Total No. of Questions :6]

SEAT No. :

P43

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Oct./ TE/ Insem. - 157

T.E. (Mechanical / Mechanical Sandwich / Automobile)

HEAT TRANSFER

(2015 Pattern) (Semester - I) (302042)

Time : 1 Hour] *[Max. Marks :30*

Instructions to the candidates:

1) ***Answer Q1 or Q2, Q3 or Q4, and Q5 or Q6.***
2) ***Assume suitable data, if necessary.***
3) ***Draw neat diagram, whenever necessary.***
4) ***Figure to the right indicate full marks.***
5) ***Use of scientific calculator is allowed.***

Q1) a) Explain the concept of critical radius of insulation over electrical cables with suitable diagram. **[4]**

b) A long cylindrical rod of radius 12 cm, consists of nuclear reacting material (k =2 W/m.K) generating 30 kW/m^3 uniformly throughout its volume. The rod is encapsulated within another cylinder (k =5 W/m.K) whose outer radius is 24 cm and surface is surrounded by air at 30°C with heat transfer coefficient of 20 W/m^2.K. Find the temperature at the interface between the two cylinders and at the outer surface. **[6]**

OR

Q2) a) A3 m ID spherical tank made of 2 cm thick stainless steel (k =15 Wm.K) is used to store iced water at 0°C. The tank is located in a large room maintained at 22°C. The outer surface of the tank is black and heat is convected and radiated on the outer surface of the tank. The convection heat transfer coefficient at inner and outer surfaces of the tank is 80 W/m^2.K and 10 W/m^2.K, respectively. The radiation heat transfer coefficient is 5.34W/m^2.K. Determine (i) rate of heat transfer to iced water, (ii) amount of ice melts during a 24 hours period. The latent heat of fusion for ice at atmospheric pressure is 333.7 kj/kg. **[8]**

b) Define thermal conductivity and thermal diffusivity. **[2]**

P.T.O.

Q3) a) Define fin effectiveness. Explain the situation, when addition of fins to a surface is not useful. **[4]**

b) A straight rectangular fin (k =55 W/m.K), 1.4 mm thick and 35mm long is exposed to air at 20°C with h=50W/m^2.K, when its base temperature is 150°C. Assume insulated fin tip. **[6]**

(i) Calculate the maximum possible heat loss rate.

(ii) What is actual heat loss for this base temperature?

OR

Q4) a) State all possible boundary conditions on fin's free end. List out any two Engineering application of Fins. **[4]**

b) A stainless steel rod 20mm diameter is carrying an electric current of 1000 Amp. The thermal and electrical conductivities are 20W/m.K and 1.25×10^4 $(\Omega\ cm)^{-1}$. What is the temperature at the centre of the rod, if its surface temperature should not exceed 400°C? **[6]**

Q5) a) Define Biot and Fourier numbers with their physical significance? **[4]**

b) What is principal assumption in the lumped system analysis and when is it applicable? **[2]**

c) Stainless steel ball bearings [ρ=8085 kg/m^3, k=15.1W/m.K, C=480 J/kg.K], 1.2 cm in diameter are taken from an oven at a uniform temperature of 900°C and are exposed to air at 30°C with h=125 W/m^2.K, for a short period and then they are dropped into water for quenching. If the temperature of balls does not fall below 850°C prior to quenching, calculate, how long they stand in air before being dropped into water? **[4]**

OR

Q6) a) Explain the selection criteria of insulating materials. **[2]**

b) A Steel pipe, 30 cm in outer diameter, carries steam and its surface temperature is 250°C. It is exposed to ambient air at 30°C. The heat is lost by convection only with the convective heat transfer coefficient is 39.1 W/m^2.K. Calculate the heat loss from 1 m length of pipe.

If a layer of insulation (k=0.36 W/m.K), 75 mm thick is applied on the pipe in order to minimise the heat loss. The cost of heat is ₹200 per 10^9J. The cost of insulation is ₹8000 per m length. The unit is in operation for 2000 h/year. The cost of capital should be recovered in two years.Check the economical merits of insulation. Neglect radiation heat transfer before and after addition of insulation. **[8]**

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