

Printed Pages : 4



CH402

(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 151402

Roll No.

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B. Tech.

(SEM. IV) THEORY EXAMINATION, 2014-15
CHEMICAL ENGG. THERMODYNAMICS - I

Time : 3 Hours]

[Total Marks : 100

- Note :**
- (1) Assume suitable data if missing.
 - (2) Use of steam table and other thermodynamic charts is allowed.

- 1 Attempt all parts of the following : 2×10=20**
- (a) A quantity of air($\gamma=1.4$) at 27°F is compressed suddenly to 1/4 of its original volume. Find the final temperature.
 - (b) Derive a formula for work done in adiabatic process.
 - (c) What is a quasistatic process ?
 - (d) What is thermodynamic system ? Explain with suitable example.
 - (e) Explain the Joule - Thomson coefficient.
 - (f) What is coefficient of Performance ?
 - (g) What is efficiency of an absorption refrigeration cycle ?
 - (h) Draw the T-S diagram of Rankine cycle.

151402]

1

[Contd...

- (i) Explain intensive and extensive property with examples.
- (j) Explain first law of thermodynamics for flow process with suitable figure.

2 Attempt any three parts of the following : 10×3=30

- (a) Calculate the change in the melting point of ice when it is subjected to a pressure of 100 atm. density of ice=0.917 g/cm³ and latent heat of ice=336J/kg.
- (b) Calculate the increase in entropy when 1 gram of ice at -10°C is converted into steam at 100°C.
Given –
Specific heat of ice=0.5, latent heat of ice=80cal/g, latent heat of steam=540cal/g.
- (c) The equation of state of certain substance is given by the expression $V=(RT/P-C/T^3)$, and the specific heat is given by the relation $C_p=A+BT$ where A,B,C are constants; derive expressions for changes in internal energy, enthalpy and entropy for an isothermal process.
- (d) One kmol of an ideal gas initially at 30 °C and 1 bar undergoes the following mechanically reversible changes. it is compressed isothermally to a point such that when it is heated at constant volume to 120 °C. Its final pressure is 12 bar. Calculate Q, W, ΔU and ΔH for the process. Take $C_p = (7/2) R$ and $C_v = (5/2) R$.
- (e) For liquid water the isothermal compressibility is given by $k=c/(VP+Vb)$ where b and c are functions of temperature only. If 1 kg of water is compressed isothermally and reversibly from 1 to 500 bar at 60°C, how much work is required ? At 60°C, $b=2700\text{bar}$ and $c=0.125 \text{ cm}^3/\text{g}$.

3 Attempt all parts of the following : 10×5=50

- (a) Air discharges from an adiabatic nozzle at 15 °C with a velocity of 580 m/s. What is the temperature at the entrance of nozzle if the entrance velocity is negligible ? Assume air to be an ideal gas for which $C_p = 3.5 R$.

OR

Liquid water enters an adiabatic hydroturbine at 5 atm and 15 °C and exhausts at 1 atm; estimate the power output of the turbine in J/kg of water if its efficiency is 0.55. What is the outlet temperature of the water ? Assume water to be an incompressible liquid.

- (b) A 0.35 m³ vessel is used to store liquid propane at vapour pressure safety consideration dictate that at a temperature of 320 K, the liquid must occupy not more than 80% of the total volume of the vessel. For these conditions, determine the mass of vapor and the mass of liquid in the vessel. At 320 K the vapor pressure of propane is 16 bar.

OR

Steam enters a nozzle at 800 kPa and 280°C with negligible velocity and discharges at a pressure of 525 kPa. Assuming isentropic expansion of the steam in the nozzle, what is the exit velocity and what is the cross sectional area at the nozzle exit for a flow rate of 0.75 kg/s.

- (c) Prove that if Henry's law is obeyed by component 1 in a binary solution over certain concentration range. Lewis-Randall rule will be obeyed by component 2 over the same concentration range.

OR

For an ideal gas prove that :

$$\frac{\Delta S}{R} = \int_{T_0}^T \frac{C_V^{ig}}{R} \frac{dT}{T} + \ln \frac{V}{V_0}$$

- (d) A 40 kg steel casting ($C_p = 0.5 \text{ kJ/kg.K}$) at a temperature of 723.15 K is quenched in 150 kg of oil ($C_p = 2.5 \text{ kJ/kg.K}$) at 208.15 K. If there are no heat losses, what is the change in entropy of: (i) casting (ii) oil (iii) both considered together.

OR

Steam at 2000 kPa containing 6% moisture is heated at constant pressure to 575 °C. How much heat is required per kilogram ?

- (e) (i) Calculate the fugacity of liquid water at 303K and 10 bar if the saturation pressure at 303 K is 4.241 kPa and the specific volume of liquid water at 303K is $1.004 \times 10^{-3} \text{ m}^3/\text{kg}$.
- (ii) What is chemical potential ? Explain the effect of temperature and pressure on chemical potential.

OR

Describe the vapour compression cycle with neat sketch and also derive its COP. An incompressible liquid flows steadily through a conduit of circular cross section and increasing diameter. At location 1, the diameter is 2.5 cm and velocity is 2m/s. At location 2, diameter is 5 cm. What is velocity at location 2 What is the kinetic energy change between location 1 and 2 ?
