Registration no: | | | | | | | | | |

Total Number of Pages: 03 **M.TECH**

HTPC102

1^{st} Semester Regular / Back Examination – 2016-17

ADVANCED HEAT TRANSFER-I

BRANCH : THERMAL ENGINEERING

Time: 3 Hours

Max Marks: 70

Q.CODE:Y851

Answer Question No.1 which is compulsory and any five from the rest.

The figures in the right hand margin indicate marks.

Q1 Answer the following questions: (2x10)

a) Write the driving force for electricity, fluid, and heat flow and discuss the similarity among them.

b) The two sides of a wall (2 mm thick, with a cross-sectional area of 0.2 m^2) are maintained at 30°C and 90°C. The thermal conductivity of the wall material is 1.28 W/(m·°C). Find out the rate of heat transfer through the wall?

c) What is the significance of Biot number and Fourier Number in heat transfer?

d) Write down the general heat conduction equation in cylindrical co-ordinate system.

e) What is range of electromagnetic wavelength, where thermal radiation effect is encountered?

f) Explain Duhamel’s principle and its application in heat transfer.

g) Define Fin efficiency and effectiveness.

h) Define Stefan-Boltzman law and write down the value of Stefan-Boltzman constant.

i) What do you mean by Radiosity and Irradiation.

j) Calculate the shape factor of a hemispherical body placed on a flat surface with respect to itself.

Q2 a) Derive an expression for the temperature distribution in a sphere of radius R with uniform heat generation and constant surface temperature. (5)

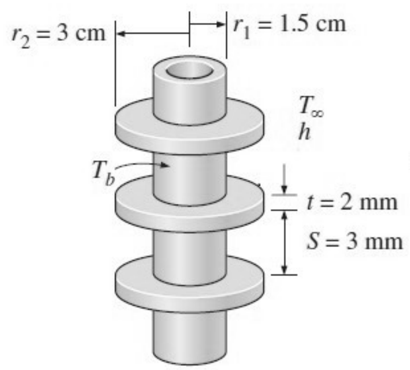
b) A hollow cylinder $r_1 \le r \le r_2$ has its boundary surfaces at r_1 and r_2 maintained at uniform surfaces T_1 and T_2 ($T_1 > T_2$) respectively. The thermal conductivity of cylinder material varies linearly with temperature from k_1 at T_1 to k_2 at T_2. Show that the heat flow rate is given by: (5)

$$q = \frac{\frac{(k1+k2)}{2}(T1-T2)}{\ln(\frac{r1}{r2})}$$

Q3 a) A glass of diameter 50 mm contains some hot milk. The height of the milk in the glass is 100 mm. To cool the milk, the glass is placed into a large pan filled with cold water at 25°C. The initial temperature of milk is 80°C. The milk is stirred slowly and continuously so that its temperature remains uniform all the time. Find time taken for the milk to cool from 80°C to 30°C. (5)

b) Find also the total amount of energy transferred from milk to water during the cooling process (5)

Q4 Steam in a heating system flows through tubes whose outer diameter is 3 cm and whose walls are maintained at a temperature of 120°C. Circular alumium fins (k= 180W/m. °C) of outer diameter 6 cm and constant thickness t= 2 mm are attached to the tube as shown in the figure. The spacing between the fins is 3 mm and there are 200 fins per meter length of the tube. Heat is transferred to the surrounding air at 25 °C with a combined heat transfer coefficient of h= 60 W/m^2. Determine the increase in heat transfer from the tube per meter of its length as a result of adding fins. Use fin efficiency as 0.95. (10)



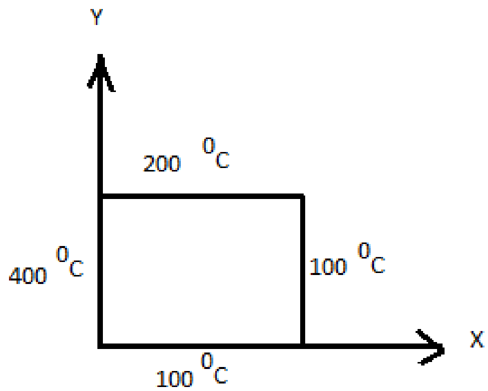
Q5 a) For two concentric spheres, outer surface of inner sphere is designated as 1 while the inner surface of the outer sphere is designated as 2. Determine all the view factors associated with the enclosure. (5)

b) Two blackbody rectangles 1.5 m by 3.0 m are placed parallel one above the other and are 3 m apart. The bottom surface (surface 1) is at 127 ^{0}C and the top surface (surface 2) is at 327 ^{0}C. Determine (i) the rate of heat transfer $Q_{1\text{-}2}$ (ii) the net rate of energy loss from surface 1 (side facing surface 2 only) if the surrounding other than the two surfaces behaves as a blackbody at 300 K. Given F_{12}=0.11 (5)

Q6 a) What do you mean by participating media and non-participating media? Give examples. Derive the governing equation for the spatial variation of radiation intensity in a participating media. (5)

b) Consider a 20 cm diameter spherical ball at 800 K suspended in air. Assuming the ball closely approximates a blackbody, determine the (i) the total blackbody emissive power (ii) the total amount of radiation emitted by the ball in 5 min and (iii) spectral blackbody emissive power at a wavelength of 3 μm. (5)

Q7 The boundary temperatures of a thin plate (1m x 1m) are shown in the figure. Determine the temperature at the centre of the plate. (10)



Q8 Write short notes on any two: (5 x 2)

a) Critical thickness of insulation
b) Lumped system analysis
c) Solar radiation