Roll No. | | | | | | | | | | |

ANNA UNIVERSITY (UNIVERSITY DEPARTMENTS)

B.E. /B. Tech / B. Arch (Full Time) - END SEMESTER EXAMINATIONS, APR / MAY 2024

MECHANICAL ENGINEERING
III Semester
ME 5301 ENGINEERING THERMODYNAMICS
(Regulation 2019)
Use of Steam tables , Mollier Chart permitted

Time:3 hrs

Max. Marks: 100

CO1	Understanding the basics and application of Zeroth and first law of thermodynamics
CO2	Analysing the second law of thermodynamics for performance of thermal systems
CO3	Imparting knowledge on availability and applications of second law of thermodynamics
CO4	Interpreting the various properties of steam
CO5	Estimating the macroscopic properties of gas mixtures

BL – Bloom's Taxonomy Levels
(L1-Remembering, L2-Understanding, L3-Applying, L4-Analysing, L5-Evaluating, L6-Creating)

PART- A (10x2=20 Marks)
(Answer all Questions)

Q. No.	Questions	Marks	CO	BL
1	What are extensive properties? Give an example	2	C1	L1
2	Why quasi-static process is an ideal process?	2	C1	L2
3	Represent reversed Carnot cycle on p-v and T-s planes.	2	C2	L1
4	List atleast two reasons for irreversibility of a thermodynamic process.	2	C2	L2
5	How do we measure the dryness fraction of wet steam?	2	C3	L2
6	Define saturation pressure and saturation temperature.	2	C3	L1
7	Write down the van der Waal's relation. How is it different from equation of state?	2	C4	L1
8	Define reduced temperature and reduced pressure.	2	C4	L1
9	Write down the Clausius - Clapeyron equation.	2	C5	L1
10	What is mass fraction?	2	C5	L1

PART- B (5x 13=65 Marks)
(Restrict to a maximum of 2 subdivisions)

Q. No.	Questions	Marks	CO	BL
11 (a)	i) A rigid cylinder of volume 0.028 m^3 contains steam at 80 bar and 350°C.The cylinder is cooled until the pressure is 50 bar. Calculate :(i) The state of steam after cooling ;(ii) The amount of heat rejected by the steam. Represent the process on p-v plane.	9	C1	L3

	OR			
11 (b)	i) A centrifugal pump delivers 50 kg of water per second. The inlet and outlet pressures are 1 bar and 4.2 bar respectively. The suction is 2.2 m below the centre of the pump and delivery is 8.5 m above the centre of the pump. The suction and delivery pipe diameters are20 cm and 10 cm respectively. Determine the capacity of the electric motor to run the pump.	**10**	C1	L3
	ii) Is zeroth law and concept of temperature measurement connected with each other? Justify	**3**	C1	L2
12 (a)	i) A reversible heat engine operates between two reservoirs at temperatures 700°C and 50°C. The engine drives a reversible refrigerator which operates between reservoirs at temperatures of 50°C and – 25°C. The heat transfer to the engine is 2500 kJ and the net. work output of the combined engine refrigerator plant is 400 kJ.(i) Determine the heat transfer to the refrigerant and the net heat transfer to the reservoir at 50°C ; (ii) Reconsider (i) given that the efficiency of the heat engine and the C.O.P. of the refrigerator are each 45 per cent of their maximum possible values.	**10**	C2	L3
	ii) Brief on the concept of entropy.	**3**	C2	L2
	OR			
12 (b)	i) In an air turbine the air expands from 7 bar and 460°C to 1.012 bar and 160°C. The heat loss from the turbine can be assumed to be negligible.(a) Show that the process is irreversible ; (b) Calculate the change of entropy per kg of air.	**10**	C2	L3
	ii) Write down the Tds equations of entropy.	**3**	C2	L2
13 (a)	i) One kg of water at 0°C is brought into contact with a heat reservoir at 90°C. When the water has reached 90°C, find : (i) Entropy change of water ;(ii) Entropy change of the heat reservoir ;(iii) Entropy change of the universe. (b) If water is heated from 0°C to 90°C by first bringing it in contact with a reservoir at 40°C and then with a reservoir at 90°C, what will the entropy change of the universe be?(c) Explain how water might be heated from 0°C to 90°C with almost no change in the entropy of the universe.	**13**	C3	L3
	OR			
13 (b)	8 kg of air at 650 K and 5.5 bar pressure is enclosed in a closed system. If the atmosphere temperature and pressure are 300 K and 1 bar respectively, determine :(i) The availability if the system goes through the ideal work producing process. (ii) The availability and effectiveness if the air is cooled at constant pressure to atmospheric temperature without bringing it to complete dead state. Take cv = 0.718 kJ/kg K ;cp= 1.005 kJ/kg K.	**13**	C3	L3
14 (a)	i) A spherical vessel of 0.9 m^3 capacity contains steam at 8 bar and 0.9 dryness fraction. Steam is blown off until the pressure drops to 4 bar. The valve is then closed and the steam is allowed to cool until the pressure falls to 3 bar. Assuming that the enthalpy of steam in the vessel remains constant during blowing off periods, determine : (i) The mass of steam blown off ; (ii) The dryness fraction of steam in the vessel after cooling ; (iii) The heat lost by steam per kg during cooling.	**13**	C3	L3
	OR			
14 (b)	i) Explain the process of converting compressed water to superheated steam with the help of a T-s diagram.	**6**	C4	L2
	ii) Draw the p-v-T surface and explain its salient features.	**7**	C4	L2

	OR			
15 (b)	i) Derive the Maxwell's relation starting from Tds equation. Brief on the usefulness of Maxwell's relations.	**2+8+3**	C5	L3

PART- C (1x 15=15 Marks)

(Q.No.16 is compulsory)

Q. No.	Questions	Marks	CO	BL
16.	i) Draw inversion curve and discuss briefly about the Joule-Thomson experiment.	**2+4**	C5	L2
	ii) In an air compressor air flows steadily at the rate of 0.5 kg/s through an air compressor. It enters the compressor at 6 m/s with a pressure of 1 bar and a specific volume of 0.85 m^3/kg and leaves at 5 m/s with a pressure of 7 bar and a specific volume of 0.16 m^3/kg. The internal energy of the air leaving is 90 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 60 kJ/s. Calculate the power required to drive the compressor ;	**9**	C1	L3