Total No. of Questions :10]

SEAT No. : ____

P2547

[Total No. of Pages :3

[5153] - 512
T.E. (Mechanical)
HEAT TRANSFER
(2012 Course) (Semester - I) (302042) (End-Sem.)

Time : 2½ Hours] ***[Max. Marks :70***

Instructions to the candidates:

1) ***Solve Q.1 or Q.2, Q.3 or Q.4, Q.5 or Q.6, Q.7 or Q.8, Q.9 or Q.10.***
2) ***Draw neat diagrams wherever necessary.***
3) ***Use of scientific calculator is allowed.***
4) ***Assume suitable data, wherever necessary.***
5) ***Figures to the right indicate full marks.***

Q1) a) Explain: **[6]**

i) Mechanism of conduction.

ii) Overall heat transfer coefficient.

b) Explain physical significance of Biot number and Fourier number. **[4]**

OR

Q2) a) Write a note on temperature boundary condition and convection boundary condition. **[4]**

b) Consider a large 5 cm thick brass plate (K = 111 w/mK) in which heat is generated uniformly at the rate of 2×10^5 W/m^3. One side of plate is insulated while the other side is exposed to an environment at 25^{o}C with heat transfer coefficient of 44 W/m^{2}K. Determine the value of highest temperature in the plate. **[6]**

Q3) a) What is critical radius of insulation and economic thickness of insulation. **[4]**

b) A 5 cm diameter steel ball, initially at a uniform temp of 450^{o}C is suddenly placed in an environment at 100^{o}C with h = 10 W/m^{2}K. Steel properties: Cp = 460 J/KgK, density = 7800 kg/m^3, K = 35 W/mK. Calculate the time required for the ball to attain a temp of 150^{o}C. **[6]**

OR

P.T.O.

Q4) a) Explain electrical analogy of heat conduction. **[4]**

b) Draw temperature Vs length sketch for fin insulated at the tip, infinitely long fin and short fin. Write boundary conditions for these three types of fins. **[6]**

Q5) a) Explain physical significance of Grashoff number and Prandtl number. **[4]**

b) Explain the significance of thermal boundary layer and velocity boundary layer. **[4]**

c) 65 kg/min of water is heated from 30°C to 60°C by passing it through a rectangular duct of 3 cm × 2cm. The duct is heated by condensing the steam on its outer surface. Find the length of the duct required. **[8]**

Properties of Water: $\rho = 995$ kg/m^3; $\mu = 7.65 \times 10^{-4}$ kg/ms; $C_p = 4.174$kJ/kgK;

k = 0.623 W/mK; Conductivity of the Duct material = 35 W/mK

Use the following correlations:

$Nu = 0.023 Re^{0.8} Pr^{0.4}$ for turbulent flow

Nu=4.36 for laminar flow

OR

Q6) a) Define and explain the physical significance of Nusselt number and Reynold's number. **[6]**

b) Find the rate of heat loss from a cubical furnace kept on a concrete floor, if the outside surface temp of the furnace is 80°C and the surrounding air is at 20°C. Sides of furnace are 1m each. Neglect heat loss due to convection and radiation from the base. **[10]**

Use the following correlations:

$Nu = 0.13 (Gr.Pr)^{0.33}$ for vertical surface

$Nu = 0.14 (Gr.Pr)^{0.33}$ for horizontal surface

Take properties of air at 50°C as follows:

Cp=1005J/kgK; k=0.0283 W/mK

$\nu = 17.95 \times 10^{-6}$ m^2/s, Pr=0.698

Q7) a) What is shape factor? Explain its reciprocity theorem, summation theorem and enclosure theorem. **[8]**

b) Find out heat transfer rate due to radiation between two infinitely long parallel planes. One plane has emissivity of 0.4 and is maintained at 200°C. Other plane has emissivity of 0.2 and maintained at 30°C. If a radiation shield (ε=0.5) is introduced between the two planes, find percentage reduction in heat transfer rate and steady state temp of the shield. **[8]**

OR

Q8) a) Write a note on: **[8]**

i) Surface resistance and space resistance.

ii) Radiation shield.

iii) Lambert's cosine rule.

iv) Kirchoff's law.

b) A gray opaque surface has an absorptivity = 0.8. It is maintained at 100°C. It receives an irradiation of 1,000 W/m^2. Its surface area is 0.1 m^2. Calculate, **[8]**

i) Radiosity of the surface,

ii) Net radiative heat transfer rate from the surface.

Recalculate the above quantities, if the surface is black.

Q9) a) Explain different regimes in pool boiling curve with neat sketch. **[8]**

b) A counter flow tube in tube heat exchanger is used to heat water from 20°C to 80°C at a rate of 1.2 kg/s using geothermal water available at 160°C. The mass flow rate of geothermal water is 2 kg/s. The inner tube is thin walled and has a diameter of 1.5 cm. If overall heat transfer coefficient of heat exchanger is 640 W/m^{2}K, determine length of the heat exchanger required to achieve desired heating. **[8]**

c) Explain effectiveness of a heat exchanger. **[2]**

OR

Q10)a) Draw and explain labeled temperature profiles for Condenser and Evaporator. **[4]**

b) Explain drop wise condensation and film condensation. **[6]**

c) Derive the expression for effectiveness of parallel flow heat exchanger. **[8]**

EEE