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UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination – May, 2016

Program/course: B.Tech CE + RP/B.Tech APE-Gas | **Semester : IV**
Subject: Chemical Engineering Thermodynamics-II | **Max. Marks : 100**
Code : GNEG-423 | **Duration : 3 Hrs**
No. of page/s: 2

PART –A (5 x 4 = 20 marks)
(Answer all questions)

Q. 1	How do you explain the significance of **Virial Coefficients?**	**CO1**
Q. 2	Derive an expression for $\mathbf{H^R}$ from **Redlich-Kwong EOS**	**CO2**
Q. 3	Explain the **graphical method** of determination of **partial molar properties** for a binary solution	**CO4**
Q. 4	Differentiate between **physical & chemical** adsorptions	**CO5**
Q. 5	Differentiate between **Dew point** & **Bubble Point**. What is **azeotrope**?	**CO3**

PART-B (5 x 8 = 40 marks)

Q. 6	Excess Gibbs free energy of a binary liquid mixture is given by $\mathbf{G^E/RT = x_1x_2\,[A + B\,(x_1\text{-}x_2)]}$ Show that the activity coefficients are given by, $\mathbf{\ln\gamma_1 = (A + 3B)\,x_2^2 - 4Bx_2^3}$ $\mathbf{\ln\gamma_2 = (A - 3B)\,x_1^2 + 4Bx_1^3}$, where **A** and **B** are functions of temperature only and are dimensionless. Obtain Excess Gibbs free energy expression from activity coefficients. Check the activity coefficient expressions satisfy the **Gibbs-Duhem** equation **[8]**	**CO4**
Q. 7	Deduce **Gibbs – Duhem** equation for a binary system **Chemical Potential** and also in terms of **activity** & **activity coefficient** **[4+4]**	**CO4**
Q. 8	Define **residual property** and obtain the expression for residual properties of pure substances from **Virial equation of state. [2+6]**	**CO2**
Q. 9	Reported values for the virial coefficients of **Isopropanol** vapor at	

	200 ^{O} C are, **B = - 388 cm^3 mol^{-1} C = -26,000 cm^6 mol^{-2}** Calculate **V** and **Z** for Isopropanol vapor at **200 ^{O} C** and **10 bar** by **(i)** The **ideal gas** equation **[2]** **(ii)** Truncated **second virial** equation **[3]** **(iii)** Truncated **third virial** equation **[3]**	**CO1**
Q.10	**(a)** Define **Henry's Law** and mention proper assumptions. **[4]** **(b)** Assuming that carbonated water contains only **CO_2 & H_2O**, determine the compositions of vapor & liquid phases in a sealed can of "**soda** "and the pressure exerted on the can at **10^{O}C**. Henry's constant for **CO_2** in water at **10^{O}C** is about **990 bar.** **P2sat = 0.01227 bar @ 283.15 K .** **[4]**	**CO3**

PART-C (2 x 20 = marks)

Q.11	Interpret the following models in thermodynamics (i) Van Laar's model **[10]** (ii) Margules Two parameter model **[10]** **OR** The system **Acetone (1) / Acetonitrile (2) / Nitromethane (3)** at **80 ^{O} C** and **110 kPa** has the overall composition z_1 **= 0.45,** z_2 **= 0.35,** z_3 **= 0.20**. Assuming Rauolt's law is appropriate to this system. Determine **L, V,** x_i and y_i using **flash calculations**. **[20]**	**CO3**
Q.12	At atmospheric pressure **Acetone (1)** and **Chloroform (2)** from an **azeotrope** that boils at **64.6 ^{O} C** and has a mole fraction of **Acetone** in the liquid of **0.335**. The saturation vapour pressure of Acetone and Chloroform at **64.6 ^{O}C** are **1.31. & 0.98 atm** Calculate the activity coefficients using modified **Rauolt's law** and **Van Laar equation** Excess Gibbs free energy and the azeotropic composition, system pressure. **[20]** **OR** The excess Gibbs free energy of a binary liquid at T & P is given by, $G^E/RT = (-2.6x_1 - 1.8x_2)\, x_1\, x_2$ (i) Find expression for Υ_1 and Υ_2 **[10]** (ii) Show that the expression satisfies Gibbs-Duhem equation **[10]**	**CO4**