CBCS SCHEME

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BME304

Third Semester B.E./B.Tech. Degree Examination, June/July 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 thermodynamics data hand book and steam tables is permitted.

		Module – 1	M	L	C
Q.1	a.	State Zeroth Law of thermodynamics. Explain its significance in the measurement of temperature.	6	L2	CO1
	b.	Prove that work is a path function.	4	L2	CO1
	c.	The temperature 't' on a thermometric scale is defined in terms of property P by the relation $t = a \ln p + b$, where a and b are constants. Experiments give values of P as 1.86 and 6.81 at the ice point and the steam point respectively. Evaluate the temperature 't' on the Celsius scale corresponding to a reading of P = 2.5 on the thermometer.	10	L3	CO1
		OR			
Q.2	a.	Define work from mechanics point of view and thermodynamics point of view. Explain the sign convention of work.	6	L2	CO1
	b.	Derive an expression for P-dV work for a polytropic process.	6	L3	CO1
	c.	Determine the total work done in a gas system following the expression process shown in Fig.Q2(c).	8	L3	CO1

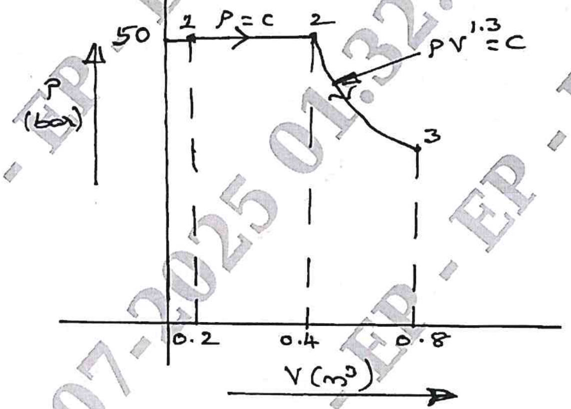

Fig.Q2(c)

		Module – 2			
Q.3	a.	State and explain the first law of thermodynamics for closed system undergoing a cycle process.	4	L2	CO2
	b.	Prove that internal energy is a property of the system.	6	L3	CO2
	c.	The work and Heat are taken with several processes as a result of which the final state is identical with the initial state. The work transfer and the heat transfer are given in the Table Q3(c). Complete the cycle.	10	L3	CO2

Process	Q(kJ)	W(kJ)	du(kJ)
1 – 2	200	500	-----
2 – 3	-----	300	400
3 – 4	-----	–200	-----
4 – 1	50	0	-----

Table Q3(c)

OR					
Q.4	a.	Write a note on Perpetual Motion Machine of Kind I (PMMK I).	4	L2	CO2
	b.	With a neat sketch of steady flow device, write the steady flow energy equation with usual notations.	6	L2	CO2
	c.	The working fluid in a steady flow process flows at the rate of 220kg/min. The fluid rejects 100 kJ/s of heat passing through the system. The fluid enters at a velocity of 320 m/s, pressure 6 bar, internal energy 2000 kJ/kg, specific volume 0.36 m^3/kg and leaves the system at a velocity of 140 m/s, pressure 1.2 bar, internal energy 1400 kJ/kg, specific volume 1.3 m^3/kg. Determine the power output in KW. The change in potential energy is neglected.	10	L3	CO2
Module – 3					
Q.5	a.	Explain the limitations of first law of thermodynamics.	4	L2	CO3
	b.	Give the Kelvin-Plands statement and Clausicus statement of second law of thermodynamics.	4	L2	CO3
	c.	Define a heat engine, a heat pump and a refrigerator. Write the mathematical expressions for the efficiency of a heat engine, COP of a heat pump and a refrigerator. Prove that $(COP)_{Heat\ pump} = 1 + (COP)_{Refrigerator}$.	12	L2	CO3
OR					
Q.6	a.	State and prove Clausius inequality.	6	L3	CO3
	b.	Explain the principle of increase of entropy.	6	L2	CO3
	c.	A heat engine receives 300 kJ/min of heat from a source at 327°C and rejects heat to a sink at 27°C. The hypothetical amounts of heat rejection are : i) 200 kJ/min ii) 150 kJ/min iii) 100 kJ/min. From these results, state which of these cores is a reversible cycle, irreversible cycle and impossible one.	8	L3	CO3
Module – 4					
Q.7	a.	With a neat sketch, explain how the dryness fraction of steam is determined using a combined separating and throttling calorimeter.	10	L2	CO4
	b.	Superheated steam from an initial condition of 5 bar and 300°C is expended isentropically to a pressure of 0.5 bars. Calculate : i) Find condition of steam after expansion ii) Change in enthalpy/kg of steam iii) Change in internal energy /kg of steam.	10	L3	CO4
OR					
Q.8	a.	Explain the following terms : i) Triple point ii) Critical point iii) Sub cooled liquid iv) Quality of steam v) P – V – T surfaces.	10	L2	CO4
	b.	Derive an expression for the available energy from C_1 finite energy source at temperature T_1 when the surrounding temperature is T_0.	10	L3	CO4
Module – 5					
Q.9	a.	Explain the following : i) Maxwell's relations ii) Clausius Clapeyron equation.	8	L2	CO5
	b.	State and explain Dalton's law of partial pressure and Anagat's law of additive volumes.	6	L2	CO5
	c.	Define the following terms : i) Mass fraction ii) Mole fraction iii) Volume fraction.	6	L2	CO5
OR					
Q.10	a.	Write a note on compressibility factor and generalized compressibility chart.	10	L2	CO5
	b.	Determine the pressure exerted by CO_2 in a container of 1.5 m^3 capacity when it contains 5 kg at 27°C using : i) Ideal gas equation ii) Vander Waal's equation . Find the compressibility factor using the value of pressure obtained from Vanderwaal's equation.	10	L3	CO5

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