Reg. No.										

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

III SEMESTER B.TECH (CHEMICAL ENGINEERING)

END SEMESTER EXAMINATIONS, NOV/DEC 2015

SUBJECT: CHEMICAL PROCESS CALCULATIONS (CHE 2101)

REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 100

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitably assumed.

1A.	Dimethyl formamide (DMF, C_3H_7NO, s.g.=0.944) and Phosphorus oxy-chloride ($POCl_3$, s.g.= 1.64) are to be taken in a flask to conduct a reaction. Find: i. The molar mass of DMF and $POCL_3$ ii. If 40 mL of DMF is taken in the flask to which $POCL_3$ is to be added in a molar ratio of 2.5:1 (DMF: $POCL_3$), calculate the volume of $POCl_3$ to be taken in mL. (At. Mass: P:31; Cl:35.5, N:14, C:12)	**14**
1B.	Convert: i. 2 $lb/ft^3\ ^oF$ to $kg/m^{3o}K$ ii. 1 $kcal/h\ ft^2\ ^oC$ to $W/m^{2o}K$	**6**
2A.	A fuel gas containing 97% CH_4 and 3% N_2 by volume is burned in a boiler furnace with 200% excess air. 85% of CH_4 is converted to CO_2, 10% to CO and 5% is unburnt. Calculate the composition of the stack gases.	**14**
2B.	An ionic solution of cadmium is to be prepared by dissolving cadmium chloride monohydrate crystals. a. Determine the mass of cadmiun chloride ($CdCl_2.H_2O$) crystals required to obtain 1 L of ionic solution having a conc. of 1000 mg/L of Cd(II) ions. b. A 50 mg/L Cd(II) ion solution is prepared using the solution of 1000 mg/L conc. prepared in step (a) above. Determine the amounts of the solution and plain water to be mixed to make 25 ml of the total solution assuming that the total volume equals sum of individual volumes. (At. Mass: Cd: 112.411 ; Cl: 35.451 ; O:16)	**6**

3A.	The equation for methanol synthesis is given by the equation $CO_2 + H_2 \rightarrow CH_3OH + H_2O$ The H_2 and CO_2 entering in stoichiometric quantities contain 0.5% inert by volume. The process is under steady state. The conc. of the inerts going into the reactor must be held at 2% by volume. The conversion is 60 % per pass. Calculate: i. Moles recycled/ moles fed ii. Moles purged/ moles fed.	**14**
3B.	Helium contains 12% by volume of ethyl acetate vapors.($C_2H_5COOCH_3$) at 98 kPa and 30 ^oC. Calculate : i. % Relative humidity ii. % Absolute humidity Data: Vapor pressure of ethyl acetate at 30^oC =15.9 kPa.	**6**
4A.	It is desired to make a 30 % by wt. of caustic soda solution. It is done in 2 steps. i. The caustic soda is dissolved in a dissolution tank in a correct quantity of water to produce 50% solution. ii. After complete dissolution, the solution is taken to a dilution tank, where some water is added to produce 30 % by wt. of solution. Calculate the wt. ratios of water added to both the tanks.	**7**
4B.	A liquid mixture of compounds A, B and C containing 20 Kg of A , 25% by wt. of B, and contains 2 mole of C per mole of B. The respective molecular wts. of A, B, C are 56, 58 and 72 and specific gravities are 0.58, 0.6 and0.67 respectively. Calculate i. The analyses of the mixture in mole %, ii. Molecular wt. of the mixture iii. The volume % of A on B free basis iv. The total number of moles of mixture.	**7**
4C	Limestone is a mixture of calcium carbonate and magnesium carbonate. When 100 kg of limestone is calcined, 48 kg of CO_2 is obtained. If the inerts are 5%, find the analysis of limestone used. (At. Mass: Ca:40;Mg:24)	**6**
5.	Liquid methanol is burnt with 100 % excess air, methanol is fed at 25^oC and air enters at 100^oC. assume complete combustion and calculate the highest temperature that the furnace wall will have to withstand. ΔH_R^o= -726.6 kJ/mole. Cp of air at 100^oC = 29.1 J/mole. Cp (J/mole^oK) $CO_2 = 36.11 + 4.233 \times 10^{-2} T - 2.887 \times 10^{-5} T^2$ $H_2O = 33.46 + 0.688 \times 10^{-2} T + 0.7604 \times 10^{-5} T^2$ $O_2 = 29.1 + 1.158 \times 10^{-2} T - 0.6076 \times 10^{-5} T^2$ $N_2 = 29.0 + 0.22 \times 10^{-2} T + 0.5723 \times 10^{-5} T^2$ Latent heat of vaporization = 44.013 kJ/mole CH_3OH (l) + 3/2 $O_2 \rightarrow CO_2 + 2\ H_2O$ (l)	**20**