Exam.Code:0942
Sub. Code: 6733

2053
B.E. (Mechanical Engineering)
Sixth Semester
MEC-604: Heat Transfer

Time allowed: 3 Hours **Max. Marks: 50**

NOTE: Attempt <u>five</u> questions in all, including Question No. I which is compulsory and selecting two questions from each Part.

x-x-x

1 a Define the concept of view factor and explain its significance in the calculation of radiation heat transfer. 10

b Why is the heat transfer coefficient higher in forced convection compared to free convection?

c What role does the thermal boundary layer play in convective heat transfer?

d When film condensation occurs on a vertical plate, would the heat flux be higher at the top or bottom of the plate, and what is the reason behind it?

e What causes metals to exhibit high conductivity for both heat and electricity, whereas certain non-metallic crystalline solids possess excellent heat conductivity but poor electrical conductivity?

<u>Part -A</u>

2 a Consider a 0.8-m-high and 1.5-m-wide glass window with a thickness of 8 mm and a thermal conductivity of k = 0.78 W/m · °C. Determine the steady rate of heat transfers through this glass window and the temperature of its inner surface for a day during which the room is maintained at 20°C while the temperature of the outdoors is -10°C. Take the heat transfer coefficients on the inner and outer surfaces of the window to be h1 = 10 $W/m^2 \cdot °C$ and h2 = 40 $W/m^2 \cdot °C$, which includes the effects of radiation. 7

b When insulating electrical cables, should the outer radius of the insulator be greater or lesser than the critical radius and why? 3

3 Derive the 3D heat conduction equation in the Cartesian coordinate system for constant properties of the medium. 10

4 a A very long rod of 50 mm diameter has one of its ends maintained at 130°C. The surface of the rod is exposed to ambient air at 20°C with a convection heat transfer coefficient of 9 W/ (m^2 K). Calculate the heat loss from rod if its thermal conductivity is 390 W/ (m K). 6

b What are the influences of (a) fin length and (b) fin thickness on the efficiency of a fin? 4

<u>Part-B</u>

5 a A spherical ball of 10 cm diameter maintained at a constant temperature of 1100 K is suspended in air. Assuming the ball to closely approximate a blackbody, determine (a) the total blackbody emissive power, (b) the total amount of radiation emitted by the ball in 10 minutes, and (c) the spectral blackbody emissive power at a wavelength of 3 μm. 7

b What is meant by blackbody radiation function? 3

6 a In a food processing facility, a brine solution undergoes heating in a double-pipe heat exchanger. The initial temperature of the brine solution is 8°C, and it is heated to 14°C. The heating is achieved by water entering the heat exchanger at 55°C and leaving at 40°C, with a flow rate of 0.18 kg/s. Given that the overall heat transfer coefficient is 800 W/ (m^2K), 7

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calculate the required heat exchanger area for both (a) a parallel flow arrangement and (b) a counter flow arrangement. The specific heat capacity of water is 4.18 kJ/ (kg K).

b How does the fouling effect rate of heat transfer and pressure drop in a heat exchanger? 3

7 a What is the definition of a gray body? 2

b What is the reason for the significantly higher heat transfer coefficients in condensation and boiling compared to forced convection without phase change? 2

c (i) List the relevant dimensionless terms that govern forced convection. Give it physical significance 3

(ii) Provide the pertinent dimensionless terms associated with free convection. Give it physical significance. 3

x-x-x