U.S.N.										

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: 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 steam data hand book 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.

		UNIT - I	*CO*	*PO*	Marks
1	a)	Define thermodynamic system. Differentiate between open system, closed system and an isolated system with an example.	*CO1*	*PO1*	**06**
	b)	A house wife, on a warm summer day, decides to beat the heat by closing the windows and doors in the kitchen and opening the refrigerator door. At first, she feels cool and refreshed, but after a while the effect begins to wear off. Evaluate the situation as it relates to first law of thermodynamics, considering the room including the refrigerator as the system.	*CO1*	*PO2*	**06**
	c)	Drive the expressions for displacement work in i) constant pressure ii) constant volume iii) isothermal iv) adiabatic processes through P-V diagrams.	*CO1*	*PO1*	**08**
		OR			
2	a)	What do you mean by thermodynamic equilibrium? Explain.	*CO1*	*PO1*	**04**
	b)	Differentiate between heat and work.	*CO1*	*PO1*	**04**
	c)	A fluid undergoes the following process i) heated reversibly at a constant pressure of 1.05 bar until it has a specific volume of 0.1 m^3/kg ii) it is then compressed reversibly according to the law PV=C to a pressure of 4.2 bar iii) it is then allowed to expand reversibly according to a law $PV^{1.3}$=C iv) finally it is heated at constant volume back to initial conditions. The work done in the constant pressure process is 515 N-m and the mass of fluid is 0.2 kg. Calculate the net work done on or by the fluid in the cycle and the sketch cycle on a PV diagram.	*CO1*	*PO2*	**12**

			UNIT - II			
	3	a)	Discuss about the contribution of J.P. Joule in establishing the first law of thermodynamics.	*CO2*	*PO1*	**06**
		b)	Derive the steady flow energy equation and apply it to a i) Boiler ii) Nozzle iii) Centrifugal Compressor.	*CO2*	*PO1*	**08**
		c)	In a steam plant, 1 kg of water per second is supplied to the boiler. The enthalpy and velocity of water entering the boiler are 800 kJ/kg and 5 m/s. The water receives 2200 kJ/kg of heat in the boiler at constant pressure. The steam after passing through the turbine comes out with a velocity of 50 m/s, and its enthalpy is 2520 kJ/kg. The inlet is 4 m above the turbine exit. Assuming the heat losses from the boiler and the turbine to the surroundings are 20 kJ/s, calculate the power developed by the turbine. Consider the boiler and turbine as single system.	*CO2*	*PO2*	**06**
			OR			
	4	a)	Derive an expression for unsteady flow process for the case i) tank filling and ii) tank emptying	*CO2*	*PO1*	**06**
		b)	0.1 m^3 of an ideal gas at 300 K and 1 bar is compressed adiabatically to 8 bar. It is then cooled at constant volume and further expanded isothermally so as to reach the condition from where it started. Determine: (i) pressure at the end of constant volume cooling. (ii) change in internal energy during constant volume process. (iii) net work done and heat transferred during the cycle. Assume Cp = 14.3 kJ/kg K and Cv = 10.2 kJ/kg K.	*CO2*	*PO1*	**10**
		c)	1.5 kg of liquid having a constant specific heat of 2.5 kJ/kg K is stirred in a well-insulated chamber causing the temperature to rise by 15°C. Find ΔE and W for the process.	*CO2*	*PO1*	**04**
			UNIT - III			
	5	a)	What is meant by PMM1? Why it is impossible? Also state the Kelvin Planck and Clausius statement of 2^{nd} law of Thermodynamics.	*CO2*	*PO1*	**06**
		b)	Explain the equivalence of Kelvin- Planck and Clausius statements with a neat sketch.	*CO2*	*PO1*	**07**
		c)	A domestic food refrigerator maintains a temperature of – 12°C. The ambient air temperature is 35°C. If heat leaks into the freezer at the continuous rate of 2 kJ/s. Determine the least power necessary to pump this heat out continuously.	*CO2*	*PO1*	**07**
			OR			
	6	a)	State and prove Clausius's theorem.	*CO2*	*PO1*	**06**
		b)	Establish the Inequality of Clausius and write the criteria for reversibility of a cycle.	*CO2*	*PO1*	**06**

		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. i) heat absorbed by the ice from atmosphere, ii) Determine the entropy increase of the universe. Take C_P of ice is 2.093 kJ/kg K and latent heat of fusion of ice is 333.3 kJ/kg K.	*CO2*	*PO1*	**08**
			UNIT - IV			
	7	a)	Explain the following i) Compressibility factor ii) Reduced properties iii) Law of corresponding states iv) Vander Walls equation of state v) Amagat's Law	*CO2*	*PO1*	**10**
		b)	A vessel of volume 0.04 m^3 contains a mixture of saturated water and saturated steam at a temperature of 250°C. The mass of the liquid present is 9 kg. Find i) the pressure ii) the mass iii) dryness fraction iv) the specific volume v) the enthalpy vi) the entropy	*CO2*	*PO1*	**10**
			OR			
	8	a)	Explain the T-S diagram for pure substance as water. Highlight the different regions.	*CO2*	*PO1*	**06**
		b)	Prove that constant volume lines have more slope than constant pressure line on a T-S plot.	*CO2*	*PO1*	**04**
		c)	Ten kg of water at 45°C is heated at a constant pressure of 10 bar until it becomes superheated vapour at 300°C. Find the change in volume, enthalpy, internal energy and entropy.	*CO2*	*PO1*	**10**
			UNIT - V			
	9	a)	Draw the P-V and T-S diagram of air standard Otto cycle and arrive its efficiency.	*CO3*	*PO2*	**10**
		b)	In an air standard diesel cycle, the compression ratio is 16, and at the beginning of isentropic compression the temperature is 15°C and the pressure is 0.1 MPa. Heat is added until the temperature at the end of constant pressure process is 1480°C. Calculate i) the cut off ratio ii) the heat supplied per kg of air iii) the cycle efficiency.	*CO3*	*PO2*	**10**
			OR			
	10	a)	Discuss about the Regenerative Rankine cycle with help of T-S plots.	*CO2*	*PO1*	**07**
		b)	Draw the P-V and T-S diagrams of air standard Brayton cycle.	*CO3*	*PO2*	**03**
		c)	Consider an air standard Brayton cycle in which the air enters the compressor at 1.0 bar and 20°C. The pressure of air leaving the compressor is 3.5 bar and the temperature at turbine inlet is 600°C. Determine per kg of air: i) efficiency of the cycle ii) heat supplied to air, iii) work available at the shaft, iv) heat rejected in the cooler, and v) temperature of air leaving the turbine.	*CO3*	*PO2*	**10**

****