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(Following Paper ID and Roll No. to be filled in your Answer Book)

Paper ID : 140504 Roll No. | | | | | | | | | |

B.Tech.

(SEM. V) THEORY EXAM. 2015-16

HEAT & MASS TRANSFER (EME-504)

[Time:3 hours] [MaximumMarks:100]

SECTION-A

1. **Attempt all parts. All parts carry equal marks. Write answer of each part in short. (2x10=20)**

   (a) What do you mean by thermal conductivity? Why good electrical conductor materials are also good heat conductors?

   (b) What do you mean by thermal cotact resistance?

   (c) State Wein's displacement law.

   (d) What do you mean by critical thickness of insulation?

   (e) Define the term "Irradiation" and Radiosity".

(f) State the assumptions made in lumped heat capacity method for analysis transient heat conduction problem.

(g) Define response time of a thermocouple. What does it signify?

(h) Explain black body, white body, gray body and opaque body.

(i) What do you mean by fouling factor in analysis of heat exchanger?

(j) A black body emits radiation of maximum intansity at wavelength of 0.5 m. calculate its surface temperature and emissive power.

SECTION-B

Note: Attempt any five questions from this section. **(10x5=50)**

2. Derive the general heat conduction equation in cylindraical coordinates.

3. Derive the Von-Karman integral enegry equation for the flow past a flat plate.

4. What are the applications of fins? Establish an expression for temperature distribution in a straight fin of rectangular profile, when fin tip is unsulated.

5. During heat treatment, cylindraical pieces of 25 mm diameter, 30 mm height and at 30 °C are placed in furnace at 750 °C with convective heat transfer coefficient 80 W/m^2-deg,Calculate the time reqired to heat the pieces to 600 °C. What will be shortfall in temperature if pieces are taken out from the furnace after 280 seconds? Assume the following properties: k=40 W/m °C, c=480 J/kg K, and $\rho = 7850\,kg/m^3$.

6. The insulation board for air conditioning purposes comprises three layers. A 12 cm thick layer of grass (k=0.22 W/mK) is sandwiched between 3 cm thick layer of plywood (k = 0. 15 W/mK) on each side. The bonding is achieved with glue which does not offer any resistance ot heat flow. If the side surfaces of board are maintained at 40 °C and 20 °C temperature, determine the heat flux. How would the heat flux be affected if instead of glue the three pieces are fastened by steel bolts (k=40 WmK) of 1.2 cm diameter at corners.

7. Consider radiative heat transfer between two large parallel planes of surface emissivity 0. 8. How many thin radiation shields of emissivity 0.05 be placed between the surfaces to reduce the radiation heat transfer by factor 75?

8. A Counter flow heat exchanger is used to cool lubricating oil of a large industrial gas turbine engine. The oil flows through the tube at 0.9 kg/s (c_p = 2.18 kJ/kgK) and the coolant water flows in the annulus in the opposite direction at the rate of 0.15 kg/s (c_p = 4.18 kJ/kgK). The oil enters at 425 K and leaves 345 K while the coolant enters at 285 K. how long must the tube be made to perfrom this duty if the heat transfer coefficient from oil to tube surface is 2250 W/m²K and from tube to water is 5650 W/m²K? The tube has a mean diameter of 12. 5 mm and its wall presents negligible resistance to heat transfer.

9. The nose section of a missile is formed of a 6 mm thick stainless plate and is held initially at uniform temperature of 88 °C. The missile enters the denser layers of the atmosphere at very high velocity. The effective temperature of air surrounding the nose region attains the value 2200 °C and the surface convective coefficient is estimated at 3405 W/m²K. Make Calculations for the maximum permissible time in these surroundings if the maximum metal temperature is not to exceed 1095 °C. Also workout the inside surface temperature under these conditions. The properties for steel are: ρ =7800kg/m³, k = 54 W/m °C, C_p = 465 J/kgK.

SECTION-C

Note: Attempt any five questions from this secrtion.

(10x5=50)

10. (a) Explain the analogy between momentum and heat transfer in turbulent flow over a flat surface.

(b) A flat plate is 2 m long, 0.8 m wide and 3 mm thick Its density and specific heat is 3000 kg/m³ and 700J/kgK respectively. The plate is having initial temperature is 80 °C. A stream of air at 20 °C of blown over both surfaces of the plate along its widht; at a velocity 2 m/s. calculate rate of heat dissipation from the plate and initial rate of cooling of the plate. The proprties of air are:

ρ =1.09 kg/m³, k =.028 W/m °C, C= 1007 J/kgK, μ =2.03 x 10^{-5} kg/ms, Pr = 0. 698

$Nu_x = 0.664 (Re_x)^{0.5} (Pr)^{0.33}$ For Laminar Flow

$Nu_x = 0.0336(Re_x)^{0.8} - 836(Pr)^{0.33}$ for Turbulent Flow

11. (a) What do you mean by shape factor? Write its salient features.

(b) Define internsity of radiation. Prove that the internsity of radiation is $1/\pi$ times of the total emissive power.

12. (a) Differentiate between Drop wise Condensation and film wise condensation.

(b) Engine Oil (c_p =2100 J)kg °C is to be heated from 20 °C to 60 °C at a rate of 0.3 kg/s in a 2 cm diameter thin walled copper tube by condensing steam outside at a temprature of 130 °C (H_{fg}=2174 kJ/kg) for an overall heat transfer coefficient of 650 W/m² °C, Determine the rate of heat transfer and the length of the tube required to achieve it.

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