Duration:3 Hours **Marks: 80**

N.B:-

1) Question **No 1** is compulsory
2) Attempt **any three** questions from the remaining **five** questions
3) Assume suitable data wherever necessary
4) Figures to the right indicate full marks.

Q.1] a) Discuss the Clausius Inequality. **5**
b) Discuss the First Law of Thermodynamics for flow processes. **5**
c) Define Exergy and give the Applications of Exergy. **5**
d) Explain the significance of enthalpy and entropy departure functions **5**

Q.2] a) Discuss about Ejectors in brief. **15**

b) A 40 kg steel casting (Cp = 0.5 kJ/kg.K) at a temperature of 4500C (723.15 K) is quenched in 150 kg of oil (Cp= 2.5 kJ/kg.K) at 250C (298.15 K). If there are no heat losses, what is the change in entropy of (a) the casting, (b) the oil, and (c) both considered together? **05**

Q.3] a) Explain P-H diagram and its applications **10**

b) Derive the relations to estimate the enthalpy **10**
y and entropy departures for a fluid using the Redlich- Kwong equation of state.

$$P = \frac{RT}{v-b} - \frac{a}{\sqrt{T}v(v+b)}$$

Q.4] a) Derive Maxwell's equations and explain their significance. **10**

b) Carbon dioxide at 1 bar and 300 K is to be compressed to a pressure of 10 bar in a single-stage compressor at a rate of 100 m3/h. Assuming that CO2 behaves as an ideal gas, calculate the temperature of the gas after compression and the work required. Take $\gamma = 1.3$. **10**

Q.5] a) Discuss the concept of entropy. Prove that the entropy is a state function. **10**

b) Calculate the fugacity and fugacity coefficient of n-hexane at 600 K and 800kPa using the van der Waals equation of state.Data : $T_c = 507.4$ K, $P_c = 2969$ kPa. **10**

Q.6] a) One kmol of an ideal gas at 298 K and 1 bar is subjected to the following processes: **10**
(i) Compressed adiabatically to 10 bar pressure
(ii)Heated at constant pressure to 623 K
(iii)Expanded at constant temperature to 1 bar
(iv)Cooled at constant pressure to 298 K.
Calculate Q, W, ΔU and ΔH for each step and for the entire cycle.
Data : $C_p = 29.170$ kJ/kmol. K, $C_v = 20.856$ kJ/kmol. K.

b) State and explain the Kelvin-Planck statement and the Clausius statement of the second law of thermodynamics. **10**

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