VIT

Vellore Institute of Technology

SCHOOL OF CHEMICAL ENGINEERING
CONTINUOUS ASSESSMENT TEST -II
FALL SEMESTER 2025-2026

SLOT: A1+TA1+TAA1

Programme Name & Branch	**: B.Tech - Chemical**
Course Code	**: BACHE101**
Course Name	**: Chemical Engineering Thermodynamics - TH**
Faculty Name(s)	**: L.Muruganandam**
Class Number(s)	**: VL2025260107117**
Date of Examination	**: 05/10/2025**
Exam Duration	**: 90 minutes** **Maximum Marks: 50**

General instruction(s): Read carefully the statement and answer all Questions.

Q. No	Question	M
1.	A high-pressure gas compressor operates with methane (CH4) at 200 K. At this temperature, the gas is highly non-ideal. The volumetric data for methane vapor can be accurately represented by the truncated virial equation of state (up to the second term): $$\frac{PV}{RT} = 1 + \frac{B}{V}$$ where Z is the compressibility factor, and B is the second virial coefficient. The experimental data for methane at 200 K yields the following values: Gas Constant, R = 8.314×10^{-5} m^3·bar/(mol·K) Second Virial Coefficient, B = -4.00×10^{-5} m^3/mol. Calculate the fugacity (f) of methane at a pressure of 50 bar and 200 K.	10
2.	A 30% mole fraction ethanol (EtOH) and water (H2O) solution is to be prepared. You need to produce a final volume of 500 mL (V_{sol} = 0.0005 m^3) of the mixture. Use the following data for the components at the given conditions: Component | Mole Fraction | Pure Molar Volume m^3/mol | Partial Molar Volume in 30% solution m^3/mol Ethanol (E) | 0.3 | 58.0×10^{-6} | 55.0×10^{-6} Water (W) | 0.7 | 18.0×10^{-6} | 17.5×10^{-6}	10
3.	For a mixture of acetic acid and toluene containing 0.46 mole fraction toluene, the partial pressure of acetic acid and toluene are found to be 0.12 bar and 0.17 bar respectively at 340 K. The vapour pressure of pure components at this temperature are 0.26 bar and 0.19 bar for toluene and acetic acid respectively. The Henry's law constant for acetic acid is 0.55 bar. Calculate the activity and activity coefficient for acetic acid in the mixture (a) Based on Lewis–Randall rule (5) (b) Based on Henry's law(5)	10

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4.	(i)What contributes to the non-ideal behaviour of the solution. (3) (ii)Calculate the available degrees of freedom for the given non-reacting system: A vapour phase containing ammonia in air and a liquid phase containing ammonia in water at a specified temperature.(2) (iii)Why does the boiling point diagram at a higher pressure lie above that at a lower pressure?(2) (iv)How would you calculate the constant pressure y-x data of a binary mixture using an average value of the relative volatility? (2)	10
5.	For the system n-pentane (1)–n-heptane (2), the vapour pressures are given by the Antoine Equation $$\ln P = A - \frac{B}{T - C}$$ where P is in kPa and T is in K. The constants are as follows. System / A / B / C n-Pentane / 13.8183 / 2477.07 / 40.00 n-Heptane / 13.8587 / 2911.32 / 56.56 Assuming that the solution formed is ideal, calculate: (a) The composition of the liquid and vapour in equilibrium at 95 kPa and 336.2 K. (5) (b) The composition of the vapour in equilibrium with a liquid containing 34% (mol) pentane and the equilibrium temperature at P = 95 kPa. (5)	10

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