Code: 9D17102

M.Tech I Semester Supplementary Examinations August 2016

CONDUCTION & RADIATION HEAT TRANSFER

(Refrigeration & Air Conditioning)

(For students admitted in 2012, 2013, 2014 & 2015 only)

Time: 3 hours Max. Marks: 60

Answer any FIVE questions

All questions carry equal marks

Use of heat transfer data hand book is permitted in the examination hall

Note: any missing data can be suitably assumed with proper justification

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1 A furnace wall slab is constructed with 100 mm fire clay inside and 475 mm red brick outside. The temperatures inside and outside the furnace wall are 1150^0C and 35℃ respectively. The thermal conductivity of the red brick is 0.82 W/m.K and that of the fire clay is 0.33(1+0.001T) W/m K where T is the temperature of the clay in ^{0}C. Assuming unit surface area, find the conductive heat loss through the furnace wall and the temperature at the interface of the fire clay and red brick.

2 The temperature distribution across a wall 1.1 m thick at a certain instant of time is give as $T(x)=a+bx+cx^2$ where T is in degrees Celsius and x is in meters, while a $=970^0$C, b = -320^0C/m and c = -40^0C/m^2. A uniform heat generation of 2200 W/m^2 is present in the wall of area 25 m^2 having the properties ρ = 1700 kg/m^3, K = 60 W/mK and Cp = 4.5 kJ/kgK. Determine the rate of heat transfer entering the wall (x=0) and leaving the wall(x=1.1 m). Determine the rate of change of energy storage in the wall. Determine the time rate of temperature change at x = 0, 0.25 and 0.5m.

3 A solid iron rod of diameter 10 cm, initially at temperature of 1000^0C is suddenly exposed to oil bath at 50^0C with a surface heat transfer coefficient of 500 W/(m^{2}C), determine the centre line temperature of the rod 10 min. after exposure to oil and time taken to reach 200^0C of centre line temperature and heat loss for one meter length of rod during this time. Assume k = 60 W/m^{0}C; α = 2.0X10^{-5} m^2/s, C=460 J/kg^{0}K and ρ = 7850 kg/m^3.

4 A hot surface at 100^0C is to be cooled by attaching 3-cm-long, 0.25-cm-diameter aluminum pin fins (k = 237 W/m$^{.0}$C) with a center-to-center distance of 0.6 cm. The temperature of the surrounding medium is 30^0C and the combined heat transfer coefficient on the surfaces is 35 W/m$^{2\ .0}$C. Assuming steady one-dimensional heat transfer along the fin and taking the nodal spacing to be 0.5 cm, determine: (i) The finite difference formulation of this problem. (ii) The nodal temperatures along the fin by solving these equations. (iii) The rate of heat transfer from a single fin. (iv) The rate of heat transfer from a 1m X 1m section of the plate.

5 A 20 cm long cylindrical aluminum block (ρ=2700 kg/m^3, Cρ=0.896 kJ/kg.^{0}C, K = 236 W/m.^{0}C and α = 9.75 x 10^{-5} m^2/s), 15 cm in diameter is initially at a uniform temperature of 20^0C. The block is to be heated in a furnace at 1200^0C until its center temperature rises to 300^0C. If the heat transfer coefficient on all surfaces of the block is 80 W/m$^{2\ .0}$C, determine how long the block should be kept in the furnace. Also, determine the amount of heat transfer from the aluminum block if it is allowed to cool in the room until its temperature drops to 20^0C throughout. What will happen if the aluminum block is inserted into the furnace on a low-conductivity material so that the heat transfers to or from the bottom surface of the block is negligible?

6 Consider a small black surface of area 2.2 cm^2 maintained at 620 K. Determine the rate at which radiation energy is emitted by the surface through a ring-shaped opening defined by $0 \le \phi \le 2\pi$ and $40 \le \theta \le 50^0$ where ϕ is the azimuth angle and θ is the angle a radiation beam makes with the normal of the surface.

7 A thermocouple shielded by aluminum foil of emissivity 0.15 is used to measure the temperature of hot gases flowing in a duct whose walls are maintained at 400 K. The thermometer shows a temperature reading of 550 K. Assuming the emissivity of the thermocouple junction to be e 0.72 and the convection heat transfer coefficient to be 120 W/m^{2}K, determine the actual temperature of the gas. What would the thermometer reading be if no radiation shield was used?

8 Consider a cylindrical cavity of diameter 110 mm and depth 55 mm whose sidewall and bottom are diffuse and gray with an emissivity of 0.62 and are at a uniform temperature of 1600 K. The top of the cavity is open and exposed to surroundings that are large and at 305 K. Calculate the net radiation heat transfer from the cavity, treating the bottom and sidewall of the cavity as one surface. Calculate the net radiation heat transfer from the cavity, treating the bottom and sidewall of the cavity as two separate surfaces. Plot the percentage difference between above heat transfer as a function of depth over the range 5 mm to 100 mm.

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