Problem Set # 10

Given: Mon., Nov. 19 **Recommended Completion Date:** Wed., Nov. 28
Do not submit for grading

Problem 1: Assume that the sun is a black body at 5800 K. Calculate: a) The total emissive power; b) The maximum monochromatic emissive power; c) The wavelength at which the maximum monochromatic emissive power occurs; d) The percentage of total emitted radiation that lies in the visible wavelength range 0.4 μm to 0.7 μm.

Ans.: a) 6.415×10^{7} W/m^2; b) 8.4435×10^{13} W/m^3; c) 0.4996 μm; d) 36.49%

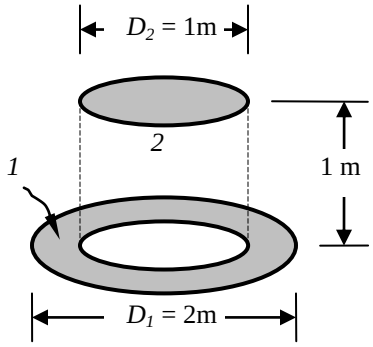
Problem 2: A surface maintained at a constant temperature of 3000 K has the following monochromatic emissivity:

$$\varepsilon_\lambda = \begin{cases} 0 & \lambda < 0.4\mu \\ 0.6 & 0.4\mu \le \lambda \le 4\mu \\ 0 & \lambda > 4\mu \end{cases}$$

Calculate:
a) The total emissivity of the surface;
b) The surface total absorptivity for irradiation from a black surface at 1000 K

Ans.: a) 0.5657; b) 0.2885

Problem 3: Find the shape factor F_{1-2} for the geometry shown below:



Ans.: $F_{1-2} = 0.1167$

Problem 4: A thermocouple is installed in a pipe to measure the temperature of the gas flowing inside of it. The convection heat transfer coefficient is given as h = 250 W/m^2-°C. The temperature at the internal surface of the pipe is constant and equal to T_w = 100°C. At steady state conditions, the thermocouple reading shows a temperature of T_{TC} = 500°C. What is the actual temperature of the gas (Hint: radiation is not negligible). The total emissivity of the thermocouple is ε_{TC} = 0.5.

Ans.: 538.31°C

Problem 5: A long thin-walled tube with a diameter of 100 mm is maintained at 120°C by the passage of steam through its interior. A radiation shield is installed around the tube, providing an air gap of 10 mm between the tube and the shield, and reaches a surface temperature of 35°C. The tube and the shield are diffuse gray surfaces with emissivities of 0.8 and 0.1, respectively. What is the radiant heat transfer from the tube per unit length?

Ans.: 30.2 W/m^2

Selected Problems from the Textbook

Please do the following problems:

6^{th} Edition → **12.20, 13.40, 13.63**

Or

7^{th} Edition → **12.20, 13.41, 13.65**