CBCS SCHEME

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BME304

Third Semester B.E./B.Tech. Degree Examination, Dec.2024/Jan.2025
Basic Thermodynamics

Time: 3 hrs. Max. Marks: 100

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. M : Marks , L: Bloom's level , C: Course outcomes.
3. Use of steam table and thermodynamics data hand is permitted.

		Module – 1	M	L	C
Q.1	a.	State and explain zeroth law of thermodynamics.	10	L1	CO1
	b.	Two Celsius thermometers 'A' and 'B' agree at ice point and steam point and the related equation is $t_A = L + Mt_B + Nt_B^2$, where L, M and N are constants, when both thermometer are immersed in fluid, 'A' registers 26°C while 'B' registers 25°C. determine the reading of 'A' when 'B' reads 37.4°C	10	L3	CO1
		OR			
Q.2	a.	Derive an expression for work done during : i) Isothermal process ii) Adiabatic process.	10	L2	CO1
	b.	A cylinder contains 1 kg of a certain fluid at an initial pressure of 20 bar. The fluid is allowed to expand reversibly behind a piston according to a law PV^2 = constant until the volume is doubled. The fluid is then cooled reversibly at constant pressure until the piston regains its original position, heat is then added reversibly with the piston firmly locked in position until the pressure rises to the original value of 20 bar. Calculate the network done by the fluid for an initial volume of 0.05 m^3 and draw a neat PV diagram.	10	L3	CO1
		Module – 2			
Q.3	a.	Explain Joule's experiment with sketch.	10	L1	CO2
	b.	Air flows steady at the rate of 0.4 kg/s through an air compressor, entering at 6 m/s with a pressure of 1 bar and a specific volume of 0.85 m^3/kg and leaving at 4.5 m/s with a pressure of 6.9 bar and a specific volume of 0.16 m^3/kg. The internal energy of the air leaving is 88 kJ/kg greater than that of the air entering. Cooling water in a jacket surrounding the cylinder absorbs heat from the air at the rate of 59 W. Calculate the power required to drive the compressor and the inlet and outlet cross-sectional areas.	10	L3	CO2
		OR			
Q.4	a.	Derive Steady Flow Energy Equation (SFEE) with a neat sketch.	10	L2	CO2
	b.	A turbine operates in a steady flow conditions, receiving steam at the following state : pressure 1.2 MPa, temperature 188°C, enthalpy 2785 kJ/kg, velocity 34 m/s, and elevation 3 m. The steam leaves the turbine at the following state : pressure 20 KPa, enthalpy 2512 kJ/kg, velocity 100 m/s and elevation 0 m. Heat is lost to the surroundings at the rate of 0.29 kJ/s. If the rate of the steam flow through the turbine is 0.42 kg/s. What is the power output of the turbine in KW?	10	L3	CO2
		Module – 3			
Q.5	a.	State and explain Kelvin – Plank and clausius statements of II law of thermodynamics.	10	L2	CO3
	b.	A heat engine receives half of its heat at 1000 K and the rest at 500 K while rejecting heat to a sink at 300 K. What is the maximum possible efficiency of this heat engine?	10	L3	CO3

		OR			
Q.6	**a.**	State and prove clausius inequality.	**10**	**L1**	**CO3**
	b.	A heat engine working on a Carnot cycle absorbs heat from three thermal reservoirs at 1000 K 800 K and 600 K respectively. The engine does 10 KW of net work and rejects 400 kJ/min of heat to the sink at 800 K, if heat supplied by the reservoir at 1000 K 60% heat supplied by reservoir at 600 K. Find the quantifier of heat supplied by each reservoir.	**10**	**L3**	**CO3**
		Module – 4			
Q.7	**a.**	Explain the concept of available and unavailable energy referred to a cycle.	**10**	**L1**	**CO4**
	b.	In a steam generator, water evaporated at 260°C, while the combustion gas (C_P = 1.08 kJ/kg K) is cooled from 13000°C to 320°C. The surrounding are at 30°C. Determine loss in energy available due to the above heat transfer per kg of water evaporated (Latent heat of vaporization of water at 260°C = 1662.5 m^3 kgmole.	**10**	**L3**	**CO4**
		OR			
Q.8	**a.**	Sketch and explain throttling calorimeter.	**10**	**L2**	**CO4**
	b.	A vessel of 0.04 m^3 contains a mixing of saturated water and saturated steam at temperature of 240°C. The mass of the liquid is 8 kg. Find the pressure, specific volume, enthalpy, entropy and internal energy.	**10**	**L3**	**CO4**
		Module – 5			
Q.9	**a.**	Explain : i) Vander Waal's equation of state ii) Compressibility factor iii) Law of corresponding states.	**10**	**L2**	**CO5**
	b.	1 kg of CO_2 has a volume of 0.86 m^3 at 120°C compute pressure using : i) Ideal gas equation ii) Vander Waal's equation. Take Vander Waal's constants for CO_2 a = 365.6 KNM^4/kg mole and b = 0.0423 m^3/kg mole.	**10**	**L3**	**CO5**
		OR			
Q.10	**a.**	Discuss Maxwell's equations and Tds equation.	**10**	**L2**	**CO5**
	b.	Volumetric analysis of a gaseous mixture yields the following results : CO_2 = 12%, O_2 = 4%, N_2 = 82%, CO = 2%. Determine the analysis on mass basis, molecular weight and gas constant for the mixture, assume ideal gas behavior.	**10**	**L3**	**CO5**

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