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

Autonomous Institute Affiliated to VTU

August 2024 Semester End Main Examinations

Programme: B.E. | **Semester: III**
Branch: Aerospace Engineering | **Duration: 3 hrs.**
Course Code: 23AS3ESTDN | **Max Marks: 100**
Course: 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. Use of Thermodynamics steam data handbook is permitted to use.

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.

			CO	*PO*	Marks
		UNIT - I			
1	a)	With suitable examples differentiate between closed system and open system.	*CO1*	*PO 1*	**4**
	b)	What do you mean my thermodynamic equilibrium? Explain.	*CO1*	*PO1*	**6**
	c)	Air initially at 60 kPa pressure, 800 K temp, and volume 0.1 m^3 is compressed isothermally until the volume is reduced by half. It undergoes further cooling at constant pressure till the volume is reduced by half again. Calculate the total work done during the process. Sketch the PV diagram.	*CO1*	*PO2*	**10**
		UNIT - II			
2	a)	In an aircraft engine compressed air at 3 bar and 450 K enters a combustion chamber in which heat is added at constant pressure to the air by the combustion of fuel. Air is thus heated to a temperature of 1250 K. It then enters a turbine with a negligible velocity. It expands in the turbine until its temperature falls to 1000 K. The velocity of air leaving the turbine is 50 m/s. Air then enters a CD nozzle where it expands until its temperature drop to 800 K. Flow through both turbine and nozzle may be considered as reversible adiabatic. Determine i) heat added in the combustion chamber per kg of air ii) work done in the turbine per kg of air iii) velocity of air leaving the nozzle iv) pressure of air leaving the turbine and at exit from the nozzle.	*CO2*	*PO3*	**12**
	b)	Explain the famous Joule's law. Write the first law expression for closed system undergoing cyclic process and change of state.	*CO1*	*PO1*	**8**
		UNIT - III			
3	a)	State and explain the Kelvin Plank and Clausius statement.	*CO1*	*PO1*	**8**
	b)	Two reversible engines operate in series between high temperature T_H and low temperature T_L reservoir. Engine A rejects heat to engine B through an intermediate reservoir T_1. Engine B rejects heat to the low temperature reservoir. Both the engines have same	*CO2*	*PO3*	**8**

			thermal efficiencies. If work of engine B is equal to 500 kJ, T_L = 300 K and heat received by engine A equal to 2000 kJ. Determine i) work of engine A in kJ ii) heat rejected by engine B in kJ iii) temperature at which heat is added to the engine B iv) temperature at which heat is added to engine A.			
		c)	What are the causes for Irreversibility?	*CO1*	*PO1*	**4**
			OR			
	4	a)	State and Prove Clausius Inequality.	*CO1*	*PO1*	**8**
		b)	A 10 kg bar of cast iron initially at 400°C is quenched in a 20 liters water tank, which is at 25°C. Assuming no heat transfer with the surroundings and no boiling away of liquid water, Calculate the net entropy change for the process. (Specific heat of cast iron = 0.5 kJ/kg K and Specific heat of water = 4.187 kJ/kg K)	*CO1*	*PO2*	**8**
		c)	What is available and unavailable energy?	*CO1*	*PO1*	**4**
			UNIT - IV			
	5	a)	Explain compressibility factor and compressibility chart.	*CO1*	*PO1*	**5**
		b)	Explain T-S diagram of pure substance. Highlighting the different region.	*CO1*	*PO1*	**5**
		c)	Steam initially at 0.3 Mpa, 250°C is cooled at constant volume. i) At what temperature will the steam become saturated vapor? ii) What is the quality at 80°C? iii) What is the heat transferred per kg of steam in cooling from 250°C to 80°C?	*CO3*	*PO1*	**10**
			OR			
	6	a)	In an engine cylinder a gas has volumetric analysis of 13% CO_2, 12.5% O_2 and 74.5 % N_2. The temperature at the beginning of expansion is 950°C and the gas mixture expands reversibly through a volume ratio of 8, according to the law $PV^{1.2}$ =C. Calculate per kg of ideal gas mixture i) The work done ii) The heat transfer and its sign iii) the change of entropy per kg of the mixture iv) the entropy generation if To = 298 K. Take Cp for the constituents CO_2, O_2 and N_2 as 1.235 kJ/kg K, 1.088 kJ/kg K and 1.172 kJ/kg K respectively. The molar mass of CO_2, O_2 and N_2 as 44 kg/kmol, 32 kg/kmol and 28 kg/kmol respectively.	*CO3*	*PO1*	**10**
		b)	Explain Amagat's law and Gibbs law.	*CO1*	*PO1*	**5**
		c)	Prove that constant volume lines have more slope than the constant pressure lines on a T-S plot.	*CO1*	*PO1*	**5**
			UNIT - V			
	7	a)	In a diesel cycle, the compression ratio is 15. Compression begins at 0.1 Mpa, 40°C. The heat added is 1.675 MJ/kg. Find i) the maximum temperature in the cycle ii) the work done per kg of air iii) the cycle efficiency iv) the temperature at the end of the isentropic expansion v) the cut-off ratio and vi) the MEP of the cycle	*CO4*	*PO2*	**10**
		b)	What are the various methods to increase the performance of Rankine cycle? Explain it with the T-S plot.	*CO3*	*PO1*	**7**
		c)	Compare Otto, Diesel and Dual cycle.	*CO4*	*PO1*	**3**

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