Assignment on Radiation
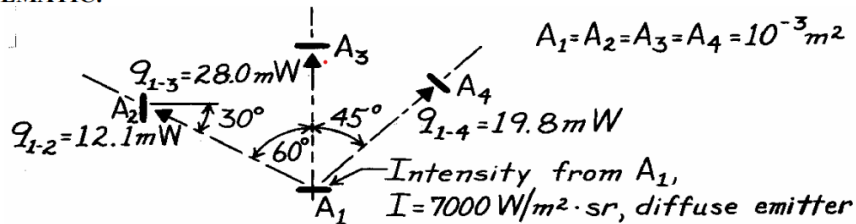
1. Radiant energy with an intensity of 800 W/m² strikes a flat plate normally. The absorptivity is twice the transmissivity and thrice the reflectivity. Determine the rate of absorption, transmission and reflection of energy.

2. Consider a tungsten filament light bulb whose filament is at temperature of 2860K. If the filament is considered to be gray, what fraction of total energy emitted by the bulb is in the visible wavelength spectrum from 0.35 μm to 0.7 μm. If the filament is a rectangle of size 5mm×2mm and consumes 60W, determine the efficiency of the bulb.

3. A small black body has a total emissive power of 4.5kW/m². Determine its surface temperature and the wavelength of maximum emission. In which range of spectrum does this emission fall?

4. The rate at which radiation is intercepted by each of the three surfaces is known as shown in the figure. Evaluate the irradiation at each of the three surfaces.

SCHEMATIC:

$A_1 = A_2 = A_3 = A_4 = 10^{-3} m^2$

$q_{1-3} = 28.0\,mW$

$q_{1-2} = 12.1\,mW$

$q_{1-4} = 19.8\,mW$

Intensity from A_1, $I = 7000\,W/m^2 \cdot sr$, diffuse emitter

5. Estimate the irradiation on a small test object placed inside an evacuated aluminum (D = 2m, serving as a radiation test chamber) sphere when its inner surface is lined with carbon black and at 500K. What effect will surface coating have?

Aluminum sphere, D=2m

Small test surface, A_1

Carbon black coating, $T_s = 600K$
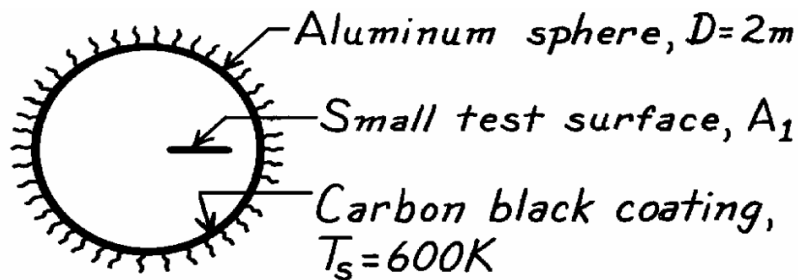
6. Calculate the shape factors for the configurations shown in the figures given below:
   (a) long tube with cross-section of equilateral triangle.
   (b) black body inside a black enclosure.
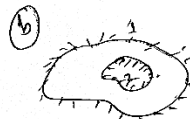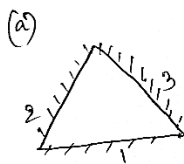
7. Consider a thin hollow cylinder of 8cm diameter and 10cm length. If the radiant shape factor of the circular surface of this cylinder is 0.172, estimate the shape factor of curved surface of the cylinder with respect to itself.

8. A truncated cone of height 10cm has top and bottom diameters of 8cm and 16cm respectively. The bottom surface is stated to intercept 15% of radiation leaving top surface. Determine the shape factor between the (i) top and the conical side surfaces, and (ii) the side surface and itself.

9. A solid cylinder (surface 2) is located at the center of a hollow sphere (surface 1). The diameter of the sphere is 1m while the cylinder has a diameter and length of 0.5m each. Calculate F_{11}.
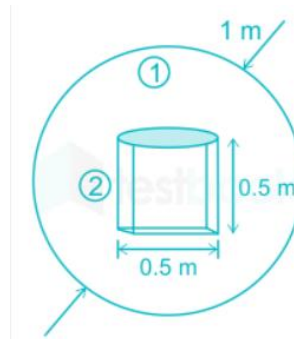
10. For a given system, calculate the transmissivity, reflectivity, absorptivity, and emissivity of the plate, along with the convection coefficient associated with the water flow, assuming an opaque and diffuse surface. Also assume water is opaque to thermal radiation.