Registration No. :

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# Fifth Semester Back Examination – 2014

## MASS TRANSFER - I

## BRANCH : CHEM

## QUESTION CODE : L 227

### Full Marks – 70

### Time : 3 Hours

*Answer Question No. 1 which is compulsory and any **five** 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 :                                                          2 ×10
    (a)  Write the equation for determination of diffusivity by Stefan's method.
    (b)  On what factors does the mass transfer rate between two fluid phases depend ?
    (c)  Write Stanton number for heat transfer and Lewis equation.
    (d)  Write the situations under which steam distillation is recommended.
    (e)  Write the Rayleigh equation.
    (f)  With a neat plot explain the effect of pressure on Txy diagram.
    (g)  Mention the desirable characteristics of absorption tower packing materials.
    (h)  State the factors on which HETP depends.
    (i)  How the wet bulb temperature is measured ? Explain with a neat diagram.
    (j)  Write the equations for height of humidity transfer unit and number of humidity transfer unit.

2.  (a)  Briefly explain the analogy between momentum, heat, and mass transfer.   6
    (b)  Calculate the diffusivity of dry hydrogen in air at 47°C and 1.62 atmospheric pressure. The molecular volumes of air and hydrogen are 32.8 and 14.9 cm$^3$/gmol.                                                          4

3.  For the McCabe-Thiele's method, derive the equation of feed line. Also draw the plot for feed lines for different conditions of feed.                          8+2

P.T.O.

4. A mixture of benzene and toluene containing 60 mole % benzene is to be separated to give a product of 95 mole % benzene and bottom product containing 10 mole % benzene. The feed enters the column at its bubble point. It is proposed to operate the column with a reflux ratio of 2.48. Find the number of theoretical plates needed and the position of feed plate. The VLE data is given below : 10

| x | 0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 | 1.0 |
|---|---|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| y | 0 | 0.21 | 0.38 | 0.5 | 0.6 | 0.71 | 0.78 | 0.84 | 0.9 | 0.96 | 1.0 |

5. (a) With a neat diagram, discuss the construction and operation of a packed column. 5
   (b) Discuss the types of packing used in packed columns. 5

6. (a) The dry bulb and dew point temperatures of ambient air were found to be 30°C and 15°C respectively. Calculate (i) the absolute molal humidity, (ii) the absolute humidity and (iii) the % relative humidity. 3
   Data :
   Barometer reads 100 kPa.
   Vapour pressure of water vapour at 15°C = 1.9 kPa
   Vapour pressure of water vapour at 30°C = 4.1 kPa

   (b) Air at 60°C and 745 mm Hg having a percent humidity of 10 is supplied to a drier at the rate of 1000 m³/hr for drying a wet solid. Water is evaporated from the drier at a rate of 20 kg/hr. The air leaves the drier at 35°C and 742 mm Hg. Calculate (i) percent humidity of the air while leaving the drier and (ii) volumetric flow rate of wet air leaving the drier. 7
   Data :
   Vapour pressure of water at 60°C = 150 mm Hg and
   At 35°C = 42 mm Hg.

7. Write briefly about the construction and operation of the following equipment with a neat diagram : 5+5
   (a) Spray tower
   (b) Sling psychrometer.

8. Write short notes on any **two** : 5×2
   (a) Molecular diffusion in gases
   (b) Boling point diagram
   (c) HETP
   (d) Criteria of solvents for gas absorption.