CBCS SCHEME

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18CH42

# Fourth Semester B.E. Degree Examination, June/July 2023
## Chemical Engineering Thermodynamics

Time: 3 hrs. Max. Marks: 100

**Note:** ***Answer any FIVE full questions, choosing ONE full question from each module.***





### Module-1

1 a. Explain the following with suitable examples :
i) Extensive and Intensive property ii) Reversible and Irreversible processes. **(08 Marks)**

b. State First Law of Thermodynamics and derive Energy Equation for Steady State Flow Process. **(12 Marks)**

**OR**

2 a. Write Phase Rule with nomenclature and State Zeroth law of Thermodynamics. **(04 Marks)**

b. Define Thermodynamic Equilibrium State. **(04 Marks)**

c. Heat is Transferred to 10kg of Air which is initially at 100 KPd and 300K until the temperature reaches to 600K. Determine the change in Internal Energy ($\Delta U$), Enthalpy ($\Delta H$), Heat supplied (Q) and work done (W) in the following processes.
i) Constant Volume Process ii) Constant Pressure Process.
Assume that air is an ideal gas for which PVT relationship is PV = nRT, where 'n' is the number of moles of the gas and 'R' is the ideal gas constant (R = 8.314 kJ/Kmol. K).
Take $C_p$ = 29.1 kJ/Kmol. K and $C_V$ = 20.7kJ/Kmol. K respectively.
Molecular weight of air is 29. **(12 Marks)**

### Module-2

3 a. With neat sketch, explain PV diagram. **(08 Marks)**

b. For an adiabatic process prove that ,
$PV^{\gamma}$ = Constant & $W = \frac{P_1V_1 - P_2V_2}{\gamma - 1}$. **(12 Marks)**

**OR**

4 a. Write the equations for following equation of states with nomenclature and constants :
i) Redlich – Kwong ii) Peng – Rabinson
iii) Vander Waals iv) Virial equation. **(12 Marks)**

b. Prove for ideal gas $C_p - C_r = R$. **(08 Marks)**

### Module-3

5 a. Define the following :
i) Reference , Energy and Derived properties with examples.
ii) Fugacity and Fugacity Coefficient.
iii) Activity an Activity coefficient. **(12 Marks)**

b. Show that $C_p - C_v = \frac{\beta^2 VT}{K}$. **(08 Marks)**

**OR**

6 a. Derive Maxwell's equations using fundamental property relations and Exact differential equation. **(12 Marks)**

b. Derive Gibbs Helmholtz equation. **(08 Marks)**

## Module-4

7 a. Write a short note on following :

i) Partial Molar Property ii) Chemical Potential

iii) Henry's Law iv) Raoult's Law. **(08 Marks)**

b. Derive Gibb's – Duhem's equation in various forms. **(12 Marks)**

**OR**

8 a. Derive Lewis – Randall Rule for fugacity in solutions. **(08 Marks)**

b. Derive equations to show effect on Pressure and Temperature on Activity coefficients. **(12 Marks)**

## Module-5

9 a. Explain the effect of temperature on Equilibrium constant. **(08 Marks)**

b. Derive the equations for molar compositions of liquid and vapor for a binary system for vapor liquid equilibrium as

$$y_1 = \frac{\alpha x_1}{1+(\alpha-1)x_1} \quad \text{and} \quad x_1 = \frac{P - P_2^{Sat}}{P_1^{Sat} - P_2^{Sat}}. \qquad \textbf{(12 Marks)}$$

**OR**

10 a. The equilibrium constant for the reaction $H_2 + I_2 \rightleftarrows 2H\,I$ at 298K is 14.35. What will be the equilibrium constant at 273K, if the heat of reaction in this temperature range is -4350 cal/gmol. **(08 Marks)**

b. Prove that $\Delta G = -RT\ell nk$. **(12 Marks)**

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