Total No. of Questions : 10]

SEAT No. :

P2400

[Total No. of Pages : 4

[5253]-112

T.E. Mechanical

HEAT TRANSFER

(2012 Pattern) (End Semester)

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) Derive an expression for critical radius of insulation of cylinder. **[6]**

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

OR

Q2) a) Explain Thermal Resistance and Thermal Conductance. **[4]**

b) A 1 meter long nichrome wire dissipates 10 kW neat to surrounding fluid at 80ºC. Find the diameter of wire if the maximum permissible operating temperature is 1000ºC. Take k = 60W/mK and h = 1000W/m^2K. **[4]**

c) Write three dimensional heat conduction equation in cylinderical coordinates. **[2]**

Q3) a) Write a note on heat flux boundary condition and radiation boundary condition. **[4]**

b) Derive an expression for fin efficiency of fin with insulated tip. **[6]**

OR

P.T.O.

Q4) a) A thermo couple junction of spherical form is to be used to measure the temperature of a gas stream. The junction is initially at 20ºC and is placed in gas stream which is at 200ºC. Determine the junction diameter needed for the thermo couple to have time constant of 1 second. Also calculate the time required for the thermo couple to reach temperature of 197ºC.

Assume thermophysical properties as : k = 20W/mK, h = 350 W/m^2K, c = 400 J/kgK, ρ= 8000 kg/m^3. **[6]**

b) Hot water is to be cooled as it flows through the tubes exposed to atmospheric air. Fins are to be attached in order to enhance heat transfer. Would you recommend attaching the fins inside or outside the tubes? Why? **[4]**

Q5) a) Explain physical significance of Nusselt number and Grashoft number. **[4]**

b) Explain Thermal Boundary Layer and Velocity Boundary Layer. **[4]**

c) CPU of a PC has dimensions of 10cm × 50cm × 40cm (height). Surface temperature of CPU is 39ºC and is kept in still air at 15ºC. Neglecting heat transfer from bottom surface, find rate of heat transfer from (i) all four vertical surfaces and (ii) top surface properties of air at 300k:

ρ= 1.1614 kg/m^3,

Cp = 1.007 kJ/kgK

$\nu = 15.89 \times 10^{-6}$ m^2/s

K = 0.0263 W/mK

Pr = 0.707

Use following correlations : **[8]**

$N_u = 0.59\ Ra^{1/4}$ $\quad 10^4 < Ra < 2\times10^9$

$= 0.1\ Ra^{1/3}$ $\quad 10^9 < Ra < 10^{13}$ } For vertical

$N_u = 0.54\ Ra^{1/4}$ $\quad 10^5 < Ra < 2\times10^7$

$= 0.14\ Ra^{1/3}$ $\quad 2\times10^7 < Ra < 2\times10^{10}$ } For horizontal

OR

Q6) a) Define and give significance of any two dimensionless numbers used in forced convection. **[6]**

b) Sketch development of velocity boundary layer for laminar flow in a tube. Label the sketch. **[4]**

c) Water is heated while flowing through a rectangular duct 20cm × 4cm at a velocity of 2 m/s. Temperature of water at inlet is 30ºC. Duct walls are maintained at 110ºC. Find length of duct required for raising water temperature by 45ºC.

Use following properties & correlation. **[6]**

$\rho = 986$ kg/m^3

$\nu = 0.518 \times 10^{-6}$ m^2/s

k = 0.655 w/mK

$N_u = 0.023\ R_e^{0.8}\ Pr^{0.4}$

Cp = 4180 J/kgK

Pr = 3.28

Q7) a) Write the statements and mathematical expressions for the following laws in radiation heat transfer : **[6]**

i) Planck's law

ii) Wien's law

iii) Kirchoff's law

b) Write a note on 'Radiation Shields'. **[4]**

c) A black body emits radiation at 2000K. Calculate : **[6]**

i) the monochromatic emissive power at 1μm wavelength

ii) wavelength at which emission is maximum, and

iii) the maximum emissive power

OR

Q8) a) What is shape factor? Explain its reciprocity theorem, summation theorem. **[6]**

b) Find out heat transfer due to radiation between two infinitely long parallel planes. One plane has emissivity of 0.4 and is maintained at 200ºC. Other plane has emissivity of 0.2 and is maintained at 30ºC. If a radiation shield $(\varepsilon = 0.5)$ is introduced between the two planes, find percentage reduction in heat transfer rate and steady state temperature of shield. **[6]**

c) What is gravy body? How does it differ from black body? **[4]**

Q9) a) Explain different regimes in a pool boiling curve with a neat sketch. **[6]**

b) Derive an expression for LMTD of counter flow heat exchanger. **[6]**

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

OR

Q10)a) Derive an expression for effectiveness of parallel flow heat exchanger. **[8]**

b) Write a note on heat pipe. **[4]**

c) Hot oil is used to keep water flowing at the rate of 0.1 kg/sec from 40ºC to 80ºC in a counter flow double pipe heat exchanger. For an overall heat transfer coefficient of 300w/m^2K, find heat transfer area if temperature of oil decreases from 105ºC to 70ºC. **[6]**