Reg. No.										

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

V SEMESTER B.TECH (CHEMICAL ENGINEERING)
MAKEUP EXAMINATIONS, DEC 2015 / JAN 2016
SUBJECT: SIMULTANEOUS HEAT & MASS TRANSFER (CHE 303)

REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 100

Instructions to Candidates:

- Answer **ANY FIVE FULL** the questions.
- Missing data may be suitably assumed.
- Use of steam table is permitted.
- At. Mass: Fe:55.85, S:32.065, O:16

1A.	What is the population density function? Derive an equation which relates it to the size of the crystals and growth rate. And mention the necessary assumptions.	**10**
1B.	Explain the process of mechanical vapour recompression with neat sketch and its significance.	**10**
2A.	Explain the Meir's super-saturation theory with its limitations?	**05**
2B	Why does a big natural draft cooling tower have a hyperbolic shape?	**03**
2C	A double effect evaporator in backward feed arrangement is employed to concentrate 10,000kg/hr caustic soda solution from 9% to 47% NaOH with a product rate of 1915 kg/hr, the feed enters the evaporator at 36^0C process steam is available at 6.77atm guage and in second effect a vacuum of 0.855 atm is maintained assuming equal heat transfer area, estimate steam consumption & evaporation rate in each effect , the overall heat transfe co-efficient at first and second effect is 2000 and 1500 Kcal/hr.m^2.^{o}C respectively, specific heat value is 0.9Kcal/kg.	**12**
3A.	Derive the equation of total drying time for cross circulation drying; at the temperature and humidity of the drying gas remain constant.	**12**
3B.	A wet slab of material weighing 5.5kg originally contains 50% moisture, the slab is 0.75m X 0.5m X 2cm. the equilibrium moisture is 4% on wet basis, both the sides are used for drying, calculate critical moisture content & time to dry the wet slab to 14% moisture by the following drying data	**08**

Wet slab weight,(kg)	5.5	4.537	4.4	4.125	3.85	3.575	3.3	3.02
Dry rate, (kg/m^2.hr)	5.5	5.5	5.4	5.2	4.8	3.4	1.2	0.5

4A.	A Swenson-Walker crystallizer is to produce 1000kg/hr of ferrous sulphate crystals by cooling a saturated solution. The solution enters the crystallizer at 55^{o}C and the slurry leaves at 27^{o}C. The cooling water flows counter currently through the jacket and its temperature rises from 16 to 21^{o}C. The overall heat transfer coefficient has been estimated to be 190 w/m^2.k i) Estimate the cooling water requirement kg/hr ii) If each crystallizer unit is 3.2m long and each meter of crystallizer provides 2.5m^2 surface, how many crystallizer units will be required? Given data:- saturated solution of ferrous sulphate contain 170 & 75 parts $FeSO_4$ per 100 parts excess water at 55^{o}C and 27^{o}C respectively. Specific heat of solution = 2930 J/kg.k Heat of crystallization of $FeSO_4$ = 66.2 KJ /kg	**10**

4B.	Explain working principle of Draft tube- baffle crystallizer with neat sketch.	**10**
5A.	A non-hygroscopic filter cake is to be dried in a continuous countercurrent dryer from 30% moisture to 2% moisture (wet basis) at a rate of 1000 kg per hour. The material enters the dryer at 27^{o}C and leaves at 52^{o}C. Fresh air is mixed with a part of the moist air leaving the dryer and heated to a temperature of 120^{o}C in a finned air heater using low pressure steam (4 kg/cm^2 gauge). Calculate (a) the rate of flow of fresh air, (b) the fraction of the air leaving the dryer that recycled, (c) the theoretical steam requirement and (d) the heat loss from the dryer, if any. The following data and information are given : temperature of fresh air = 29^{o}C; humidity=0.018 kg/(kg dry air); humidity of the air leaving the heater = 0.03 kg/(kg dry air); humidity and temperature of the air leaving the dryer = 0.05 kg/(kg dry air), 70^{o}C; specific heat of the dry solid = 920 J/kg.K	**10**
5B.	Explain the importance of vapor recompression and write short notes on thermal recompression with neat sketch.	**10**
6A.	Explain the classification of cooling towers with a neat sketch & working principle of mechanical draft cooling tower.	**10**
6B.	Solution contains ***5%*** solid is to be concentrated to a level of ***40%*** solid, feed is entering at ***25^{0}C*** with a flow rate of ***28000 Kg/hr***, the evaporator is working at reduced pressure such that solution boiling point is ***61^{0}C, U= 2900 Kj/hr.m^2.K*** and ***C_{pf} = 4.12 Kj/kg.K Negligible heat of dilution*** a) Estimate economy and b) if the feed temperature is increased to ***45^{0}C***, then what is steam consumption? (steam available at 126^{o}C) c)if the evaporator is maintained at atmospheric pressure than change in steam consumption ?.	**10**