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

Autonomous Institute Affiliated to VTU

January / February 2025 Semester End Main Examinations

Programme: B.E **Semester: III**
Branch: Aerospace Engineering **Duration: 3 hrs.**
Course Code: 19AE3DCATD / 22AS3ESTDN **Max Marks: 100**
Course: Aero-Thermodynamics / Thermodynamics

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.
3. Thermodynamics Steam Data handbook is permitted to use.

			UNIT - I	
1	a)		Distinguish between: i) Classical and Statistical thermodynamics ii) Open system and Closed system iii) Intensive and Extensive properties	**09**
	b)		Identify the following system as Open system, closed system and isolated system i) Li-N battery ii) Thermo flask with ice iii) Thermometer iv) Aircraft engine v) Universe	**05**
	c)		Unit mass of a certain fluid is contained in a cylinder at an initial pressure of 20 bar. The fluid is allowed to expand reversibly behind a piston according to a law $PV^2 = C$ until the volume is doubled. The fluid is then cooled reversibly at constant pressure until the piston regains its original position; heat is then supplied reversibly with the piston firmly locked in piston until the pressure rises to the original value of 20 bar. Calculate the net work done by the fluid, for an initial volume of 0.05 m^3.	**06**
			OR	
2	a)		A gas is taken in a piston and cylinder arrangement at an initial pressure of 25 bar. It undergoes a cyclic process as follows: i) the gas is expanded reversibly to the relation $PV^{2.5}=C$ until the volume is doubled ii) then the gas is cooled reversibly at a constant pressure until the piston reaches the initial position iii) now the piston is kept fixed and heat is added until the pressure rises to the original value of 25 bar. Calculate the net work	**07**

			done by the fluid. Take initial volume of $0.05m^3$ and mass 1 kg. write the PV plot.	
		b)	Derive an expression for work done in an adiabatic process. Write the PV plot for the process.	**06**
		c)	The resistance of a platinum wire is found to be 11000 ohms at the ice point, 15247 ohms at the steam point and 28.887 ohms at the sulphur point. Find the constant A and B in the equation, $R = R_o [1 + At + Bt^2]$ and plot R against t in the range of o to 660°C.	**07**
			UNIT - II	
	3	a)	An air turbine forms part of an aircraft refrigeration plant. Air at a pressure of 295 kPa and a temperature of 58°C flows steadily into the turbine with a velocity of 45 m/s. The air leaves the turbine at a pressure of 115 kPa, a temperature of 2°C and a velocity of 150 m/s. The shaft work delivered by the turbine is 54 kJ/kg of air. Neglecting changes in elevation, determine the magnitude and sign of the heat transfer per unit mass of air flowing. For air, take Cp = 1.005 kJ/kg K and the enthalpy h = Cp.t.	**10**
		b)	10 kg of fluid per min goes through a steady flow process. Fluid properties at inlet are p_1=1.5 bar; ρ_1 = 26 kg/min, v_1=110 m/s; u_1 = 910 kJ/kg and at exit are p_2=5.5 bar; ρ_2 = 5.5 kg/min, v_2=190 m/s; u_2 = 710 kJ/kg. During the passage the fluid rejects 55 kJ/s and rises through 55m. Evaluate i) change in enthalpy ii) work done during the process.	**07**
		c)	Explain PMM1.	**03**
			OR	
	4	a)	Hydrogen flow isentropically in a nozzle from an initial pressure of 500 kPa, with negligible velocity to a final pressure of 100 kPa. Because the pressure falls during its journey through the nozzle, this flow is called expansion. The initial gas temperature is 500K. Assume steady flow with the hydrogen behaving as a perfect gas with constant specific heat Cp=14.5 kJ/kg K. Determine the final velocity of the gas and the mass flow through the nozzle for an exit area of $500cm^2$. Take for hydrogen gas R = 4.124 kJ/kg K.	**12**
		b)	Explain the famous Joule's law. Write the mathematical expression for the same.	**08**
			UNIT - III	
	5	a)	State Kelvin plank and Clausius statement of II law with the help of diagram.	**08**

		b)	Three real engines have the same thermal efficiency are connected in series. The first engine absorbs 2400 kJ of heat from a thermal reservoir at 1280 K and heat engine rejects its waste of 300 kJ to sink at 150 K. Determine the work output from each engine.	**08**
		c)	What are the causes for Irreversibility?	**04**
			OR	
	6	a)	State and prove "Clausius theorem".	**06**
		b)	Show that mixing of two fluids is an irreversible process.	**06**
		c)	A reversible engine operates between 3 heat reservoirs at 1000 K, 800K and 600K and rejects heat to a reservoir at 300K. The engine develops 10 kW and rejects 412 kJ/min if heat supplied by the reservoir at 1000 K is 60% of heat rejected by the reservoir at 600 K. Find the quantity of heat supplied by each reservoir.	**08**
			UNIT - IV	
	7	a)	Define the following terms with reference to the pure substances i) Latent heat of vaporization ii) Tipple point iii) Wet steam iv) Dryness fraction	**08**
		b)	With a neat sketch, explain the P-T diagram of water.	**06**
		c)	A mass of wet steam at temperature 165°C is expanded at constant quality 0.8 to pressure 3 bar. It is then heated at constant pressure to a degree of superheat of 66.5°C. Find the enthalpy and entropy changes during expansion and during heating. Draw the T-S diagram.	**06**
			OR	
	8	a)	Explain the following: i) Compressibility factor ii) Reduced properties iii) Law of corresponding states iv) Vander walls equation of state	**08**
		b)	With a neat sketch explain the T-S diagram of water. Highlight the different regions.	**08**
		c)	Show that the constant volume lines have more slope than constant pressure lines on a T-S plot.	**04**

			UNIT - V	
	9	a)	Derive an expression for the air standard efficiency of an Otto cycle. List out the various assumptions made.	**10**
		b)	Explain the Rankine cycle with a neat sketch and mention the various methods to improve the efficiency of Rankine cycle with the help of a TS diagram.	**10**
			OR	
	10	a)	An engine working on the Otto cycle is supplied with air at 0.1 Mpa, 35°C. The compression ratio is 7. The maximum temperature of the cycle is 1100°C. Find i) the pressure and temperature of the cycle ii) the heat supplied per kg of air iii) the work done per kg of air iv) the cycle efficiency iv) the mean effective pressure.	**10**
		b)	Explain the various methods to increase the performance of a Rankine cycle. Use necessary T-S plot.	**10**

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