compress 306 Sm^3/h of methane from 0.95 atm a to 61.3 atm a. The inlet temperature is 26.7 °C. Specific heat ratio of methane is 1.31. Calculate (1) Power required for compression, if mechanical efficiency is 80% and (2) discharge temperature of gas after 1st stage. **07**

$$P_0 = \frac{2.78x10^{-4}}{\eta}\frac{K}{K-1}q_{v1}P_1\left[\left(\left[\frac{P_2}{P_1}\right]^{1/n}\right)^{\frac{K-1}{K}} - 1\right]$$

Q.2 **(a)** Discuss the criteria for the choice of solvent for liquid – liquid extraction. **07**

(b) Write a brief note on selection between horizontal and vertical condenser. **07**

OR

(b) Discuss various applications of liquid – liquid extraction in chemical industry. **07**

Q.3 **(a)** Discuss the advantages and disadvantages of vacuum distillation in detail. **07**

(b) Discuss criteria of selection among the different types of trays used in tray tower. **07**

OR

Q.3 Determine minimum reflux ratio, minimum number of theoretical stages required, optimum reflux ratio and theoretical stages required for desired separation for following system by FUG method. Feed flow rate is 70 kmol/hr and feed is saturated liquid. Composition of distillation column streams and average relative volatilities of all components of feed are as follows. **14**

Component	α_{avg}	Feed	Distillate	Residue
Benzene	8.96	2.2	22.8	0
Toluene	2.8407	7.4	72.2	0.5
Ethylbenzene	1	43.4	5.0	47.5
Styrene	0.6506	47	0	52

Toluene is light key and ethyl benzene is heavy key component. Gilliland co relation is given by:

$N - Nm / N+1 = 1 - \exp ((1 + 54.4\psi / 11 + 117.2\psi) * (\psi - 1 / \psi^{0.5}))$

Where $\psi = R -- R_m / R + 1$

Q.4 **(a)** Explain the method of selection of operating pressure in distillation column. **07**

(b) Write a brief note on Fluid allocation in shell and tube heat exchanger. **07**

OR

Q.4 **(a)** Write a short note on selection of equipments for distillation. **07**

(b) Benzene at 38°C is pumped through the system at a rate 9.09 m^3/hr with the help of a centrifugal pump. The reservoir is at atmospheric pressure. Pressure at the end of discharge line is 345 kPa g. The discharge head is 3.05 meter and the **07**

pump suction head is 1.22 meter above the level of liquid in reservoir. The friction loss in suction line is 3.45 kPa and that in discharge line is 37.9 kPa. The mechanical efficiency of the pump is 0.6. The density of benzene is 865 kg/m^3 and its vapor pressure at 38°C is 26.2 kPa. Calculate (1) NPSH and (2) Power required by pump. Power required by pump is given by,

$$P = (H \times q_v \times \rho) / (3.67 \times 10^5 \times \eta)$$

Where P= power required in kW, H= Total dynamic head in meter, q_v= volumetric flow rate, m^3/hr, ρ= density of fluid, kg/m^3, η= mech. efficiency of pump.

Q.5 Give the stepwise design procedure for Shell & Tube heat exchanger. **14**

OR

Q.5 (a) Explain in brief Tinker's Flow Model for Shell and Tube heat exchanger. **07**

(b) Discuss in brief about NPSH for centrifugal pumps. **07**

****