[Time: Three Hours]   [Marks:80]

N.B.:   1   Question **ONE** is compulsory
        2   Attempt any **THREE** questions out of the remaining
        3   Figure to the right indicate full marks
        4   Illustrate answers with sketches wherever required and Diagram at appropriate places carries marks
        5   Assume suitable data if necessary and indicate it clearly.

1   Attempt any four.   **(20)**

   (a)   Derive the operating line equation for the steady state concurrent processes.   **(05)**

   (b)   Write short note Venturi scrubber.   **(05)**

   (c)   Derive the equation for molar flux for steady state equimolar counter diffusion of two gases.   **(05)**

   (d)   List the factors affecting the choice of solvent in gas absorption.   **(05)**

   (e)   Discuss the terms used to describe the moisture content of substances.

2 (a)   Derive the relation between F-type and k type mass transfer coefficients by considering all driving forces for the following cases.   **(10)**
         i) Gas A diffusing in non-diffusing gas B.
         ii) Equimolal counter diffusion of liquid A and B.

   (b)   Explain the rate of drying curve and derive the equation for total drying time.   **(10)**

3 (a)   In a dilute concentration region, equilibrium data for SO_2 distributed between air and water can be approximated by: $P_A = 25x_A$ (P_A is partial pressure of SO_2 in air in atm and x_A is the mole fraction of SO_2 in water). For absorption column operating at 10 atm, the bulk vapour and liquid concentrations at one point in the column are $y_A = 0.01$ and $x_A = 0.05$. The individual mass transfer coefficients, $K_x = 10$ kmole/m^2.hr and $K_y = 8$ kmole/m^2.hr. Find: **(10)**
                 a.   Overall mass transfer coefficient K_x'
                 b.   Interfacial compositions x_{Ai} and y_{Ai}
                 c.   Calculate molar flux N_A

   (b)   Derive the equation of operating line for steady state Counter-current absorption operation.   **(10)**

4 (a)   Slabs of paper pulp 100cm x 100cm x 1.5cm are to be dried under constant drying conditions from 67% to 30% moisture. The value of the equilibrium moisture content is 0.5%. If the critical moisture content is 60% and the rate of drying at the critical point is 1.5 kg/m2 hr., calculate the drying time. The dry weight of each slab is 2.5kg.All moisture content are on wet basis. The falling rate may be assumed to be linear.   **(10)**

(b) Oxygen (A) is diffusing through carbon monoxide (B) under steady state **(10)** conditions with carbon monoxide non-diffusing. The total pressure is 1×10^5 N/m^2 and temperature is 0°C. The partial pressures of oxygen at two planes 2mm apart are respectively 13000 and 6500 N/m^2. Calculate the rate of diffusion of oxygen in kmole/s through each square meter of the plane. The diffusivity for the mixture is 1.87×10^{-5} m^2/s.

5 (a) Give the classification of cooling towers. Also explain any one in detail. **(8)**

(b) A coal is to be freed of its light oil vapors with wash oil as an absorbent. Gas **(12)** enters at the rate of 0.250 m^3/s at 26 °C and total pressure of 1.07×10^5 N/m^2 containing 2% by volume of light oil vapors. The light oil is assumed entirely be benzene and a 95% removal is required. The wash oil enters at 26 °C and containing 0.005 mole fraction benzene and has average molecular weight of 260. Wash oil and benzene solution is ideal. An oil circulation rate of 1.5 time the minimum is to be used. Calculate the oil circulation rates and the steam rate required.

6 Attempt any four **20**

(a) What is mist eliminator? Give the applications of mist eliminators. **(5)**

(b) Write short note on adiabatic saturation curve **(5)**

(c) Write short note on spray dryer. **(5)**

(d) Write short note on diffusion through Crystalline Solids **(5)**

(e) Discuss the analogy between Mass, Heat and Momentum Transfer. **(5)**