QP Code: R264A002 | Reg. No | | | | | | | | | | | AY 23

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

B. Tech (Fourth Semester – Regular/Supplementary) Examinations, April 2026

23BCHPC24001 – Chemical Engineering Thermodynamics

(Chemical Engineering)

Time: 3 hrs | Maximum: 60 Marks

Answer ALL questions

(The figures in the right hand margin indicate marks)

PART – A **(2 x 5 = 10 Marks)**

		CO #	Blooms Level
Q.1.	Answer ***ALL*** questions		
a.	Define a thermodynamic system. Classify it and give one example of each.	CO1	K1
b.	If the pressure of an ideal gas changes from 2 bar to 5 bar at constant temperature, calculate its entropy change?	CO2	K3
c.	Write the reason behind the death of aquatic animals in summer season, through Henry's law.	CO2	K3
d.	Define partial molar temperature and partial molar pressure in terms T and P?	CO1	K2
e.	What should be the criteria of chemical reaction equilibrium in terms of Gibb's free energy?	CO2	K2

PART – B **(10 x 5 = 50 Marks)**

		Marks	CO #	Blooms Level
	Answer ***ALL*** the questions			
2. a.	Reported values of Virial coefficients of isopropanol vapor at 200 °C are B = -388 cm^3/mol and C = -26000 cm^6/mol^2. Calculate molar volume (V) and compressibility factor (Z) for isopropanol vapor at 200 °C and 10 bar by using (i) Ideal gas equation (ii) $Z = \frac{PV}{RT} = 1 + \frac{B}{V} + \frac{C}{V^2}$	5	CO2	K3
b.	An ideal gas at 8 bar and 600 K undergoes a mechanical reversible ideabatic process to a final pressure of 1 bar. If $C_p = \frac{7}{2}R$ *and* $C_v = \frac{5}{2}R$, find Q, W, ΔU and ΔH.	5	CO2	K3
	(OR)			
c.	Write the short note on P~T diagram for for pure component with free hand graph.	5	CO2	K2
d.	Express the volume expansivity and isothermal compressibility as function of density ρ and its partial derivatives. For water at 500C and 1 bar, κ = 44.18×10-6 bar-1. To what pressure must water be compressed at 50°C to change its density by 1%? Assume that κ is independent of P.	5	CO2	K3
3.a.	The binary system of acetonitrile (1)/ nitromethane (2) conforms closely to Raoult's law. The following Antoine equations give vapor pressures for the pure species: $\ln P_1^{sat}/kPa = 14.2724 - \frac{2945.47}{T-49.15}$ $\ln P_2^{sat}/kPa = 14.2043 - \frac{2972.64}{T-64.15}$ Given T is in K in the Antoine equation	10	CO3	K4

Prepare a graph showing T vs x_1 and T vs y_1 for a pressure of 70 kPa by using the above Antoine equation.

(OR)

b.	The system acetone(1) / acetonitrile(2) / nitromethane(3) at 353.15 K and 110 kPa has the overall composition, z_1=0.45, z_2= 0.35 and z_3= 0.20. Assuming Raoults law is appropriate to this system, determine L, V, $\{x_i\}$ and $\{y_i\}$. The vapor pressure of the pure species at 353.15 K are P_1^s= 195.75, P_2^s= 97.84 and P_3^s=50.32 kPa	10	CO3	K4
4.a.	Prove that (a) $dH = C_p dT + (1 - \beta T)\, V\, dP$ (b) $dS = C_p \frac{dT}{T} - \beta V\, dP$	6	CO3	K3
b.	Derive the criterion for phase equilibrium in terms of the chemical potential of components present in a system.	4	CO2	K3

(OR)

c.	What is partial molar properties and write its application?	3	CO3	K2
d.	The need arises in the laboratory for 2000 cm^3 of an antifreeze solution consisting of 30 mol% methanol in water. What volumes of pure methanol and of pure water at 25 ^{0}C must be mixed to form 2000 cm^3 of an antifreeze solution, also at 25 ^{0}C? Partial molar volumes of methanol and water in a 30 mol% methanol solution and their pure species molar volumes, both at 25 ^{0}C, are Methanol(1): $\bar{V}_1$=38.632 $cm^3\ mol^{-1}$ V_1=40.727 $cm^3\ mol^{-1}$ Water(2) : $\bar{V}_2$=17.765 $cm^3\ mol^{-1}$ V_2= 18.068 $cm^3\ mol^{-1}$	7	CO3	K4
5.a.	Define fugacity and fugacity coefficient. Derive their expressions for the components in solution.	5	CO2	K3
b.	Derive the criterion of phase equilibrium in terms of fugacity coefficients of the component present in the solution.	5	CO2	K4

(OR)

c.	Define activity, activity coefficients, fugacity and fugacity coefficient with their significance.	5	CO2	K2
d.	Determine the activity of solid magnesium (MW= 24.32) at 300 k and 10 bar if the reference state is 300 K and 1 bar. The density of magnesium at 300 K is 1.754 $\times 10^3$ kg/m^3 and is assumed constant over the pressure range.	5	CO3	K3
6.a.	Derive the expression of mole fraction in terms of reaction coordinate for multiple reactions.	5	CO2	K3
b.	For the system in which the following reaction occurs, $CH_4 + H_2O = CO + 3H_2$ Assume there are present initially 2 mol CH_4, 1 mol H_2O, 1 mol CO, and 4 mol H_2. Determine expressions for the mole fractions y_i as functions of ε.	5	CO2	K4

(OR)

c.	Derive the expression for the effect of temperature on equilibrium constant.	5	CO3	K3
d.	The water gas shift reaction $CO_{(g)} + H_2O_{(g)} \rightarrow CO_{2(g)} + H_{2(g)}$ is carried out under following condition. The reactants consist of 1 mol of H_2O and 1 mol of CO. The temperature is 1100 K and the pressure is 1 bar. Given at 1100 K the value of lnK= 0. Calculate the fraction of steam reacted assuming ideal gas mixture.	5	CO2	K3

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