B.E.(with Credits)-Regular-Semester 2012-Mechanical Engineering Sem V

ME505 - Heat Transfer

P. Pages : 3 **GUG/W/16/3795**

Time : Three Hours * 3 9 8 5 * Max. Marks : 80

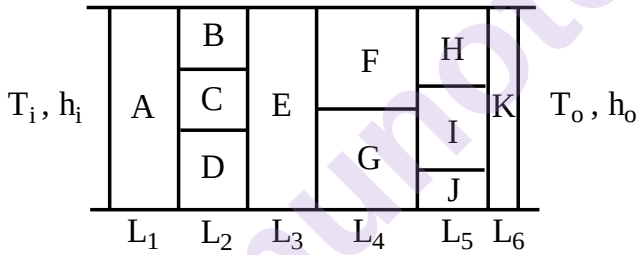
Notes :
1. All questions carry equal marks.
2. Answer Q. 1 or 2; 3 or 4; 5 or 6; 7 or 8 & 9 or 10.
3. Assume suitable data wherever necessary.
4. Illustrate your answers wherever necessary with the help of neat sketches.
5. Use of Heat Transfer Data Handbook is permitted.
6. Use only non programmable calculator.
7. Mobiles are strictly prohibited.

1. a) Derive a Temperature distribution and heat flow equation for a hollow sphere without internal heat generation. **8**

b) For critical Radius of Insulation show that heat flow is maximum through composite structure when $r_c = \frac{K}{h}$. **8**

OR

2. a) A composite wall as shown below. **13**



Consists of 6 layers.
The conductivities of different layer are
$K_A = 0.02$, $K_B = 0.2$; $K_C = 0.4$, $K_D = 0.8$; $K_E = 1.5$; $K_F = 0.5$;
$K_G = 2$; $K_H = 0.04$; $K_I = 0.06$; $K_J = 0.08$; $K_K = 5$ w/mk.
$L_1 = 20$ cm; $L_2 = 16$ cm; $L_3 = 12$ cm; $L_4 = 30$ cm; $L_5 = 10$ cm; $L_6 = 05$ cm.
$T_i = 600^oC$; $T_o = 30^oC$;
$h_i = 400$ w/m^{2}k ; $h_o = 25$ w/m^{2}k.
The cross sectional Area of wall Ac = 1m x 1m.
The height of wall
B=20 cm; C=30 cm; D=50 cm, F=50 cm, G=50 cm; H=40 cm, I=50 cm; J=10 cm.

i) Draw thermal circuit diagram.

ii) Find Individual Resistance.

iii) Find Total Resistance of structure.

iv) Find Heat flow rate through composite structure.

v) Find overall heat transfer coefficient value.

b) 'Thermal contact Resistance' Explain briefly. **3**

3. a) Derive a temperature distribution and heat flow equation for a straight fin with end surface insulated. **8**

b) The cylindrical head of an engine is 1 meter long and has an outside diameter of 50mm. Under typical operating conditions the outer surface of the head is at a temp. of 150ºC and is expose to ambient air at 30ºC with a convective coefficient of 80 w/m^2k. The head has been provided with 12 longitudinal fins which are 1.5mm thick and protrude 5cm from the cylinder surface. Calculate the increase in heat dissipation rate due to addition of fins. Also calculate the temperature of fin at x = 2.5 cm. Take K_{fin} = 260 w/mk. **8**

OR

4. a) A cylindrical ingot 100mm radius and 250 mm height initially at 800ºC is immersed in water at 25ºC with convective heat transfer coefficient of 25 w/m^2k; the ingot is immersed till it come to temp of 400ºC.
Then ingot is expose to atmospheric air at 25ºC with convective coefficient of 2.5 w/m^2k till it attain a temp. of 80ºC.
If the ingot material has conductivity of 50 w/mk; specific heat C_P = 250 J/kgk and density = 800 kg/m^3.
Calculate the total time required for the ingot to cool it from 800ºC to 80ºC. **10**

b) Derive a temperature distribution and heat flow equation for a solid cylinder with internal heat generation. **6**

5. a) A square cross section (60cm x 60cm) horizontal duct surface is maintained at 10ºC by passing cold air through it. Calculate the amount of heat carried by cold air if duct outer surface is expose to atmospheric air at 28ºC.
Take length of duct = 3m.
Consider steady state heat transfer. **9**

b) Distinguish between Dropwise and Filmwise condensation. **4**

c) Define : **3**
i) Grashoff Number.
ii) Reynold Number.
iii) Prandtle Number.

OR

6. a) In a certain process castor oil at 30ºC flows over a flat plate at 8 cm/s velocity. The length of plate is 3m. The plate is heated uniformly and maintained at 90ºC. **8**
Calculate

i) Velocity and Thermal boundary layer thickness at x = 0.5m.

ii) Total drag force per unit width of plate.

The properties of oil are.
ρ = 956.8 kg/m3 K = 0.213 w/m k.
α = 7.2 x 10^{-8} m^2/s ν = 6.5 x 10^{-5} m^2/s.

b) 121 Tubes are arranged in square array and expose to saturated steam at 100ºC. **8**
Calculate the mass of steam condensed per meter length of tube if tube surface is maintained at 25ºC.
Take $h_{fg} = 2255\ kg/kg$
$d_o = 2.5 cm.$

7. a) Consider a thin hollow cylinder of 10cm diameter and 20cm long. If the radiant shape factor of circular surface of this cylinder is 0.18, make calculation for the shape factor of the curved surface of the cylinder with respect to itself. **8**

b) Discuss briefly the planks law of radiation and its observations related to monochromatic emissive power with respect to temperature of body; wavelength and maximum value of emissive power. **5**

c) Discuss effects of radiation on temperature measurement. **3**

OR

8. a) Thermic oil is cooled in a counter flow heat exchanger from 120ºC to 40ºC by the use of water which enter at 22ºC. The mass flow of oil is 1.2 kg/sec and C_P = 2.4 kJ/kg k. The overall heat transfer coefficient is estimated to be 1100 w/m^2k. Presume that the exit temperature of water is not to exceed 75ºC. **13**
Calculate

i) Mass flow rate of water required.

ii) Using NTU method find surface Area of heat exchanger required and

iii) Effectiveness of heat exchanger.

iv) If mass flow of oil is reduced to 0.6 kg/s. Find the change in exit temperature of oil and water (Tho and Tco); remaining things are same.

b) Discuss briefly about compact heat exchanger. **3**

9. a) Discuss briefly Kirchoff's law of radiation. **6**

b) Explain briefly 'Shape Factor' and Reciprocity equation. **5**

c) Discuss briefly 'Radiation shield' also discuss about its advantages. **5**

OR

10. a) Derive LMTD equation for a parallel flow type heat exchanger? Also discuss about the assumptions made. **9**

b) Develop the overall heat transfer coefficient equation for a double pipe (Concentric Tube) type heat exchanger. **7**

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