CH-302 **Roll No.** | | | | | | | | | | |

B.TECH
(SEM III) ODD SEMESTER EXAMINATION, 2015-16
CHEMICAL PROCESS CALCULATIONS

Time: 3 Hours **Max. Marks: 100**

Note: Attempt all questions. All questions carry equal marks. Assume suitable data if missing.

1. Attempt **any four** parts of the followings: **(5 x 4= 20)**
   (a) What are basic and derived units? Give three examples of both the unit systems.
   (b) Define weight percent, volume percent and mole percent for expressing the compositions of mixtures and solutions.
   (c) An aqueous solution of sodium chloride is prepared by dissolving 25 kg of sodium chloride in 100 kg of water. Determine (i) weight % and mole % composition of solution.
   (d) Derive a relation between partial pressure and mole fraction of a component gas to total pressure.
   (e) Define Roult's law and Henry's law with suitable examples.
   (f) A gas mixture contains 0.274 kmol of HCl, 0.337 kmol of N_2 and 0.089 kmol of O_2. Calculate (i) average molecular weight of gas and (ii) volume occupied by this mixture at 405.3kPa and 303 K.

2. Attempt **any four** parts of the followings: **(5 x 4= 20)**
   (a) Write short notes on purge ratio and recycle ratio in a chemical process with suitable examples.
   (b) A single effect evaporator is fed with 10000 kg/h of week liquor containing 15% caustic by weight and is concentrated to get thick liquor containing 40 % by weight caustic (NaOH). Calculate (a) kg/h of water evaporated and (ii) Kg/h of thick liquor obtained.
   (c) What do you understand from limiting reactant, excess reactant, yield and selectivity?
   (d) In the production of sulphur trioxide, 100 kmol of SO_2 and 200 kmol of O_2 are fed to a reactor. The product stream is found contain 80 kmol SO_3. Find the percent conversion of SO_2. (Reaction: $SO_2 + \frac{1}{2}O_2 \rightarrow SO_3$)
   (e) A combustion chamber is fed with butane and excess air. Combustion of butane is complete. the composition of combustion gases of volume basis is given below:
   CO2 = 9.39 %, H2O = 11.73%, O2 = 4.70% and N2 = 74.18%
   Find % excess air used and mole ratio air to butane used.
   Reaction: $C_4H_{10} + \frac{13}{2}O_2 \rightarrow 4CO_2 + 5H_2O$
   (f) What do you understand by humid heat, humid volume and dry bulb temperature?

3. Attempt **any two** parts of the followings: **(2 x 10= 20)**

(a) What is the importance of humidity measurement in engineering applications and how do you measure it? Explain in brief and what is the significance or meaning of equal dry and wet bulb temperature?

(b) Helium contains 12% by volume ethyl acetate. Calculate (i) percent relative saturation (ii) percent absolute saturation of mixture at a temperature of 30^0C and a pressure of 98 kPa. (The partial pressure of ethyl acetate at 30^0C is 15.9 kPa).

(c) In the Deccan process of manufacturing of chlorine, a dry mixture of hydrochloric acid gas and air is passed over a heated catalyst which promotes oxidation of acid. Air is used 30% in excess of that theoretically required. Calculate the weight of air supplied per kilogram of the acid. (atomic weight of chlorine = 35.5, air contains 23.2% O_2 by weight)

4. Attempt **any two** parts of the followings: **(2 x 10= 20)**

(a) A furnace is fired with fuel oil. The Orsat analysis of the flue gas indicated 10.6% CO_2, 6% O_2 and rest N_2 by volume. Find C:H ratio in the fuel oil assuming that fuel oil does not contain nitrogen.

(b) A stream of carbon dioxide flowing at a rate of 100 kmol/min is heated from 298K (25^0C) to 383K (110^0C). Calculate the heat that must be transferred using C_P^0 data:

$C_P^0 = a + bT + cT^2 + dT^3$, kJ/(kmol. K)

Gas	a	b x 10^3	c x 10^6	d x 10^9
CO_2	21.3655	64.2841	-41.0506	9.7999

(c) Explain Hess's law of constant heat of summation and explain standard heat of combustion, formation, reaction and neutralization.

5. Explain and define **any four** of the followings: **(4 x 5= 20)**

(a) Specific gravity and molarity.
(b) Dew point and bubble point temperature
(c) Modular approach of simulation
(d) Control of pollutants from fuel combustion process
(e) API gravity and Aniline point
(f) Adiabatic flame temperature and latent heat of vaporisation.