QPC: RJ19BTECH121 AR 19 Reg. No

GIET UNIVERSITY, GUNUPUR – 765022

B. Tech (Fourth Semester – Regular) Examinations, June – 2021

BPCCH4020 / BPCPR4020 – CHEMICAL ENGINEERING THERMODYNAMICS

(Common to Chemical Engg. & PRE)

Time: 2hrs Maximum: 50 Marks

Answer ALL Questions

The figures in the right hand margin indicate marks.

PART – A: (Multiple Choice Questions) **(1 x 10 = 10 Marks)**

Q.1. Answer ***ALL*** questions		[CO#]	[PO#]
a.	Which one of the following is called as a path function (i) Temperature (ii) Volume (iii) work (iv) pressure	1	1
b.	Compressibility factor of an ideal gas is --- (i) 0 (ii) 1 (iii) 2 (iv) 0.5	1	1
c.	For a binary ideal solution if x1 and x2 are the mole fraction of the components 1 and 1 respectively. Then (i) $x_1 + x_2 = 0$ (ii) $x_1 + x_2 = -1$ (iii) $x_1 + x_2 = 1$ (iv) $x_1 + x_2 = \infty$	3	1
d.	Raoults's law states that the ____ of a component over an ideal solution is directly proportional to its mole fraction in the solution. (i) Partial pressure (ii) Temperature (iii) Chemical potential (iv) activity	3	1
e.	The ratio of fugacity to fugacity at standard sate is called the (i) activity (ii)activity coefficient (iii) Fugacity coefficient (iv) chemical potential	2	1
f.	The excess property of component can be schematically represented by (i) $H^E = H - H^{id}$ (ii) $H^E = H^{id} - H$ (iii) $H^E - H^{id} = H$ (iv) $H^E = H^{id} + H$	2	1
g.	The value of activity coefficient for an ideal solution is (i) one (ii) zero (iii) equal to Henry's law constant (iv) equal to vapour pressure	2	1
h.	Acetylene is catalytically hydrogenated to ethylene at 1500 K and 1 bar. Starting with an equimolar mixture of acetylene and hydrogen what will be the overall equilibrium constant? Assume ideal gases. $C_2H_2 \rightarrow 2C + H_2$ K = 5.2 $2C + H_2 \rightarrow C_2H_4$ K = 0.1923 (i) 0.2 (ii)0.4 (iii)0.5 (iv) 1.0	4	1
i.	For highly favourable chemical reaction, the standard free energy change is (i) zero (ii) unity	4	1

(iii) positive (iv) Negative

j. Equilibrium constant and Gibbs free energy relation given by the following relation 4 1

(i) $\Delta G^0 = RTlnK$ (ii) $\Delta G^0 = -RTlnK$

(iii) $\Delta G^0 = -RlnK$ (iv) $\Delta G^0 = -RT$

PART – B: (Short Answer Questions) **(2 x 5 = 10 Marks)**

Q.2. Answer *ALL* questions [CO#] [PO#]

a. Theorem of law of corresponding state 1 1

b. Define Non-ideal solutions 3 1

c. Lewis Randall Rule 2 1

d. Differentiate homogenous and heterogeneous reaction? 4 1

e. Write the effect of temperature on the equilibrium constant. 4 1

PART – C: (Long Answer Questions) **(6 x 5 = 30 Marks)**

Any missing data my suitably be assumed

Answer ***ANY FIVE*** questions Marks [CO#] [PO#]

3. Calculate the volume occupied by one mole of oxygen at 300 K and 100 bar using (6) 1 1

(a) The ideal gas law

(b) The van der Waals equation.

Take a = 0.1378 N m^4/mol^2 and b = 3.18 × 10^{-5} m^3/mol.

4. Derive the Q,W,ΔU, and ΔU relation for the following Process (6) 1 2

a) Constant volume process
b) Constant pressure process
c) Constant temperature process

5. Assuming Raoults law to be valid for the system benzene (1)-ethyl benzene (2) and the vapor pressures given by Antoine equations (6) 2 1

$$lnP_1^{sat} = 13.8858 - \frac{2788.51}{T - 52.41}$$

$$lnP_2^{sat} = 14.0045 - \frac{3279.47}{T - 60.00}$$

Where P is in kPa and T is in K.

Calculate P-x-y data at 373 K. and Tabulate the values for various mole fractions.

6. For a binary system draw the graphical diagram and explain the following (6) 2 2

(i) T-xy diagram

(ii)P-xy diagram

(iii) xy diagram

7. At 300 K and 1 bar the volumetric data for a liquid mixture of benzene and cyclohexane are represented by $V = 109.4 \times 10^{-6} - 16.8 \times 10^{-6}x_1 - 2.264 \times 10^{-6}x_1^2$, where x_1 is the mole fraction of benezene and V has the units of m3/mol. Find expression for the partial molar volumes of benzene and (6) 3 1

cyclohxane.

8. Do the following equation satisfy Gibbs- Duhem equations? (6) 3 1

$ln\gamma_1 = Ax_2^2 + Bx_2^2(3x_1 - x_2)$
$ln\gamma_2 = Ax_1^2 + Bx_1^2(x_1 - 3x_2)$

9. A gas mixture containing 12mol% SO_2, 8mol%O_2 and 80mol% N_2 is fed to a catalyst chamber containing 1 atm 610°C for conversion in to SO_3. What is equilibrium conversion of SO_2 to SO_3. The reaction is $SO_2 + \frac{1}{2}O_2 \rightarrow SO_3$ (6) 4 2

10. Acetic acid is esterified in the liquid phase with ethanol at 100°C and atmospheric pressure to produce ethyl acetate and water according to the reaction. (6) 4 2

$$CH_3COOH + C_2H_5OH \rightarrow CH_3COOC_2H_5 + H_2O$$

If initially there is one mole each of acetic acid and ethanol, estimate the mole fraction of ethyl acetate in the reacting mixture at equilibrium.

Component	ΔH_{298}^0	ΔG_{298}^0
Acetic acid	-484,500J	-389,900J
Ethanol	-277,690J	-174,780J
Ethyl acetate	-463250J	-318,280J
Water	-285,830J	-237,130J

--- End of Paper ---