Gandhi Institute of Engineering and Technology University, Odisha, Gunupur
(GIET University)

B. Tech (Third Semester – Regular & Supplementary) Examinations, November 2025

23BHPC23003 – Chemical Process Calculation

(Chemical Engineering)

Time: 3 hrs Maximum: 60 Marks

(The figures in the right hand margin indicate marks)

PART – A **(2 x 5 = 10 Marks)**

Q.1. Answer ***ALL*** questions

		CO #	Blooms Level
a.	The specific gravity of hydrocarbon oil is 0.88 at 288 K. Calculate its value in Baume scale and API scale.	CO2	K2
b.	What is ideal solution?	CO1	K1
c.	What is purging and purging ratio?	CO1	K2
d.	Differentiate between limiting reactant and excess reactant.	CO1	K1
e.	Differentiate between adiabatic flame temperature and theoretical flame temperature.	CO2	K1

PART – B **(10 x 5 = 50 Marks)**

Answer ***ALL*** the questions

		Marks	CO #	Blooms Level
2. a.	A compound whose molecular weight is 103 analyses as following (percentage weight basis): C – 81.5; H – 4.9; N – 13.6. What is its formula?	5	CO2	K3
b.	An aqueous solution of NaCl contains 20% NaCl. The density of the solution is 1.16 g/ml. 500 ml of water of density 1 g/ml is added to 1 litre of solution. What will be the molarity, normality and molality of the resulting solution?	5	CO2	K4
	(OR)			
c.	10 kg of liquid A of specific gravity 1.2 is mixed with 3 kg of liquid B of sp. Gravity of 0.8. Assuming there is no volume change on mixing, what is the specific gravity of the mixture?	5	CO3	K3
d.	Prove that for ideal gas mixture mole fraction= pressure fraction =volume fraction.	5	CO2	K3
3.a.	Write short note on Raoult's law.	5	CO2	K2
b.	An aqueous solution of acetaldehyde contains 2% acetaldehyde by weight. The partial pressure of acetaldehyde over the solution is found to be 41.4 kPa at 367 K. What will be the partial pressure over a 0.1 molal solution at the same temperature?	5	CO3	K4
	(OR)			
c.	The Antoine constants for n-heptane are A=13.8587, b=2911.32 and C= 56.56. P^s s in kPa and t is in K. Calculate i) The vapour pressure of n-heptane at 325 K ii) The normal boiling point of n-heptane	5	CO3	K3
d.	Moist air contains 0.025 kg water vapour per cubic metre of mixture at 313K and 103.15 kPa. Calculate the following: (i) The absolute humidity of the air (ii) The percent saturation The vapour pressure of water (in kPa) is approximated by the Antoine equation as $lnP^S = 16.262 - \frac{3799.887}{T-46.854}$	5	CO3	K4
4.a.	A single-effect evaporator is fed with 10000 kg/h of weak liquor containing 15% caustic by weight and is concentrated to get thick liquor containing 40% by weight (NaOH). Calculate the (a) kg/h of water evaporated (b) kg/h thick liquor	5	CO4	K3

b. What will be the yield of hypo ($Na_2S_2O_3.5H_2O$) if 100 kg of a 40% solution of $Na_2S_2O_3$ is cooled to 293 K. The solubility at 293 K is 70 parts $Na_2S_2O_3$ per 100 parts water? — 5 CO2 K3

(OR)

c. A drier is fed with wet solid to reduce the moisture content from 80% to 15%. The product leaving the drier is admitted to an oven which further brings down the moisture to 2%. If the drier can handle 1000 kg of wet solid per hour, calculate: — 5 CO3 K4
(i) The weight of water evaporated in the drier and in the oven per hour.
(ii) The percentage of original water that is removed in the drier and the oven.

d. Soap as produced contains 50% moisture on a wet basis. Before it can be pressed into cake for sale, the moisture would be reduced to 20%. How many 100g cakes can be pressed from 1000 kg of wet soap? — 5 CO2 K3

5.a. Carbon monoxide is reacted with hydrogen to produce methanol. Calculate — 5 CO3 K4
i. Stoichiometric ratio of H_2 to CO
ii. Kmol of methanol produced per kmol CO reacted
iii. The quantity of CO required to produce 1000 kg CH_3OH.

b. Ethylene oxide is produced by oxidation of ethylene. 100 kmol of ethylene are fed to the reactor and the product is found to contain 80 kmol ethylene oxide and 10 kmol CO_2. Calculate- i) The percent conversion of ethylene ii) The percent yield of ethylene oxide — 5 CO3 K3

(OR)

c. Oxidation of ethylene to produce ethylene oxide is given by the reaction — 5 CO4 K4

$C_2H_4 + \frac{1}{2}O_2 \rightarrow C_2H_4O$

If air is used 20% in excess of that theoretically required, calculate the quantity of air supplied based on 100 kmol of ethylene fed to the reactor.

d. Calculate NCV at 298 K of a sample of fuel oil having C/H ration 9.33 (weight) and containing S as 1.3% by weight. — 5 CO4 K3
GCV_{298K} = 41785 kJ/kg, λ = 2442.5 kJ

6.a. Calculate the standard heat of formation of ethane gas at 25 ^{0}C using the following data. — 5 CO4 K4
Heat of formation of CO_2(g)= -393.5 kJ/mol
Heat of formation of H_2O(l)= -285.8 kJ/mol
Heat of combustion of C_2H_6(g)= -1560.7 kJ/mol

b. Derive the expression for the effect of temperature on standard heat of reaction. — 5 CO2 K2

(OR)

c. Obtain an empirical equation for calculating the heat of reaction at any temperature T (in K) for the reaction: — 5 CO4 K4

Component	a	b × 10^3	c × 10^6
$CO_{(g)}$	29.0277	-2.8165	11.6437
$H_{2(g)}$	28.6105	1.0194	-0.1476
$CH_3OH_{(g)}$	21.137	70.843	25.86

$CO_{(g)} + 2\,H_{2(g)} \rightarrow CH_3OH_{(g)}$

Data: $\Delta H_R^0 = -90.41\ kJ/mol$
Also calculate the standard heat of reaction at 700 K.

d. The molal heat capacity of CO is given by — 5 CO3 K4
C_p= 26.586 + 7.582 × 10^{-3} -1.12 × 10^{-6} T^2, Where C_p is in kJ/kmol.K and T in K
(a) Calculate the mean molal heat capacity in temperature range of 500-1000 K.
(b) CO enters a heat exchanger at a rate of 500 m^3 per hour at STP. Calculate the heat to be supplied to the gas to raise its temperature from 500 to 1000K.