Printed Pages:02 **Sub Code: KME-301**

Paper Id: 233541 **Roll No.** | | | | | | | | | | |

B.TECH
(SEM III) THEORY EXAMINATION 2022-23
THERMODYNAMICS

Time: 3 Hours ***Total Marks: 100***

Note: Attempt all Sections. If require any missing data; then choose suitably.

SECTION A

1. Attempt *all* questions in brief. 2 x 10 = 20

(a) What is the concept of continuum in thermodynamics?
(b) Explain the state, path and cycle for a thermodynamics process.
(c) Define COP. Derive an expression between COP of refrigerator and heat pump.
(d) State the Clausius theorem.
(e) Distinguish between Helmholtz function and Gibb's function.
(f) Define coefficient of volume expansion.
(g) What do you understand by second law efficiency? How does it differ from first law efficiency?
(h) What is meant by saturated states, sub cooled liquid and superheated vapour state?
(i) Define Unit of Refrigeration.
(j) Describe different types of refrigerants.

SECTION B

2. Attempt any *three* of the following: 10x3=30

(a) What do you mean by an isolated system? Give the concept of temperature and differentiate among heat, temperature and internal energy.

An insulated rigid tank contains 0.6 m^3 of air at 12 bar and 150^0C. This air is allowed to expand to 1 bar. Find the maximum work that can be obtained from the escaping air in a adiabatic process. Take R= 0.277 kJ/kg-K and C_p= 1.005 kJ/kg-K for air.

(b) Show that the entropy change of 1 kg gas between state 1 and 2 is given as:

$$S_2 - S_1 = R \ln (V_2/V_1) + C_v \ln (T_2/T_1)$$

(c) Define Joule- Thomson coefficient. Also explain the significance of inversion curve.

(d) 3 kg of steam at 18 bars occupies a volume of 0.225m^3. The steam expands at constant volume to a pressure of 10 bars. Determine final dryness fraction, final internal energy, change in entropy and work done.

(e) Sketch and explain the actual vapour compression refrigeration cycle. Discuss the effect of evaporator and condenser pressure on performance of vapour compression refrigeration cycle.

SECTION C

3. Attempt any *one* part of the following: 10x1=10

(a) What is perpetual motion machine of second type? A gas of mass 1.5 Kg undergoes a quasi static process expansion which follow relationship
$p = a + bV$, where a and b are constants. The initial and final pressures are 100 kPa and 200 kPa respectively and the corresponding volumes are 0.20 m^3 and 1.20 m^3. The specific internal energy of the gas is given by the relation.

$$U = 1.5\ pV - 85\ kJ/Kg$$

Where p is the KPa and v is in m^3/Kg. Calculate net heat transfer and the maximum internal energy of the gas attained during expansion.

(b) A gas undergoes a thermodynamic cycle consisting of three processes beginning at an initial state where $p_1 = 1$ bar, $V_1 = 1.5$ m3 and $U_1 = 512$ kJ. The processes are as follows:
(i) Process 1–2: Compression with pV = constant to $p_2 = 2$ bar, $U_2 = 690$ kJ
(ii) Process 2–3: $W_{23} = 0$, $Q_{23} = -150$ kJ, and
(iii) Process 3–1: $W_{31} = +50$ kJ.
Neglecting KE and PE changes, determine the heat interactions Q_{12} and Q_{31}.

4. Attempt any *one* part of the following: 10x1=10

(a) A heat engine is used to drive a heat pump. The heat transfers from the heat engine and from the heat pump are used to heat the water circulating through the radiators of a building. The efficiency of the heat engine is 27% and the COP of the heat pump is 4. Evaluate the ratio of the heat transfer to the circulating water to the heat transfer to the heat engine.

(b) Estimate the change of entropy of the universe due to each of the following processes:
(i) A copper block of mass 0.6 kg at 100°C is placed in lake of water at 10°C.
(ii) Two such blocks at 100°C and 10°C are joined together. Take C_p (for copper) = 0.393 kJ/ Kg-K.

5. Attempt any *one* part of the following: 10x1=10

(a) Explain Clausius- Clapeyron equation. Represent it on p-T diagram.

(b) A pressure vessel has a volume of 1 m^3 and contains air at 1.4 MPa, 175°C. The air is cooled to 25°C by heat transfer to the surroundings at 25°C. Calculate the availability in the initial and final states and the irreversibility of this process. Take $p_0 = 100$ kPa.

6. Attempt any *one* part of the following: 10x1=10

(a) A cyclic steam power plant is to be designed for a steam temperature at turbine inlet of 360°C and an exhaust pressure of 0.08bar. After isentropic expansion of steam in the turbine, the moisture content at the turbine exhaust is not to exceed 15%. Determine the greatest allowable steam pressure at the turbine inlet, and calculate the Rankine efficiency.

(b) With help of psychometric chart, explain the followings:
(i) Heating and dehumidification processes
(ii) Cooling and humidification processes
(iii) Sensible heating
(iv) Sensible cooling.

7. Attempt any *one* part of the following: 10x1=10

(a) Explain the working of a Reversed Carnot cycle of refrigeration with P-V and T-S Diagrams. What are the limitations of Carnot cycle of refrigeration?

(b) In a refrigeration plant working on Bell Coleman cycle, air is compressed to 5 bar from 1 bar. Its initial temperature is 10°C. After compression, the air is cooled up to 20° C in a cooler before expanding to a pressure of 1 bar. Determine the theoretical C.O.P of the plant and net refrigerating effect. Take Cp = 1.005 KJ/Kg K and Cv = 0718 KJ/Kg K.