Total No. of Questions :6]

SEAT No. :

P5058

[Total No. of Pages : 3

T.E./Insem.-607
T.E.(Mechanical) (Semester - I)
HEAT TRANSFER
(2015 Pattern)

Time : 1 Hour] ***[Max. Marks :30***

Instructions to the candidates:

1) ***Solve Q.1 or Q.2, Q.3 or Q.4 and Q.5 or Q.6***
2) ***Draw Neat diagrams wherever necessary.***
3) ***Use of scientific calculator is allowed.***
4) ***Assume suitable data where ever necessary.***
5) ***Figures to the right indicate full marks***

Q1) a) Two large parallel plates with surface conditions approximating those of a blackbody are maintained at 816°C and 260°C, respectively. Determine the rate of heat transfer by radiation between the plates in W/m^2 and the radiative heat transfer coefficient in $W/(m^2K)$. [Take Stefan-Boltzmann constant (σ) = 5.7 x $10^{-8}W/(m^2K^4)$] **[4]**

b) Define and explain significance of each in heat transfer: **[6]**

i) Thermal conductivity

ii) Thermal contact resistance

iii) Thermal diffusivity

OR

Q2) a) With increasing emphasis on energy conservation, the heat loss from buildings has become a major concern. For a small tract house the typical exterior surface areas and R-factors (area × thermal resistance) are listed below: **[6]**

Element	Area (m^2)	R-factors (m^2K/W)
Walls	150	2.0
Ceiling	120	2.8
Floor	120	2.0
Windows	20	0.1
Doors	5	0.5

P.T.O.

i) Calculate the rate of heat loss from the house when the interior temperature is 22°Cand the exterior is —5°C.

ii) Suggest ways and means to reduce the heat loss and show quantitatively the effect of doubling the wall insulation and the substitution of double glazed windows (thermal resistance= $0.2 m^2K/W$) for the single glazed type in the table above.

b) Show that the radial heat conduction through a hollow cylinder depends on logarithmic mean area of inside and outside surface? **[4]**

Q3) a) Consider a long resistance wire of radius $r_1 = 0.2$ cm and thermal conductivity $k_{wire} = 15$ W/m°C in which heat is generated uniformly as a result of resistance heating at a constant rate of $g = 50\ W/cm^3$. The wire is embedded in a 0.5 cm thick layer of ceramic whose thermal conductivity is $k_{ceramic} = 1.2$ W/m°C. If the outer surface temperature of the ceramic layer is measured to be $T_S = 45°C$, determine the temperatures at the center of the resistance wire and the interface of the wire and the ceramic layer under steady conditions. **[6]**

b) A solid cylinder and sphere are of the same radius and material. These have same outside surface temperature with same amount of heat generation. Prove that the maximum temperature at center of cylinder and sphere is,

$$T_c = \frac{g}{4k} R^2 + T_w \ \text{[cylinder]}$$

$$T_c = \frac{g}{6k} R^2 + T_w \ \text{[sphere]}$$

Where,

g = uniform heat generation (W/m^3)

T_c = Temperature at center (k)

T_w = Surface Temperature (k)

R = Outer radius (m)

OR

Q4) a) Explain how the fin enhances heat transfer from a surface. Also, explain how addition of fins may actually decrease heat transfer from a surface. **[4]**

b) Obtain relation for the fin efficiency for a fin of constant cross sectional area A_C; perimeter P; length L and thermal conductivity k, exposed to convection to a medium at T_∞ with heat transfer coefficient h. Assume fins are very sufficiently long so that the temperature of the fin tip is nearly T_∞. Take temperature of fin at base to be T_b and neglect heat transfer at fin tips. Simplify the relation for (i) a circular fin of diameter "D" (ii) a rectangular fin of thickness "t"

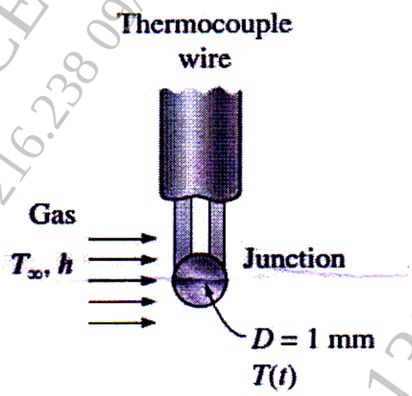
Q5) a) Classify Thermal Insulations. **[2]**

b) A salesman for insulation material claims that insulating exposed steam pipes in the basement of a large hotel will be cost effective. Suppose saturated steam at 5.7 bars flows through a 30 cm OD steel pipe with a 3cm wall thickness. The pipe is surrounded by air at 20°C. The convective heat transfer coefficient on the outer surface of the pipe is estimated to be 25 W/(m^2K). The cost of generating steam is estimated to be Rs. 5 per 109 J and the salesman offers to install a 5 cm thick layer of 85% magnesia insulation on the pipes for Rs. 200/m or a 10 cm thick layer for Rs. 300/m. Estimate the payback time for these two alternatives assuming that the steam line operates all year long and make a recommendation to the hotel owner. Assume that the surface of the pipe as well as the insulation have a low emissivity and radiative heat transfer is negligible. **[8]**

OR

Q6) a) What is lumped system analysis? When is it applicable? **[4]**

b) The temperature of a gas stream is to be measured by a thermocouple whose junction can be approximated as a 1-mm-diameter sphere, as shown in figure. The properties of the junction are k = 35 W/m°C, ρ =8500 kg/m^3, and C_P = 320 J/kg °C, and the convection heat transfer coefficient between the junction and the gas is h = 210 W/m^2 °C. Determine how long it will take for the thermocouple to read 99 percent of the initial temperature difference. **[6]**



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