Reg. No.																

Question Paper Code	12987

B.E. / B.Tech. - DEGREE EXAMINATIONS, NOV / DEC 2024

Sixth Semester

Mechanical Engineering

20MEPC602 - HEAT TRANSFER

Regulations - 2020

(Use of Heat Transfer Data Books, Molier Charts, Steam Tables permitted)

Duration: 3 Hours | Max. Marks: 100

PART - A (MCQ) (20 × 1 = 20 Marks)

Answer ALL Questions

		Marks	K – Level	CO
1.	Metals are good conductors of heat because (a) Their atoms collide frequently (b) Their atoms-are relatively far apart (c) They contain free electrons (d) They have high density	1	K1	CO1
2.	Which of the following is a case of steady state heat transfer (a) I.C. engine (b) Air preheaters (c) Heating of building in winter (d) None of the above	1	K1	CO1
3.	When heat is transferred from one particle of hot body to another by actual motion of the heated particles, it is referred to (a) Conduction (b) Convection (c) Radiation (d) Conduction and Convection	1	K1	CO1
4.	The value of Prandtl number for air is about (a) 0.1 (b) 0.3 (c) 0.7 (d) 1.7	1	K2	CO2
5.	The value of the wavelength for maximum emissive power is given by (a) Wien's law (b) Planck's law (c) Stefan's law (d) Fourier's law	1	K2	CO2
6.	According to Stefan-Boltzmann law, ideal radiators emit radiant energy at a rate proportional to (a) Absolute temperature (b) Square of temperature (c) Fourth power of absolute temperature (d) Fourth power of temperature	1	K2	CO2
7.	When heat is Transferred by molecular collision, it is referred to as heat transfer by (a) Conduction (b) Convection (c) Radiation (d) Scattering	1	K1	CO3
8.	Heat transfer in liquid and gases takes place by (a) Conduction (b) Convection (c) Radiation (d) Conduction and convection	1	K1	CO3
9.	A non-dimensional number generally associated with natural convection heat transfer is (a) Grashoff number (b) Nusselt number (c) Weber number (d) Prandtl number	1	K2	CO3
10.	The boiling point of a solution is a colligative property because? (a) It depends on the temperature of solution (b) It depends on the concentration of solution (c) It depends on the applied pressure on the solution (d) It depends on the heat capacity of the solution	1	K2	CO4
11.	_____ is the change of vapour in a non-condensable gas. (a) Saturation (b) Vaporization (c) Condensation (d) None of the mentioned	1	K2	CO4
12.	Condensation is a/an------- Process (a) Exothermic (b) Endothermic (c) Ectothermic (d) None of the above	1	K2	CO4
13.	Log mean temperature difference in case of counter flow compared to parallel flow will be (a) Same (b) More (c) Less (d) Depends on other factors	1	K1	CO5
14.	The unit of overall coefficient of heat transfer is (a) W/m^2 (b) W/hr °C (c) W/m^2 K (d) W/m hr °C	1	K2	CO5
15.	LMTD in case of counter flow heat exchanger as compared-to parallel flow heat exchanger is (a) Higher (b) Lower (c) Same (d) Depends on the area of heat exchanger	1	K1	CO5

16. In heat exchangers, degree of approach is defined as the difference between temperatures of — *1 K2 CO5*
(a) Cold medium inlet and outlet
(b) Hot medium inlet and outlet
(c) Hot medium outlet and cold water inlet
(d) Hot medium outlet and cold medium outlet

17. All radiations in a black body are — *1 K1 CO6*
(a) Reflected (b) Refracted (c) Transmitted (d) Absorbed

18. Which of the following is a case of steady state heat transfer — *1 K1 CO6*
(a) I.C. engine (b) Air pre-heaters
(c) Heating of building in winter (d) None of the above

19. Unit of thermal conductivity in S.I. units is — *1 K1 CO6*
(a) J/m^2 sec (b) J/m sec (c) W/m °K (d) None of the above

20. Cork is a good insulator because it has — *1 K2 CO6*
(a) Free electrons (b) Atoms colliding frequency (c) Low density (d) Porous body

PART - B (10 × 2 = 20 Marks)

Answer ALL Questions

21. Define thermal conductivity. — *2 K1 CO1*

22. State Newton's law of cooling for convection. — *2 K1 CO1*

23. Write the reciprocity theorem for two surfaces which exchange radiation with each other. — *2 K2 CO2*

24. What is a Radiation Shield? When it is used? — *2 K1 CO2*

25. Distinguish between natural and forced convection heat transfer. — *2 K2 CO3*

26. Define Reynolds number and Prandtl number. — *2 K1 CO3*

27. Mention any two techniques commonly used to achieve drop wise condensation. — *2 K1 CO4*

28. List out the merits of drop wise condensation. — *2 K1 CO4*

29. In a schematic show the flow configuration of cross flow heat exchanger. — *2 K2 CO5*

30. Write any two examples of heat Exchanger. — *2 K2 CO6*

PART - C (6 × 10 = 60 Marks)

Answer ALL Questions

31. a) Derive the general heat conduction equation for a differential volume element with internal heat generation in Cartesian coordinate system. — *10 K2 CO1*

OR

b) Derive generalized heat conduction equation in cylindrical coordinate system. — *10 K2 CO1*

32. a) For an industrial furnace in the form of a black body at 3000 K emits radiation. Calculate the followings: — *10 K2 CO2*
(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.

OR

b) The sun emits maximum radiation at $\lambda = 0.52$ μ. Assuming the sun to be a black body, calculate the surface temperature of the sun. Also calculate the monochromatic emissive power of the sun's surface. — *10 K2 CO2*

33. a) A thin 80 cm long and 8 cm wide horizontal plate is maintained at a temperature of 130^oC in a large tank full of water at 70^oC. Estimate the rate of heat input into the plate necessary to maintain the temperature of 130^OC. — *10 K3 CO3*

OR

b) Air at a pressure of 8 kN/m^2 and a temperature at 250^{0}C flows over a flat plate 0.3 mm wide and 1 m long at a velocity of 8 m/s. If the plate is to be maintained at a temperature of 78^{o}C. Estimate the rate of heat to be removed continuously from the plate. Also estimate the drag force exerted on the plate using the analogy between fluid friction and heat transfer. *10 K3 CO3*

34. a) Water is boiled at the rate of 24 kg/h in a polished copper pan, 300 mm in diameter, at atmospheric pressure. Assuming nucleate boiling conditions, Calculate the temperature of the bottom surface of the pan. *10 K2 CO4*

OR

b) Explain the various regimes of pool boiling of water at atmospheric pressure with a neat sketch. *10 K2 CO4*

35. 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/kg K. The mass flow rate of water is 65kg/min and specific heat of water is 4186 J/kg K. Determine the heat exchanger area and heat transfer rate for an overall heat transfer coefficient of 340W/m^2K. *10 K3 CO5*

OR

b) In a parallel flow double pipe heat exchanger water flows through the inner pipe and is heated from 30°C to 80°C. Oil flowing through the annulus is cooled from 220°C to 100°C. It is desired to cool the oil to a lower exit temperature by increasing the length of the heat exchanger. Determine the minimum temperature to which the oil may be cooled. *10 K3 CO5*

36. a) A turbine blade 6 cm long and having a cross sectional area 4.65 cm^2 and perimeter 12 cm is made of stainless steel (k = 23.3 W/mK). The temperature at the root is 500 °C. The blade is exposed to a hot gas at 870 °C. The heat transfer coefficient between the blade surface and gas is 442 W/m^2K. Determine the temperature distribution and rate of heat flow at the root of the blade. Assume the tip of the blade to be insulated. *10 K4 CO6*

OR

b) 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. *10 K4 CO6*