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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: 23ME3PCETD / 22ME3PCETD **Max Marks: 100**
Course: Engineering Thermodynamics

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Use of Thermodynamics Data Hand Book is permitted.
3. Missing data, if any, may be suitably assumed.

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	*CO*	*PO*	Marks
1	a)	Compare the following with examples: i) open and closed systems, ii) extensive and intensive properties, iii) microscopic and macroscopic approaches, and iv) point and path functions.	*CO1*	*PO1*	**08**
	b)	Draw the graphical comparison of all the thermodynamic expansion processes on a single p-v diagram.	*CO1*	*PO1*	**04**
	c)	A spherical balloon of 2 m diameter is filled with a gas at 200 kPa and 300 K. The gas inside the balloon is heated. Finally the pressure reaches 1 MPa. During the process of heating, assume that the pressure is proportional to the diameter of the balloon. Find the work done by the gas inside the balloon.	*CO1*	*PO2*	**08**
		UNIT - II			
2	a)	State first law of thermodynamics for a system undergoing a thermodynamic cycle and prove that internal energy is a property of the system.	*CO2*	*PO1*	**08**
	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.	*CO2*	*PO1*	**06**
	c)	Heat of 100 kJ is supplied to a system at constant volume process, the system rejects 90 kJ of heat at constant pressure and 20 kJ of work is done on it. The system is brought to original state by an adiabatic process. Determine, (i) the adiabatic work and (ii) the internal energy at all end states, if initial value of internal energy is 105 kJ.	*CO2*	*PO2*	**06**
		UNIT - III			
3	a)	State Clausius and Kelvin-Planck statements. Establish the equivalence between Clausius and Kelvin-Planck statements.	*CO3*	*PO1*	**08**

		b)	Show that for a reversible heat pump and refrigerator operating under same temperature, $COP_{HP} = COP_{Ref} + 1$.	*CO3*	*PO2*	**04**
		c)	A heat engine operates between the maximum and minimum temperatures of 677ºC and 57ºC, respectively, with an efficiency of 50% of appropriate Carnot efficiency. It drives a heat pump which uses river water at 5ºC to heat a block of flats in which the temperature is to be maintained at 22ºC. Assuming that the temperature difference of 10 ºC exists between the working fluid and the river water. The heat pump to operate on the reversed Carnot cycle but with a COP of 50% of the ideal COP. Find the heat input to the engine per unit heat output from the heat pump. Why is direct heating thermodynamically more wasteful?	*CO3*	*PO2*	**08**
			OR			
	4	a)	Define entropy and prove that entropy is property of the system.	*CO3*	*PO1*	**08**
		b)	State Carnot's and Clausius theorems. Explain how Clausius inequality provides the criterion of the reversibility and feasibility of a cycle.	*CO3*	*PO1*	**04**
		c)	Two kg of water at 80°C are mixed adiabatically with 3 kg of water at 30°C in a constant pressure process of 1 atmosphere. Find the increase in the entropy of the total mass of water due to the mixing process (Cp of water = 4.187 kJ/kg K).	*CO3*	*PO2*	**08**
			UNIT - IV			
	5	a)	Explain the following: (i) Vander Waal's equation of state, (ii) Compressibility factor, (ii) Reduced Properties, and (iv) Compressibility chart	*CO4*	*PO1*	**08**
		b)	From an experimental determination the specific heat ratio for acetylene (C_2H_2) is found the1.26. Find the two specific heats.	*CO4*	*PO2*	**06**
		c)	Calculate the density of N_2 at 260 bar and 15°C by using the compressibility chart.	*CO4*	*PO2*	**06**
			UNIT - V			
	6	a)	Explain the following terms with respect to pure substances using phase change diagram: (i) sublimation line (ii) vaporization line (iii) melting or fusion line and (iv) triple point.	*CO4*	*PO1*	**08**
		b)	Vessel having a capacity of 0.05 m^3 contains a mixture of saturated water and saturated steam at a temperature of 245°C. The mass of the liquid present is 10kg. Find the following parameters: (i) pressure, (ii) mass, (iii) specific volume, (iv) specific enthalpy, (v) specific entropy, and (vi) specific internal energy.	*CO4*	*PO2*	**12**
			OR			

	7	a)	With the help of a T-S diagram, explain the energy analysis of the ideal Rankine Cycle.	*CO5*	*PO1*	**05**
		b)	Discuss the effect of following on efficiency of Rankine Cycle. (i) Lowering the Condenser Pressure (ii) Superheating of the steam to high temperatures (iii) Increasing the boiler pressure.	*CO5*	*PO1*	**09**
		c)	In a steam power cycle, the steam supply is at 15 bar and dry saturated. The condenser pressure is 0.4 bar. Calculate the Carnot's and Rankine efficiencies of the cycle. Neglect the pump work.	*CO5*	*PO2*	**06**

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