Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

A Constituent Institution of Manipal University

IV SEMESTER B.TECH. (CHEMICAL ENGINEERING)

END SEMESTER EXAMINATIONS, APRIL 2017

SUBJECT: MASS TRANSFER-I [CHE 2203]

REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 100

Instructions to Candidates:

Answer **FIVE FULL** questions. Missing data may be suitably assumed.

1A	A beaker with 0.07 m height is filled with liquid benzene at 25^0C to within 0.02 m from top. A gentle breeze of dry air at 25^0C, 1 atm is flown across the mouth of the beaker so that evaporated benzene is carried by convection after it transfer through stagnant layer. Calculate the initial rate of evaporation of benzene as molar flux? Calculate the level of the benzene after 6 hrs time period, if the specific gravity of liquid benzene is 0.874. Neglect the accumulation of benzene and air in the stagnant layer as it increases in height	13
1B	Derive the equation for molar flux from basic flux equation for steady state conditions where A is diffusing through B with the stoichiometry of A→3B.	07
2A	Prove that $k_c \propto D_{AB}^n$ with various theories (atleast three) and give the assumptions used. (where n=0 to 1)	09
2B	A wet sugar candy (cylindrical structure) with radius of 50 mm and height of 500 mm has an initial moisture content of 12 % (wt). At time t=0 the candy is exposed to air on all surfaces except the bottom base such that surface concentration was maintained at 2%. Estimate the time required to get the moisture content of 6% in wet sugar candy. The diffusivity is $1x10^{-12}$ m^2/s.	11
3	It is desired to dry 10 kg of soap from 20% moisture (wt.) by contact with hot air. The wet soap is placed in a vessel containing 8.06 m^3 of air at 375^0C, 1 atm with water vapour partial pressure of 1.6 kPa. Practical problems led the vessel to be replaced from second stage with a capacity of 10 m^3 of air. The system is allowed to reach equilibrium and then the air in the vessel was replaced by fresh air of same conditions. Find the final moisture content in soap after four stages. The equilibrium data was given below at these conditions.	20

Wt% of moisture in soap	2.4	4.76	7.83	12.62	15.4	19.02
Partial pressure of moisture in air (kPa)	1.29	3.79	6.19	8.42	9.58	10.6

4A	State Raoults Law and Henry's Law	04
4B	Briefly explain atleast four mechanical problems (due to gas/liquid flow rates) encountered in tray tower design?	04

4C	6000 kg/hr of a SO_2 –Air mixture containing 6% by volume of SO_2 is to be scrubbed with 2,50,000 kg/hr of water in packed tower. The exit concentration of SO_2 is reduced to 0.2 %. The tower operates at 1 atm. Calculate the height of transfer unit, if the packed height of tower is 0.45 m. Also calculate the Absorption factor The equilibrium relation is **Y=30 X** (Y moles of SO_2/moles of pure air, X moles of SO_2/moles of pure water)	12
5A	Define the following i) Relative humidity ii) percent saturation iii) dry bulb temperature iv) wet bulb temperature	06
5B	An aqueous solution containing a valuable solute is coloured by small amounts of impurity. Before crystallization the impurity is to be removed by adsorption. On decolourization carbon which adsorbs the solute. A series of laboratory tests was made by stirring various amounts of the adsorbent into batches of original solution until equilibrium was established. The colour intensity was measured on an arbitrary scale, proportional to the concentration of the colored substance. It is desired to reduce the colour to 5% of its original value, 9.6. Determine the quantity of used carbon (25 units of adsorbate/kg of carbon) required per 1000 kg of solution for a single stage operation, for a two stage cross current operation process using minimum total amount of carbon. The data will be represneted as Freildilish Isotherm $Y^* = 8.91 \times 10^{-5} X^{1.66}$ where X=kg of solute/kg of carbon (solid) and Y = kg of solute in Kg of carbon (liquid)	14