

# CBCS SCHEME

USN

18BT45

## Fourth Semester B.E. Degree Examination, Dec.2024/Jan.2025 Biochemical Thermodynamics

Time: 3 hrs.

Max. Marks: 100

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

### Module-1

- 1 a. Distinguish between
  - i) Intensive and Extensive properties
  - ii) Mechanical and Thermal equilibrium
  - iii) Closed and Open system
  - iv) System and surroundings

(10 Marks)
- b. Consider a closed system (piston and cylinder) with constant pressure process suffix 1 and 2 represents initial and final state respectively.  
 $P_1 = 2 \text{ bar}$ ,  $V_1 = 0.5 \text{ m}^3/\text{Kg}$ ,  $V_2 = 0.75 \text{ m}^3/\text{Kg}$   
 $T_1 = 25^\circ\text{C}$ ,  $T_2 = 300^\circ\text{C}$   
 $C_p = \left[ 0.5 + \frac{20}{T+30} \right] \text{ KJ/Kg.K}$  where T is in  $^\circ\text{C}$ .  
 Calculate:
  - i) Heat added
  - ii) Work done
  - iii)  $\Delta U$
  - iv)  $\Delta H$ .

(10 Marks)

OR

- 2 a. A reversible heat engine takes heat at the rate of 500 kJ/sec from a heat source at 700 K. The work done by the cyclic device is 200 kJ/sec and rejects heat to two sinks at 400 K and 500 K. Calculate :
  - i) The engine thermal efficiency
  - ii) Amount of heat rejected to each sink

(10 Marks)
- b. Show the equivalence of both the statements of second law of thermodynamics. (10 Marks)

### Module-2

- 3 a. Determine the pressure exerted by oxygen in a contain of  $2 \text{ m}^3$  capacity when it contains 5 Kg at  $27^\circ\text{C}$  using
  - i) Ideal gas equation
  - ii) Vander Waals equation

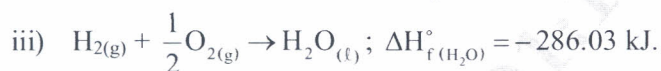
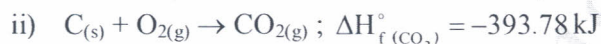
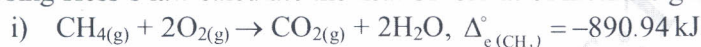
(10 Marks)
- b. Write a note on a PVT behaviour of pure fluids and explain the physical significance triple point and critical point. (10 Marks)

OR

- 4 a. The equation of state of certain substance of given by the expression,  $V = \frac{RT}{P} - \frac{C}{T^3}$ , and the specific heat is given by the relation  $C_p = A + BT$  where A, B and C are constants. Derive an expressions for changes in internal energy  $\Delta U$ , enthalpy ( $\Delta H$ ) and entropy for
  - i) An isothermal process
  - ii) Isobaric process

(10 Marks)

b. Using Hess's law calculate the heat of format of methane gas from the following data :



(10 Marks)

### Module-3

5 a. Derive Maxwell's equations starting from fundamental property relations.

(10 Marks)

b. Using the relationship between  $C_p$  and  $C_v$ , show that  $C_p - C_v = \frac{\beta^2 VT}{K}$ .

(10 Marks)

### OR

6 a. Define fugacity and fugacity coefficient. Explain the effect of temperature and pressure on fugacity.

(10 Marks)

b. Calculate the fugacity of liquid water at 303 K and 10 bar if the saturation pressure at 303 K is 4.241 KPa and specific volume of liquid water at 303 K is  $1.004 \times 10^{-3} \text{ Kg}$ .

(05 Marks)

c. Define Activity. Explain the effect of temperature on activity.

(05 Marks)

### Module-4

7 a. Explain how partial motor properties can be measured by graphical method.

(10 Marks)

b. Derive Gibb's – Duhem equation.

(10 Marks)

### OR

8 a. The activity coefficients for component 1 in a binary solution can be represented by  $\ln \gamma_1 = ax_2^2 + bx_2^3 + cx_2^4$ , where a, b and c are concentration independent parameters. Derive an expression for  $\ln \gamma_2$ .

(10 Marks)

b. Explain Lewis – Randall rule and Henry's law.

(06 Marks)

c. Explain the criteria for phase equilibria.

(04 Marks)

### Module-5

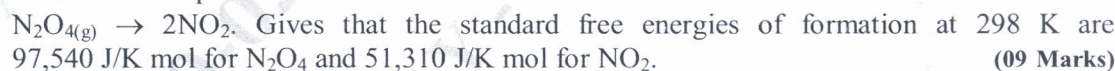
9 a. Write a note on coupled reactions.

(05 Marks)

b. Discuss briefly about feasibility of chemical reaction.

(06 Marks)

c. Calculate the equilibrium constant at 298K of the reaction



(09 Marks)

### OR

10 a. Derive Van't Hoff equation and show that  $\ln \frac{K_2}{K_1} = \frac{\Delta H^{\circ}}{R} \left[ \frac{1}{T_1} - \frac{1}{T_2} \right]$ .

(10 Marks)

b. With a short notes on the following :

i) Phase rule for reacting system

ii) Factors affecting equilibrium conversion

(10 Marks)

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