M.Tech I Semester Supplementary Examinations August/September 2018

CONDUCTION & RADIATION HEAT TRANSFER

(Refrigeration & Air Conditioning)

(For students admitted in 2013, 2014, 2015 & 2016 only)

Time: 3 hours Max. Marks: 60

Answer any FIVE questions

All questions carry equal marks

Note: Standard heat & mass transfer data book and steam tables are permitted.

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1 (a) Differentiate between steady and transient heat conduction.

(b) Calculate the rate of heat loss for a red brick wall of length 5 m, height 4 m and thickness 0.25 m. The temperature of the inner surface is 110°C and that of the outer surface is 40°C. The thermal conductivity of the red brick, k = 0.70 W/mK. Calculate also the temperature at an interior point of the wall at a distance of 20 cm from the inner wall.

2 (a) Drive an expression for heat transfer through a plane and composite walls.

(b) A 40 x 40 cm copper slab 5 mm thick at a uniform temperature of 250°C suddenly has its surface temperature lowered at 30°C. Find the time at which the slab temperature becomes 90°C. Take $\rho = 9000\ \text{kg/m}^3$, $C = 0.38\ \text{kJ/kg K}$, $K = 370\ \text{W/mK}$ and $h = 90\ \text{W/m}^2\ \text{K}$.

3 (a) What is meant by lumped heat analysis?

(b) Aluminum sphere weighing 5.5 kg and initially at a temperature of 290°C is suddenly immersed in a fluid at 15°C. The convective heat transfer coefficient is 58 W/m^{2}K. Estimate the time required to cool the aluminum to 95°C, using lumped capacity method of analysis.

4 (a) What is Heisler chart?

(b) A surface wall consists of 23 cm of fire brick and 11.5 cm of insulating brick having thermal conductivities of 0.72 W/mK and 0.27 W/mK respectively. Calculate the rate of heat lost per square meter when the temperature difference between inner and outer surface is 650 K.

5 (a) What are Biot and Fourier numbers? Explain their physical significance.

(b) The inner surface temperature of an annealing oven varies according to a sine function from 800°C to 200°C. Each complete cycle requires 12 hours, compute;

(i) Time lag of the temperature wave at a depth of 10 cm from the inner surface.

(ii) The heat flow through a surface located at a distance of 10 cm from the surface during the first six hours interval while the temperature is above the mean value. Assume $\alpha = 0.02\ \text{m}^2/\text{h}$; $K = 1.8\ \text{W/mK}$.

6 (a) Derive the expression for radiation exchange between small gray bodies.

(b) Emissivities of two large parallel planes maintained at 800°C and 300°C are 0.3 and 0.5 respectively. Find the net radiant heat exchange per square meter for these plates.

7 (a) Distinguish between the black body and grey body.

(b) Two parallel plates of size 0.5 m x 1 m are placed parallel to each other at a distance of 0.5 m. One plate is maintained at a temperature of 1000°C and other at 500°C and the emissivities are 0.2 and 0.5 respectively. The plates are located in a large room whose walls are at 27°C. If the plates exchange heat with each other and with the room, but only plate surface facing each other are to be consider in the analysis. Calculate: (i) Heat lost by the plates. (ii) Heat gain by the room.

8 (a) Determine the radiation heat transfer per unit length between two long concentric cylinders of radius 0.5 m and 0.6 m with emissivity values of 0.6 and 0.4 respectively. The inner cylinder is at 600°C while the outer is at 300°C.

(b) Derive the radiation heat transfer coefficient.