M.E. First Semester (Mechanical Engineering (Thermal Engg.)) (New-CGS)

13508 : Advanced Heat Transfer : 1 MTE 4

P. Pages : 3 | AU - 3362

Time : Three Hours | Max. Marks : 80

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Notes : 1. Answer **three** question from Section A and **three** question from Section B.
2. Due credit will be given to neatness and adequate dimensions.
3. Assume suitable data wherever necessary.
4. Diagrams and chemical equations should be given wherever necessary.
5. Illustrate your answer necessary with the help of neat sketches.
6. Use of slide rule logarithmic table, Steam tables, Mollier Chart, Drawing instrument, Thermodynamic table for moist air, Psychrometric Chart and Refrigeration charts is permitted.
7. Use of pen Blue/Black ink/refill only for writing the answer book.

SECTION - A

1. a) What are Heisler Charts? Explain their significance in solving transient conduction problems. **6**

b) A metallic sphere of radius 10 mm initially at a uniform temperature of 400°C. It is heated by first cooling if in air ($h = 10\,w/m^2k$) at 20°C until its central temperature reaches 335°C. It is then quenched in a water bath at 20°C with $h = 6000\,w/m^2k$ until the centre of the sphere cools from 335°C to 50°C. Compute the time required for cooling in air and water for the following physical properties of the sphere. **7**

$\rho = 3000\,kg/m^3$, $C_P = 1000\,J/kgk$

$k = 20\,w/mk$ & $\alpha = 6.6\times10^{-6}\,m^2/s$

2. a) Explain relaxation method in solving two dimensional heat conduction problem. **6**

b) A cube 0.3 m on each external side is constructed of the fire clay brick ($k = 1.04\,w/mk$) the wall thickness is 6 cm. The inner surface temperature is 600°C and the outer surface temperature is 60°C. Calculate heat flow in watts. **7**

3. a) Why are triangular fins preferred over rectangular fins? Deduce an expression for temperature distribution along the straight triangular fin. **6**

b) Alluminium fins ($k = 210\,w/mk$) of triangular profile are attached to a plane wall, whose surface is at 250°C. The fin base thickness is 2 mm and it is 6 mm long, the ambient air temperature is 20°C, with convection coefficient of $40\,w/m^2k$. **7**

i) What is fin efficiency and effectiveness.
ii) What is the heat dissipation per unit width by a single fin?

4. a) Solve the Laplace equation for two dimensional heat conduction by using separation of variables method. State the assumptions made. **6**

b) Liquid sodium is to be heated from 120°C to 149°C at a rate of 2.3 kg/s in a 2.5 cm diameter electrically heated tube (constant heat flux) Calculate the minimum length of the tube if the wall temperature is not to exceed 200°C. **7**

5. a) A 10 mm diameter spherical steel ball at 260°C is immersed in air at 90°C. Estimate the rate of convective heat loss. 7

b) How is the velocity and temperature field developed for natural flow of fluid over a vertical plate when its surface is maintained at temperature. 7

i) Higher ii) Lower than its surrounding.

SECTION - B

6. a) Calculate the shape factor of a cylindrical cavity, shown in fig. 6 (a), with respect to itself. 6

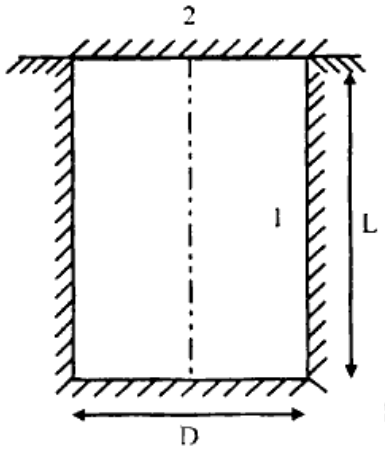

Fig. 6. (a)

b) A pipe carrying steam having an outside diameter of 20 cm runs in a large room and is exposed to air at a temperature of 30°C. The pipe surface temperature is 400°C. Calculate the loss of heat to surroundings per metre length of pipe due to thermal radiation the emissivity of pipe surface is 0.8. 7
What would be the loss of heat due to radiation if the pipe is enclosed in a 40 cm diameter brick conduit of emissivity 0.91 ?

7. a) Two large plates are at temperatures T_1 = 700k and T_2 = 500 k with emissivities $\varepsilon_1 = 0.7$ and $\varepsilon_2 = 0.5$ resp. A radiation shield with emissivity $t_3 = 0.05$ is placed between the plates calculate the reduction in heat transfer rate between the plates and final equilibrium temperature of the radiation shield. 6

b) The orientation of two surfaces is shown in fig. 7 (b). Calculate the view factors between the surfaces if they are 8.0 cm apart and their surfaces are 5 cm^2 and 8 cm^2 resp. 7

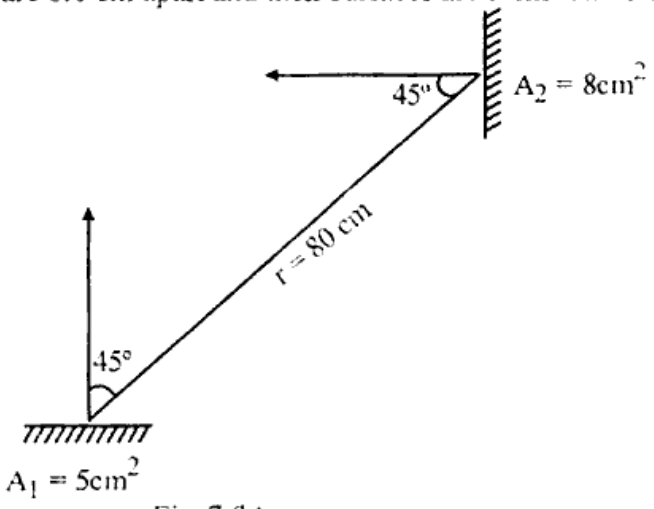

Fig. 7 (b)

8. a) Saturated steam condenses at 110°C on the outside of a bank of 64 horizontal tubes 25 mm outer diameter 1m long arranged in a 8 x 8 square array. Calculate the rate of condensation if the tube surface is maintained at 100°C. **6**

   b) Discuss briefly with neat sketch the various regimes in boiling heat transfer. How does radiation play an important role in boiling heat transfer. **7**

9. a) What is heat pipe ? Discuss its applications. How are they classified ? Explain with a neat sketch the working of a heat pipe ? **6**

   b) A vertical square plate 0.3 m by 0.3 m, is exposed to steam at atmospheric pressure. The plate temperature is 98°C. Calculate the heat transfer and mass of steam condensed per hour. Assume Laminar flow. **7**

10. a) The net radiation from the surface of two parallel plates maintained at temperatures T_1 and T_2 is to be reduced by 79 times. Calculate the number of screens to be placed between the two surfaces to achieve this reduction in heat exchange, assuming the emissivity of the screens as 0.05 and that of the surfaces as 0.8. **7**

   b) Explain how heat transfer by radiation from gases is different that from solids. **7**

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