III SEMESTER B.TECH (CHEMICAL ENGINEERING)

END SEMESTER EXAMINATIONS, MAY 2016

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.
- Use of humidity chart permitted

1A	Convert: i. 3 atm. to N/cm2 ii. 10 cm Hg to dynes/ cm2 iii. 25 ft. of water to kPa iv. 10 psi(g) vacuum to mm Hg absolute v. 20 psi to cm of Hg. (S.G. of mercury =13.6)	12
1B	A solution of Caustic Soda (NaOH) in water contains 20% by wt. of NaOH at 333K. The density of the solution is 1.196 kg/lit. Find the molarity, normality and molality of the solution.	8
2A	A solution containing sodium sulfate in water is crystallized out by cooling the solution to 5^oC. The original solution is saturated to 40^oC and deca-hydrate crystals are obtained. Estimate the wt. of crystal obtained by cooling a batch of 2000 kg of this solution. Solubility at 40^oC= 32.6 % Solubility at 5^oC= 5.75 % Both solubilities have units of kg Na_2SO4/ kg solution (Molecular Wts: Na_2SO_4=142 , $Na_2SO_4.10H_2O$= 322)	10
2B	A waste acid from a nitration process contains 21 % HNO_3, 55 % H_2SO_4, and 24 % water. The acid is to be concentrated to contain 28 % HNO_3, 62% H_2SO_4 by wt. by the addition of conc. H_2SO_4 and HNO_3 having concentrations 93 % and 90% by wt. respectively. Calculate the weight of the waste acid and conc. acid required to obtain a product of 1000kg.	10
3A	Determine the flue gas analysis and air-fuel ratio by wt. when a fuel oil with 84.5% C, 11.8% H_2, 3.2 % S, 0.4% O_2, 0.1% ash is burned with 25% excess air.	12
3B	In the Decon process of manufacturing Chlorine gas, HCl gas is oxidized with air. The reaction is given as $4HCl+O_2 \rightarrow 2Cl_2+2H_2O$ If the air is used in 30% excess & the reaction is 70% complete, calculate the composition of the dry gas leaving	8

4A	A gas mixture flowing through a pipe line contains 4% oxygen by volume and rest an inert gas. The flow rate is 500 m^3/ min. It is desired to increase the oxygen content of the gas so that the leaving gas contains 8% by oxygen by volume. i) Calculate the rate of addition of oxygen, ii) If the change in composition is caused by pure air, find the rate of addition of pure air, iii) Find the volume of gas mixture leaving under condition (ii) iv) What is the composition of outgoing gas mixture under condition (ii) v) What is the composition in wt% of gas leaving under condition (ii) If the M.Wt. of inert gas is 40? vi) What is the average molecular wt. of the leaving gas mixture?	12
4B	Fresh orange juice contains 12% solids and balance water, the concentrated juice contains 42% solids. In the present process the evaporator is bypassed with a fraction of fruit juice. The juice that exits out of the evaporator is concentrated to 58% solids and the product is mixed with fresh juice to achieve the final concentration. Calculate i) Amount of concentrated fruit juice produce per 750 kg of fresh juice. ii) Fraction of feed that bypasses the evaporator.	8
5A	The flue gases are leaving the chimney of a boiler at 300^oC the molar composition of which are as follows. CO_2=11.3%, CO=0.26%, H_2O=13.04%, O_2=2%, N_2=73.4%. Calculate Q in 100 kg mole of gas mixture above 25^oC using the following C_p data (Kcal / Kg mole ^oK) CO_2= 6.396+ 10.1 x 10^{-3} T - 3.354 x 10^{-7} T^2 CO=6.48+ 1.566 x 10^{-3} T – 2.359 x 10^{-7} T^2 H_2O=6.732+ 1.505 x 10^{-3} T – 1.791 x 10^{-7} T^2	15
5B	Calculate the heat of reaction for the following. Is the reaction exothermic or endothermic ? $CH_4 + 2\ H_2O \rightarrow CO_2 + 4H_2$ ΔH^o_F Data (KJ / Kg mole) CH_4 = -74.9 H_2O = -2412 CO_2 = -393.7 H_2=0	5
6A	An air water vapor system at 1 atm. has a dry bulb temperature of 40^oC and wet bulb temperature of 30^o C . Determine i. The absolute humidity ii. The % saturation iii. The relative saturation iv. The dew point v. The humid heat	10
6B	How many of each of the following are contained in 150.0 g of CO_2 (M = 44.01)? (1) mol CO_2 ; (2) lb-moles CO_2; (3) mol of Carbon (C); (4) mol of O; (5) mol of O_2; (6) gram of O; (7) molecules of CO_2 .	10