Exam.Code:0942
Sub. Code: 6733

2023

B.E. (Mechanical Engineering)

Sixth Semester

MEC-604: Heat Transfer

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

NOTE: Attempt five questions in all, including Question No. 1 which is compulsory and selecting two questions from each Part.

x-x-x

1. A What are the important consequences of Fourier's law? 10
   B What is the analogy between flow of heat and flow of electricity?
   C Define 'fin efficiency' and 'fin effectiveness'
   D Differentiate between fundamental and derived dimensions?
   E Differentiate between heat transfer coefficient and thermal conductivity.
   F What are applications of heat exchanger?
   G What do you understand by net radiant heat flux?
   H Show the temperature distributions of counter flow heat exchanger.
   I What is a dropwise condensation?
   J Why the radiation shape factor is important to study?

Part –A

2. A Consider a system of composite cylinders of inner radius r_1, outer radius r_2 and thermal conductivity k_1 is covered with another layer (say, insulation) of radius r_3 and thermal conductivity k_2. There is no temperature drop at the interface. Let T_2 be the interface temperature. Further, let a hot fluid at a temperature T_a flow through the inner pipe with a heat transfer coefficient h_a. On the outside, let the heat be lost to a cold fluid at a temperature T_b flowing with a heat transfer coefficient of h_b. Let L be the length of the cylindrical system. Derive the relation for heat transfer for this composite cylinder. 5
   B Obtain three-dimensional heat conduction equation in Cartesian coordinates 5
3. A Determine the steady state heat transfer through a double pane window, 0.8 m high, 1.5 m wide, consisting of two 4 mm thick glass layers (k = 0.78 W/(mC)), separated by a 10 mm thick stagnant layer of air (k = 0.026 W/(mC)). Inside temperature of room air is maintained at 20°C with a convective heat transfer coefficient of h_a = 10 W/(m^2 C). Outside air temperature is –10°C and the convective heat transfer coefficient on the outside is h_b = 40 W/(m^2 C). Also, determine the 5

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overall heat transfer coefficient.

B Derive the relation for critical thickness of insulation in case of cylindrical rod. 5

4. A Determine the thermal conductivity of a long, solid 2.5 cm diameter rod; one half of the rod was inserted to a furnace while the other half was projecting into air at 27°C. After steady state had been reached, the temperatures at two points 7.6 cm apart were measured and found to be 126°C and 91°C, respectively. The heat transfer coefficient over the surface of the rod exposed to air was estimated to be 22.7 $W/(m^2 K)$. What is the thermal conductivity of the rod? 5

B Derive heat flow relationship when the fin is thin and long enough that the heat loss from the tip is negligible. 5

Part-B

5. A Planck's law of monochromatic radiation. What is its significance? 4

B Using the technique of dimensional analysis establish the following relation for forced convection heat transfer. Nu = F (Re, Pr) 6

6. A Derive an expression for the LMTD of a parallel-flow HX. State clearly the assumptions 6

B Discuss various regimes in pool boiling with a diagram. 4

7. A A spherical liquid oxygen tank, 0.3 m in diameter is enclosed concentrically in a spherical container of 0.4 m diameter and the space in between is evacuated. The tank surface is at −183°C and has an emissivity of 0.2. The container surface is at 25°C and has an emissivity of 0.25. Determine the net radiant heat transfer rate. 5

B It is observed that intensity of radiation is maximum in case of solar radiation at a wavelength of 0.49 microns. Assuming the sun as a black body, estimate its surface temperature and emissive power. Wein displacement constant = 0.289×10^{-2}mK. 5

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