Total No. of Questions : 10]

SEAT No. :

P3249

[Total No. of Pages : 4

[5353] - 112
T.E. (Mechanical)
HEAT TRANSFER
(End Semester)
(2012 Pattern)

Time :2½ Hours] *[Max. Marks :70*

Instructions to the candidates:

1) ***Solve Q.1 or Q.2. Q.3 or Q.4, Q5. 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 where ever necessary.***
3) ***Figures to the right indicate full marks.***

Q1) a) A chemical reactor vessel of spherical shape of outside redius of 0.5 m has to loose heat at the rate of 650w in order to maintain the temperature of the chemical. The surface temperature of vessel is 125°C. The surrounding is at 113°C. If the heat loss is by both convection and radiation, determine the value of convective heat transfer coefficient required. Assume $\varepsilon = 0.55$ **[6]**

b) Derive an expression for critical radius of insulation for cylinder. **[4]**

OR

Q2) a) Write 3D Heat conduction equation in cartesian co-ordinates and reduce it to fouriers equation, poissons equation and laplace equation. **[6]**

b) What is an insulating material? Give four examples of insulating materials **[4]**

Q3) a) Consider a solid sphere of radius 2cm, in which internal energy is generated uniformly at constant rate of 2×10^8 w/m^3 conductivity of cylinder material is 30 w/mk and its outer surface is maintained at 100°C. Calculate centre temperature and heat flux at the surface of the sphere. Derive the expressions you use. **[6]**

b) Write a note on temperature boundary condition and heat flux boundary condition. **[4]**

P.T.O.

OR

Q4) a) A cylindrical fin is 3mm in diameter and 3cm long. Calculate the value of the temperature at fin tip if the fin is made of. **[6]**

i) Copper (k = 350 w/mk) and

ii) Teflon (k = 0.35 w/mk)

Assume the heat loss from fin tip is negligible.

Take h = 10 w/m^2k, Tbase = 120°C.

Surrounding fluid temperature is 20°C

b) Steel balls of 12mm diameter are annealed by heating to 877°C and then slowly cooling to 127°C in an environment where temperature is 52°C. The heat transfer coefficient is $20 w/m^2k$. Calculate the time required by the balls to reach the desired temperature. Use following properties, for steel. Density = 7800 kg/m^3, Cp = 600 J/kg k, K = 40 w/mk **[4]**

Q5) a) Explain the following with their applicability. **[8]**

i) Nusselt number

ii) Grashoff's Number

iii) Rayleigh number

iv) Prandtl number

b) Liquid mercury flows at a rate of 1.6 kg/sec through a copper tube of 20mm diameter. The mercury enters the tube at 15°C and leaves at 35°C. Calculate the tube length if the tube wall temperature is 50°C. The properties of mercury at 25°C are. **[8]**

$\rho = 13582\ kg/m^3$. $C_\beta = 140$ J/kg k, k = 8.69 w/mk, $\nu = 1.5\times10^{-7} m^2/s$

Pr = 0.0248

Use $Nu = 7 + 0.025\ (Re\ Pr)^{0.8}$

OR

Q6) a) A rectangular plate of length 7 cm and width 4cm is maintained at 115°C. It is exposed to still air at 25°C on both sides. Calculate convective heat transfer rate if smaller side of the plate is held vertical compare heat transfer when larger side is held vertical. **[8]**

Use correlation $Nu = 0.59\ (Gr.\ Pr)^{0.25}$

For air, at 70°C , k = 0.03 w/mk , Pr = 0.697;

Kinematic viscosity $\nu = 2.076 \times 10^{-6}\ m^2/s$

b) Explain the concept of thermal boundary layer. **[4]**

c) Show with neat sketch direction of natural convection Fluid flow (Development of thermal boundary layer) when **[4]**

i) Plate is kept vertical and surrounding fluid temperature is higher than plate.

ii) Cylinder is kept vertical and surrounding fluid temperature is lower than cylinder.

Q7) a) Two large parallel planes 'A' and 'D' are maintained at temperature of 1500k and 600k respectively $\varepsilon_A = 0.9$ & $\varepsilon_D = 0.4$ Two radiation shields 'B' with emissivity = 0.5 and 'C' with emissivity = 0.2 are inserted in between them such that A,B, C and D are placed one after the other. Calculate. **[10]**

i) Heat transfer rate without radiation shields

ii) Heat transfer rate with radiation shields.

iii) Temperature attained by planes 'B' and 'C'

b) State and explain any 4 properties/ rules of radiation shape factor. **[6]**

OR

Q8) a) If the shape factor between two adjacent sides of rectangular room is 0.22, find the shape factor between opposite faces. **[4]**

b) Define radiosity and irradiation. **[4]**

c) i) Differentiate between filmwise and dropwise condensation. **[8]**

ii) Design criteria for Heat exchanger

Q9) a) Derive the expression for effectiveness of parallel flow heat exchanger by using NTU method using standard notations. **[9]**

b) A counter flow shell and tube type heat exchanger is used to heat water at a rate of 0.8 kg/sec from 30°C to 80°C with hot oil entering at 120°C and leaving at 85°C. Calculate the size of heat exchanger required. Overall heat transfer coefficient is 125 w/m^2°C. Take specific heat for water as 4180 J/kg °C. **[9]**

OR

Q10) a) Hot air at 66°C is cooled up to 38°C by means of cold air entering at 15.5°C. Mass flow rates of hot and cold air are 1.25 kg/s and 1.6kg/s respectively sp. heat of hot and cold air = 1.05kJ/kg k U = 80 w/m^2k. Find the area of the heat exchanger for parallel flow configuration.

If the same exchanger is operated in counter flow mode, find the exit temperatures of both the fluids. **[12]**

b) Explain 'Film boiling 'Phenomenon in pool boiling process and show this region on the pool boiling curve. **[6]**