Reg. No.															

Question Paper Code	14140

B.E. / B.Tech. - DEGREE EXAMINATIONS, NOV / DEC 2025

Sixth Semester

Mechanical Engineering

20MEPC602 – HEAT TRANSFER

Regulations - 2020

(Use of Heat Transfer *Data Book and Steam Tables* is permitted)

Duration: 3 Hours | Max. Marks: 100

PART - A (MCQ) (10 × 1 = 10 Marks)

Answer ALL Questions

		Marks	K – Level	CO
1.	The unit of thermal conductivity in S.I. units is (a) J/m^2 sec (b) J/m sec (c) W/m K (d) None of the above	1	K1	CO1
2.	The critical thickness of insulation is the thickness at which the heat transfer rate is (a) Minimum (b) Maximum (c) Zero (d) Independent of thickness	1	K2	CO1
3.	What is the defining characteristic of a black body? (a) It reflects all incident radiation (b) It transmits all incident radiation (c) It absorbs all incident radiation (d) It emits no radiation	1	K1	CO2
4.	What material property is most important for an effective radiation shield? (a) High thermal conductivity (b) High emissivity (c) Low emissivity (d) High density	1	K1	CO2
5.	Convection heat transfer involves (a) Heat transfer by molecular vibrations (b) Heat transfer by electromagnetic waves (c) Heat transfer by fluid motion (d) Heat transfer in a vacuum	1	K1	CO3
6.	The thermal boundary layer is the region where (a) Temperature gradients are significant (b) Velocity gradients are significant (c) Both temperature and velocity gradients are negligible (d) Momentum transfer is negligible	1	K1	CO3
7.	Nusselt's theory of condensation primarily applies to (a) Nucleate boiling. (b) Film boiling (c) Film condensation on a vertical plate (d) Dropwise condensation	1	K1	CO4
8.	The critical heat flux (CHF) in pool boiling signifies (a) The onset of nucleate boiling (b) The transition from nucleate to film boiling (c) The maximum heat transfer rate (d) The minimum heat transfer rate	1	K1	CO4
9.	Baffles in a shell and tube heat exchanger primarily increase the heat transfer rate by (a) Reducing the pressure drop (b) Increasing the residence time and fluid velocity (c) Promoting laminar flow (d) Reducing fouling.	1	K2	CO5
10.	The "effectiveness" of a heat exchanger is defined as (a) The ratio of actual heat transfer to the maximum possible heat transfer (b) The ratio of maximum possible heat transfer to the actual heat transfer (c) The ratio of LMTD to the temperature difference between the fluids (d) The ratio of fluid velocities to the heat transfer rate	1	K1	CO6

PART - B (12 × 2 = 24 Marks)

Answer ALL Questions

		Marks	K – Level	CO
11.	State Fourier's law of heat conduction. What is the significance of minus sign in this law?	2	K1	CO1
12.	Define overall heat transfer co-efficient and infer its physical significance.	2	K1	CO1
13.	What is meant by Absorptive, Reflectivity and Transmissivity?	2	K1	CO2
14.	Compare the concept of black body with grey body.	2	K2	CO2
15.	Define hydrodynamic boundary layer thickness and thermal boundary layer thickness.	2	K1	CO3
16.	Give some common examples of forced convection in engineering applications.	2	K1	CO3

17.	Outline the differences between the boiling and the condensation.	2	K2	CO4
18.	List out the merits of drop wise condensation.	2	K1	CO4
19.	Compare direct contact and indirect contact type heat exchangers.	2	K2	CO5
20.	What is meant by Fouling factors?	2	K1	CO5
21.	State any four important engineering applications of fins.	2	K1	CO6
22.	What is the primary function of an automotive radiator?	2	K1	CO6

PART - C (6 × 11 = 66 Marks)

Answer ALL Questions

23.	a)	Derive the general heat conduction equation for a differential volume element with internal heat generation in Cartesian coordinate system.	11	K3	CO1
		OR			
	b)	Identify the heat loss from an insulated steel pipe carrying a hot liquid to the surroundings per meter length of the pipe, given the following particulars: I.D of the pipe = 10 cm; Wall thickness = 1 cm; Thickness of insulation = 3 cm; Temperature of hot liquid = 85°C; Temperature of surroundings = 25°C; k_1 for steel = 58 W/mK; k_2 for insulating material = 0.2 W/mK; Inside heat transfer coefficient = 720 W/m^2 K; Outside heat transfer coefficient = 9 W/m^2 K.	11	K3	CO1
24.	a)	For an industrial furnace in the form of a black body at 3000 K emits radiation. Calculate the followings: i) Monochromatic emissive power at 1μm wave length, ii) Wave length at which the emission is maximum, iii) Maximum emissive power, iv) Total emissive power, v) Total emissive power of the furnace if it is assumed as a real surface having emissivity equal to 0.85.	11	K2	CO2
		OR			
	b)	Two circular discs of diameter 20 cm each are placed 2 m apart. Calculate the radiant heat exchange for these discs if they are maintained at 800°C and 300°C respectively, and the corresponding emissivities are 0.3 and 0.5.	11	K2	CO2
25.	a)	Air at 20^0C, at a pressure of 1 bar is flowing over a flat plate at a velocity of 3 m/s. if the plate maintained at 60^0C, Identify the heat transfer per unit width of the plate. Assuming the length of the plate along the flow of air is 2m.	11	K3	CO3
		OR			
	b)	A thin 100 cm long and 10 cm wide horizontal plate is maintained at a uniform temperature of 150°C in a large tank full of water at 75°C. Identify the rate of heat to be supplied to the plate to maintain constant plate temperature as heat is dissipated from either side of plate.	11	K3	CO3
26.	a)	Demonstrate the various regimes of pool boiling.	11	K2	CO4
		OR			
	b)	A vertical plate of 0.4m height and 0.3m wide at 40°C, is exposed to saturated steam at atmospheric pressure. Find the following i) Film thickness at the bottom of the plate. ii) Maximum velocity at the bottom of the plate. iii) Total heat flux to the plate.	11	K2	CO4

27. a) In a counter flow double pipe heat exchanger, Water is heated from 50°C to 75°C by oil entering at 115°C and leaving at 70°C. The specific heat of oil is 1780 J/kgK. The mass flow rate of water is 65Kg/min and specific heat of water is 4186 J/kgK. Identify the heat exchanger area and heat transfer rate for an overall heat transfer coefficient of 340W/m^2K. *11 K3 CO5*

OR

b) In a parallel flow heat exchanger, hot water is cooled from 80°C to 40°C by cold water entering at 20°C. Mass flow rate of hot water is 0.2kg/s and the mass flow rate of cold water is 0.5kg/s. If the individual heat transfer coefficients on both sides are 600W/m^2K, Identify the area of the heat exchanger. *11 K3 CO5*

28. a) In a food processing plant water is to be cooled from 18^{o}C to 6.5^{O}C by using brine solution entering at an inlet temperature of -1.1 ^{O}C and leaving at 2.9 ^{O}C. How much area is required when using a shell-and-tube heat exchanger with the water making one shell pass and the brine making two tube passes? Assume an average overall heat transfer coefficient of 850 W/m^2K and a design load of 6000 W. *11 K3 CO6*

OR

b) A body of an electric motor is 300 mm in diameter and 240 mm long. It dissipates 360 W of heat and its surface temperature should not exceed 55°C. Longitudinal fin of 15 mm thickness and 40 mm height are proposed. The heat transfer coefficient is 40 W/m^2K. When the ambient temperature 30°C Identify the number of fins required, if k of the fin material is 40 W/mK. *11 K3 CO6*