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

Autonomous Institute Affiliated to VTU

April 2024 Semester End Main Examinations

Programme: B.E. **Semester: III**
Branch: Mechanical Engineering **Duration: 3 hrs.**
Course Code: 19ME3ESBTD **Max Marks: 100**
Course: Basic Thermodynamics

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 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) Compare the following: **06**
i) Open and closed system.
ii) Intensive and extensive property.
iii) Microscopic and macroscopic approaches.

b) Explain the working principle of thermocouple with the help of neat sketch. **06**

c) A platinum resistance thermometer has a resistance of 2.8 Ω at 0 °C and 3.8 Ω at 100 °C. The variation in resistance R with temperature T is given by $R=R_o(1+aT)$. Where R_o is the resistance of the platinum wire when it is surrounded by melting ice (0 °C) and a is constant. Calculate the values of R_o, and a. And also determine the temperature when the resistance indicated is 5.8 Ω. **08**

OR

2 a) Explain and derive the work transfer expressions for the following: **10**
i) Electrical work ii) Spring work

b) A mass of gas is compressed in a quasi-static process from 80 kPa, 0.1 m^3 to 0.4 MPa, 0.03 m^3. Assuming that the pressure and volume are related by pv^n = constant, find the value of index n and magnitude and direction of the work transfer. **10**

UNIT - II

3 a) What is PMM-1? List two limitations of first law of thermodynamics. **04**

b) Define the internal energy and prove that it is a property of the system. **08**

c) A turbine operates under steady flow conditions, receiving steam at the following state: Pressure 1.2 MPa, temperature 188 °C, enthalpy 2785 kJ/kg, velocity 33.3 m/s and elevation 3 m. The steam leaves the turbine at the following state: Pressure 20 kPa, enthalpy 2512 kJ/kg, velocity 100 m/s, and elevation 0 m. Heat is lost to the surroundings at the rate of 0.29 kJ/s. If the rate of steam flow through the turbine is 0.42 kg/s, what is the power output of the turbine in kW? **08**

UNIT - III

4	a)	What is irreversibility? What are the causes for irreversibility?	**04**
	b)	Explain Carnot cycle with the help of p-v diagram and derive the thermal efficiency of Carnot heat engine.	**08**
	c)	A domestic food freezer maintains a temperature of -15 °C. The ambient air temperature is 30°C. If heat leaks into the freezer at the continuous rate of 1.75 kJ/s what is the least power necessary to pump this heat out continuously? And also determine the COP and amount of the heat rejection to surrounding from the freezer.	**08**

OR

5	a)	Explain the Clausius inequality and show the criteria for the reversibility of a cycle.	**04**
	b)	Derive an expression for maximum work obtainable from finite bodies at temperatures T_1 & T_2.	**08**
	c)	One kg of ice at -5 °C is exposed to the atmosphere which is at 20 °C. The ice melts and comes into thermal equilibrium with the atmosphere. Determine the following: (i) change in entropy of water, (ii) change in entropy of atmosphere and (iii) change in entropy of universe. The Cp of ice is 2.093kJ/kg K and latent heat of fusion of ice is 333.3 kJ/kg.	**08**

UNIT - IV

6	a)	Define the following terms i) Available energy ii) Unavailable energy iii) Dead state iv) Second law efficiency v) Helmholtz function.	**10**
	b)	A 80 kg of water at 100°C is mixed with 50 kg of water at 60°C in an insulated tank, while the temperature of the surroundings is 15°C. The pressure is assumed to remain constant. Determine the following: i) total available energy before mixing, ii) final temperature of water after mixing, iii) total available energy after mixing, and iv) change in available energy due to mixing. Take C_p for water as 4.2 kJ/kg K.	**10**

UNIT - V

7	a)	Define the following terms: (i) Law of corresponding states, (ii) Compressibility factor.	**04**
	b)	Write down Vander Waal's equation of state and obtain expressions for the constants *a*, *b* and *R* in terms of critical properties of a Vander Waal's gas.	**08**
	c)	A spherical shaped balloon of 12 m diameter contains H_2 at 30 °C and 1.21 bar. Find the following for a real gas: (i) Critical pressure, (ii) Critical temperature, (iii) Reduced pressure, (iv) Reduced temperature, (v) Compressibility factor and (vi) mass of H_2 in the balloon.	**08**

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