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B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

August 2023 Semester End Make-Up Examinations

Programme: B.E. **Semester: III**
Branch: Mechanical Engineering **Duration: 3 hrs.**
Course Code: 22ME3PCETD **Max Marks: 100**
Course: Engineering Thermodynamics **Date: 17.08.2023**

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may suitably be assumed.
3. Use of steam tables and Mollier chart, Thermodynamics data hand book is permitted.

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

UNIT - I

1 a) Explain the following with respect to thermometer: **04**
(i) thermometric material
(ii) thermometric property

b) Define the following: **08**
i) isolated system, ii) thermodynamic property, iii) thermodynamic equilibrium and iv) quasi-static process.

c) A mass of 1.5 kg of air is compressed in a quasi-static process from 0.1 MPa to 0.7 MPa for which Pv = constant. The initial density of air is 1.16 kg/m3. Find the work done by the piston to compress the air. **08**

UNIT - II

2 a) What is PMM-1?. Why it is impossible?. **04**

b) Derive the expressions for mass balance and steady flow energy equation for a single stream entering and leaving a control volume of a steady flow device. **08**

c) A stationary 2 kg of gas is compressed without friction from an initial state of 0.3 m^3 and 0.105 Mpa to a final state of 0.15 m^3 and 0.105 Mpa, the pressure remaining constant during the process. There is a transfer of 37.6 kJ of heat from the gas during the process. Determine the following: i) work transfer, ii) change in internal energy of gas, and iii) change in temperature of gas if Cv is 0.787 kJ/kg K. **08**

UNIT - III

3 a) Show that for a reversible heat pump and a reversible refrigerator operating under same temperature level, $COP_{HP} = COP_{Ref} + 1$. **04**

b) State Clausius and Kelvin-Planck's statements. Establish the equivalence between Clausius and Kelvin-Planck statements. **08**

c) A heat pump working on the Carnot cycle takes in heat from a reservoir at 5 °C and delivers heat to a reservoir at 60 °C. The heat pump is driven by a reversible heat engine which takes in heat from a reservoir at 840 °C and rejects heat to a reservoir at 60 °C. The reversible heat engine also drives a **08**

machine that absorbs 30 kW. If the heat pump extracts 17 kJ/s from the 5 °C reservoir, determine; i) rate of heat supply from the 840°C source, and ii) rate of heat rejection to the 60 °C sink.

OR

4 a) Explain the following: **04**
i) available energy and ii) unavailable energy

b) Define entropy and prove that entropy is a property of the system. **08**

c) Two kg of water at 80 °C is mixed adiabatically with 3 kg of water at 30 °C in a constant pressure process of 1 atmosphere. Determine the following: **08**
i) final temperature of the mixture.
ii) increase or decrease in the entropy of the total mass of water due to the mixing process.
iii) entropy change of the surrounding.
iv) entropy change of the universe. Take Cp of water = 4.187 kJ/kg K.

UNIT - IV

5 a) Define the following terms: **04**
i) Compressibility factor and ii) Reduced Properties.

b) Write down Van der Waal's equation of state and obtain expressions for the constants a, b and R in terms of critical properties of a Van der Waal's gas. **08**

c) A container of 3 m^3 capacity contains 10 kg of CO_2 at 27 °C. Estimate the pressure exerted by CO_2 by using: i) Perfect gas equation and ii) Van der Waals' equation. **08**

UNIT - V

6 a) Define the following with respect to pure substance: i) Sub cooled liquid, ii) Sensible heat, iii) Dryness fraction, iv) Enthalpy of superheated vapour and iv) Critical point. **10**

b) Steam at a pressure of 7 bar and 200 °C expands isentropically to a pressure of 1 bar. Show the process on T-s diagram and determine the following for the process: i) Initial and final condition of steam, ii) Change in enthalpy per kg of steam, iii) Change in internal energy per kg of steam and iv) Heat transfer and work done per kg of steam. **10**

OR

7 a) List the various losses of actual vapour power cycle and show the cycle on T-s diagram. **04**

b) Draw the schematic of reheat Rankine cycle and explain its working principle with the help of T-s and h-s diagrams. **08**

c) In a simple Rankine cycle, steam at 20 bar, 350 °C is expanded in a stream turbine to 0.1 bar. It then enters a condenser, where it is condensed to saturated liquid water. The pump feeds back the water into the boiler. Show the cycle on T-s diagram and calculate the following: i) condition of steam at condenser inlet, ii) pump work, iii) turbine work, iv) steam rate and v) cycle efficiency. **08**

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