Registration No.										

Total Number of Pages : 03 **B.Tech**
PCE5I102

5th Semester Regular Examination 2017-18
Process Equipment Design
BRANCH : CHEM
Time : 3 Hours
Max Marks : 100
Question Code : B231

Answer Question No.1 and 2 which are compulsory and any four from the rest.
The figures in the right hand margin indicate marks.
Assume suitable notations and any missing data wherever necessary.
Answer all parts of a question at a place.

1. Answer the following questions : (2x10)

(a) Relative volatility ($\propto_{AB}$) is
- i. y(1-y)/x(1-x),
- ii. yx/(1-y)(1-x)
- iii. y(1-x)/x(1-y),
- iv. None of these

(b) In McCabe Thiele Plot of continuous distillation operation $x_D/(R+1)$ represent
- i. x-intercept of enriching section operating line
- ii. y-intercept of enriching section operating line
- iii. x-intercept of exhausting section operating line
- iv. y-intercept of exhausting section operating line

(c) Slope of the feed line in continuous distillation operation is
- i. q/(1-q)
- ii. q/(q-1)
- iii. q
- iv. (q-1)/q

(d) When minimum solvent is employed in absorption operation, the dissolved component in outlet liquid solvent is
- i. Maximum
- ii. Minimum
- iii. Zero
- iv. None of theses

(e) Packing height of absorption is defined as
- i. HTU+NTU
- ii. HTU-NTU
- iii. HTU×NTU
- iv. HTU/NTU

(f) How many tube side partitions are required for a 4-6 STHE construction?
- i. 3
- ii. 4
- iii. 5
- iv. 6

(g) In forced convection, Nusselt number (Nu) is a function of
- i. Re, Gr
- ii. Re, Pr
- iii. Pr, Gr
- iv. All of these

(h) Overall heat transfer coefficient in STHE has the unit of
- i. W/m.K
- ii. $W/m^2.K$
- iii. Kcal/m.K
- iv. $Kcal/m^2.K$

(i) Steam economy for a single effect calendria type evaporator is
- i. Less than 1
- ii. More than 1
- iii. Both i and ii
- iv. All of these

(j) TEMA stands for
- i. Tubular exchanger manufacture association
- ii. Testing exchanger monitoring allocation
- iii. Tuning exchanger motion association
- iv. Tubular erection maintenance accreditation

2. Answer the following questions : (2x10)

(a) What is the ideal vapour composition leaving a tray when liquid compositions are 25 mole% A and 75mole% B for a relative volatility 3.0?

(b) Reflux is necessary for distillation operation. Justify.

(c) When partial condenser is used in distillation operation?

(d) What is channeling in packed tower?

(e) What is HETP and how it is calculated?

(f) Mention the characteristics of solvent for absorption operation.

(g) Define heat effectiveness for STHE.

(h) What are the roles of baffle in a STHE?

(i) Why downtake area is required in a vertical tube evaporator?

(j) Define BPR or BPE.

3. (a) Explain parallel flow and counter flow. **(4)**

(b) Explain why counter flow is more efficient than parallel flow in heat exchanger? **(3)**

(c) Draw a box diagram of triple effect mixed feed method (2-3-1 sequence) showing all the notations for material, component and heat balance equations. **(8)**

4. (a) A methanol (CH_3OH)-water(H_2O) solution of relative volatility 2.6 at 27^0C is to be continuously rectified at 2 std. atm. pressure at a rate of 5000 kg/hr to provide a distillate containing 99% methanol and a residue containing 1.0% methanol(all % by mole). The feed is to be preheated by heat exchanger with residue to its boiling point. For this purpose 30 number of actual trays are used in a distillation column employing actual reflux 2.5 times of the minimum. The reboiler supplied the vapour at a rate of 6000 m^3/hr with 1.5 m/sec velocity. Tray spacing of 75cm is used inside the column. Find the diameter and height of the column. **(10)**

(b) Draw a neat sketch of plate type distillation column with all necessary accessories with specification. **(5)**

5. **(a)** A packed tower is to be designed to absorb SO_2 from air by scrubbing it with water. The entering air and the leaving air streams are containing 15% and 0.5 % SO_2 by volume. The entering water flow rate is 450 kg/hr.m^2(SO_2 free). The air flow rate (SO_2 free basis) is 1000 kg/hr m^2. The operation is carried out at 30^0C and 2 atm pressure. The equilibrium relation is y= 2.0 x, where x and y are mole fractions of SO_2 in liquid and gas phases. The value of mass transfer coefficient (K_{ya}) is 65. Calculate the packing height and diameter of the absorption tower for inlet air velocity 1m/sec. **(10)**

(b) Draw a neat sketch of packed absorption tower with specifications. **(5)**

6. **(a)** A 1-2 shell and tube heat exchanger is to supply hot water receiving heat from flue gas at 420K and cooled to 400K. 1000kg/sec of water at 300K enters the tubes at a velocity of 1.2 m/sec and leaves at 325K. Gas inlet pressure may be taken as 1 atm. Determine the number of tubes, shell ID, and length of heat exchanger. **(10)**
Data: Tubes ID =2.12cm, OD =2.54cm, P_T = 3.175cm(Δ), U_D=1000 Kcal/hr.m^2.K.

(b) Calculate the pressure drop in tube side for the part (a). **(5)**

7. A forward feed double effect evaporator is employed to produce 6000kg/hr of aqueous solution with 45% solids from a solution containing 10% solids at 25^0C. The dry and saturated steam at 240 KPa is used as a heating medium and the temperature in the second effect is 50^0C. The specific heat of the feed and product is 0.8 kcal/kg ^{0}C. BPR of 5^0C and 7^0C cannot be avoided in 1^{st} and 2^{nd} effects respectively. The overall heat transfer coefficients are 1500 and 950 kcal/hr.m^2.^{0}C in 1^{st} and 2^{nd} effects respectively.Tubes of 25.4mm OD and 19mm ID of 1.2 m long are arranged in 35mm triangular pitch.Design the double effect evaporator. **(15)**

8. Draw a neat sketch of 4-4 shell and tube heat exchanger with specifications. **(15)**

9. **(a)** Draw a neat sketch of packing materials for mass transfer operation. **(5)**
(b) Draw a neat sketch of counter flow double pipe heat exchanger. **(5)**
(c) Explain temperature correction factor. **(5)**