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ANNA UNIVERSITY (UNIVERSITY DEPARTMENTS)

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

INDUSTRIAL ENGINEERING – IV SEMESTER

MF5351–THERMODYNAMICS

(Regulation2019)

Time:3hrs

Max.Marks: 100

CO1	To describe the basic concepts and first law of thermodynamics
CO2	To analyse the second law of thermodynamics
CO3	To evaluate the properties of pure substances
CO4	To gain knowledge on the concepts of conduction, convection and radiation.
CO5	To apply the concepts of thermodynamics in IC engines, boilers, turbines, refrigeration and air-conditioning

BL – Bloom's Taxonomy Levels

(L1-Remembering, L2-Understanding, L3-Applying, L4-Analysing, L5-Evaluating, L6-Creating)

PART- A(10x2=20Marks)

(Answer all Questions)

Q.No.	Questions	Marks	CO	BL
1	If a shaft transmitting 350 hp rotates at a rate of 3200 rpm, determine the torque applied to the shaft?	2	1	L3
2	what are limitations in the first law of thermodynamics?	2	1	L1
3	Define entropy principle with real world model?	2	2	L2
4	Air in a cylinder at an initial volume of 0.01 m3 and initial pressure of 6 MPa expands following a quasi-static process given by PV^4 = constant. If the final volume of the gas is 0.025 m3, determine the work done by the gas	2	2	L1
5	Explain about latent heat of vaporization?	2	3	L1
6	Determine the state of steam at a pressure of 12 bar with its specific volume of 0.175 m^3/kg?	2	3	L4
7	What are the advantages of effectiveness NTU method over the LMTD method?	2	4	L1
8	A copper plate of 1 m x 2 m size and 30 cm thickness is maintained hot at 200°C. Air at 22°C blows over the plate and 500 W of heat energy is lost from the surface by radiation. Calculate the inside temperature of the plate. [Take K = 375 W/(m °C) and h = 22 W/(m^2 °C)?	2	4	L2
9	Compare the Air-standard efficiency of Otto, Diesel and dual cycles?	2	5	L2
10	What are the factors influence the environment during refrigerator design?	2	5	L2

PART- B(5x 13=65Marks)

Q. No.	Questions	Marks	CO	BL
11 (a)	(i) A fluid flows through a steady-flow open system at the rate of 3 kg/s. At the system inlet, the pressure, velocity, and internal energy are 5 atm, 150 m/s, and 2000 kJ/kg, respectively, and the specific volume is 0.4 m^3/kg. The fluid leaves the system with 1.2 atm, 80 m/s, an internal energy of 1300 kJ/kg and specific volume of 1.1 m^3/kg. The fluid loses 25 kJ/kg through heat transfer during the process. Determine the power output of the system, neglecting the change in potential energy. (8M) (ii) Differentiate microscopic and macroscopic approaches of thermodynamics. (5M)	8 5	1	L2
	OR			
11 (b)	(ii) 1kg of gas at 1.1bar, 27°C is compressed to 6.6bar as per the law $p^{1.3}$ = const. Calculate work and heat transfer, if (1) When the gas is ethane (CH) with molar mass of 30kg/k mol and C_p of 2.1kJ/kgK. (2) When the gas is argon (Ar) with molar mass of 40kg/k mol and C_p of 0.52kJ/kgK.	13	1	L3
12 (a)	(i) A reversible heat engine operates between two reservoirs at temperatures of 600°C and 40°C. The engine drives a reversible refrigerator which operates between reservoirs at temperatures of 40°C and -20°C. The heat transfer to the heat engine is 2000 kJ and the net work output of the combined engine refrigerator plant is 360 kJ. (a) Evaluate the heat transfer to the refrigerant and the net heat transfer to the reservoir at 40°C. (b) Reconsider (a) given that the efficiency of the heat engine and the COP of the refrigerator are each 40% of their maximum possible values.	13	2	L4
	OR			
12 b)	(i) A metal piece of 1 kg mass with constant specific heat of 0.4 kJ/(kg K) is cooled from 200°C to 100°C by transferring heat to the surrounding air at 27°C. Determine thereversible work and the irreversibility for this process. (ii) Explain about Kelvin-Planck and Clausius statements and their equivalence.	8 5	2	L4
13 (a)	(i) The dry- and wet-bulb temperatures of atmospheric air at 1 atm pressure measured with a sling psychrometer are determined to be 25°C and 10°C, respectively. Determine (a) the specific humidity, (b) the relative humidity, and	8 5	3	L4

OR				
(iii)	(i) Atmospheric air at a pressure of 1 bar and 25°C has a relative humidity of 75%. Find 1. Partial pressure of the water vapour and the air 2. Specific volume 3. Dew point temperature 4. Specific humidity 5. Degree of saturation 6. Density of the mixtures. 7. Water vapour condensed per kg of dry air when the mixture is cooled a constant pressure to a temperature of 10 °C. (use either psychrometric chart or formula) (ii) State the Vander waals equations with limitations?	**8** **5**	3	L5
14 (a)	(i) A composite plane wall of materials A and B has thickness L_A = 50 mm and L_B = 25 mm. The thermal conductivity of the materials are K_A = 70 W/(m K) and K_B = 100 W/(m K). The outer surface of wall A is perfectly insulated and inside it heat is generated at an uniform rate of 2000 kW/m^3. The outer surface of wall B is cooled by a water stream at 20°C and h = 1 kW/(m^2 K). Determine the temperatures at the insulated surface and the cooled surface, at steady state condition. Assume the conduction to be one-dimensional and also assume negligible contact resistance between the walls.	**13**	4	L5
OR				
14 (b)	(ii) Air at 20°C at atmospheric pressure flows over a flat plate at a velocity of 3 m/s. If the plate is 1 m wide and 80 °C, calculate the following at x=300 mm. 1. Hydrodynamic boundary layer thickness, 2. Thermal boundary layer thickness, 3. Local friction coefficient, 4. Average friction coefficient, 5. Local heat transfer coefficient, 6. Average heat transfer coefficient, 7. Heat transfer.	**13**	4	L3
15 (a)	(i) Explain the working of Vapour Compression & vapour absorption system with neat sketch.	**13**	5	L2
OR				
15 (b)	(i) Differentiate Four Stroke and two stroke engines with valve time diagram? (ii) Compare the Fire tube boiler & Water Tube Boilers?	**7** **6**	5	L2

PART- C (1x 15=15Marks)

(Q.No.16 is compulsory)

Q. No.	Questions	Marks	CO	BL
16.	(i) A refrigerator is designed to cool 250 kg/h of hot liquid of specific heat 3350 J/kg K at 120°C using a parallel flow arrangement. 1000 kg/h of cooling water is available for cooling purposes at a temperature of 10°C. If the overall heat transfer coefficient is 1160 W/m^2K and the surface area of the heat exchanger is 0.25 m^2, calculate the outlet temperatures of the cooled liquid and water and also the effectiveness of the heat exchanger. (ii) Explain the laws involved in the changes in fire color as temperature increases in a furnace. ?	**10** **5**	4	L4