Total No. of Questions :10]

SEAT No. :

**P2547**

[Total No. of Pages :3

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# 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 $2\times10^5$ 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 ( $\varepsilon$=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*