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

Autonomous Institute Affiliated to VTU

September / October 2024 Supplementary 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 be suitably assumed.

		UNIT - I	*CO*	*PO*	Marks
1	a)	Explain the following with an example: (i) Thermodynamic system. (ii) Thermodynamic state. (iii) Thermodynamic process.	*CO1*	*PO1*	**06**
	b)	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*. Also determine the temperature when the resistance indicated is 5.8 Ω.	*CO2*	*PO2*	**06**
	c)	Derive the expressions for the following: (i) Electrical work and power. (ii) Pdv work for a polytropic process.	*CO1*	*PO1*	**08**
		OR			
2	a)	Compare the following: (i) Open and closed systems. (ii) Intensive and extensive properties. (iii) Microscopic and macroscopic approaches.	*CO1*	*PO1*	**06**
	b)	Explain the working principle of a thermocouple with the help of neat sketch.	*CO1*	*PO1*	**06**
	c)	A piston and cylinder arrangement containing a fluid has a stirring device inside the cylinder. The piston is frictionless, and it is held down against the fluid, due to the atmospheric pressure of 101.325 kPa. The stirring device is turned 10,000 rpm with an average torque against the fluid of 1.275 N m. Meanwhile the piston of 0.6 m diameter moves out 0.8 m/min. Find (i) The rate of work done on the fluid, (ii) The rate of work done by the fluid on the surrounding and (iii) the net power transfer for the system.	*CO2*	*PO2*	**08**

			UNIT - II			
	3	a)	Derive the steady flow energy equation for a single stream entering and leaving a control volume of a steady flow device.	*CO1*	*PO1*	**06**
		b)	Explain the following: (i) First law of thermodynamics applied to a closed system undergoing a process. (ii) What is PMM-1. Why it is impossible?	*CO1*	*PO1*	**06**
		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 remains 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 C_v is 0.787 kJ/kg K.	*CO2*	*PO2*	**08**
			UNIT - III			
	4	a)	Write any two limitations of first law of thermodynamics. Establish the equivalence between Clausius and Kelvin-Planck statements.	*CO1*	*PO1*	**06**
		b)	What is a reversible process? List and explain the causes for irreversibility?	*CO1*	*PO1*	**06**
		c)	Two Carnot engines A and B are connected in series between two thermal reservoirs maintained at 1000 K and 100 K respectively. Engine A receives 1680 kJ of heat from the high-temperature reservoir and rejects heat to the Carnot engine B. Engine B takes in heat rejected by engine A and rejects heat to the low-temperature reservoir. If engines A and B have equal thermal efficiencies, Show the schematic of the arrangement and determine: (i) The temperature at which heat is rejected by engine A, (ii) The efficiencies of both the engines A and B, (iii) The heat rejected by engines A and B, and (iv) The work done during the process by engines A and B.	*CO2*	*PO2*	**08**
			OR			
	5	a)	Derive an expression for the final temperature of mixing two fluids in an adiabatic enclosure and also for the change in entropy of the universe due to the mixing of fluids.	*CO1*	*PO1*	**06**
		b)	Define entropy and prove that entropy is a property of the system.	*CO1*	*PO1*	**06**
		c)	A block of iron weighing 100 kg and having a temperature of 100 °C is immersed in 50 kg of water at a temperature of 20 °C in an insulated vessel. Specific heats of iron and water are 0.45 and 4.18 kJ/kg K respectively. Determine the following: (i) final temperature of combined system of iron and water, (ii) change in entropy of iron block, (iii) change in entropy of water, (iv) change in entropy of combined system of iron and water, (v) change in entropy of the universe.	*CO2*	*PO2*	**08**

			UNIT - IV			
	6	a)	Define and explain the following terms: (i) Available energy. (ii) Unavailable energy. (iii) Dead state. (iv) Second law efficiency. (v) Helmholtz function.	*CO3*	*PO1*	**10**
		b)	A system at 500 K receives 7200 kJ/min from a source at 1000 K. The temperature of atmosphere is 300 K. Assuming that the temperatures of system and source remain constant and also no heat loss to surrounding during the heat transfer. Determine: (i) Change in entropy of the source, (ii) Change in entropy of the system and (iii) Change in entropy of the universe and (iv) Decrease in available energy due to heat transfer.	*CO3*	*PO2*	**10**
			UNIT - V			
	7	a)	Derive the expressions for the constants *a*, *b* and *R* in terms of critical properties for the Vander Waal's gas equation.	*CO4*	*PO1*	**06**
		b)	Explain the following: (i) Reduced properties, (ii) Law of corresponding states, and (iii) Compressibility chart.	*CO4*	*PO1*	**06**
		c)	The reduced pressure and temperature for a Neon gas is 2 and 1.3 respectively. Determine the following: (i) Critical properties (ii) Compressibility factor, (iii) Pressure, and (iv) Temperature.	*CO4*	*PO2*	**08**

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