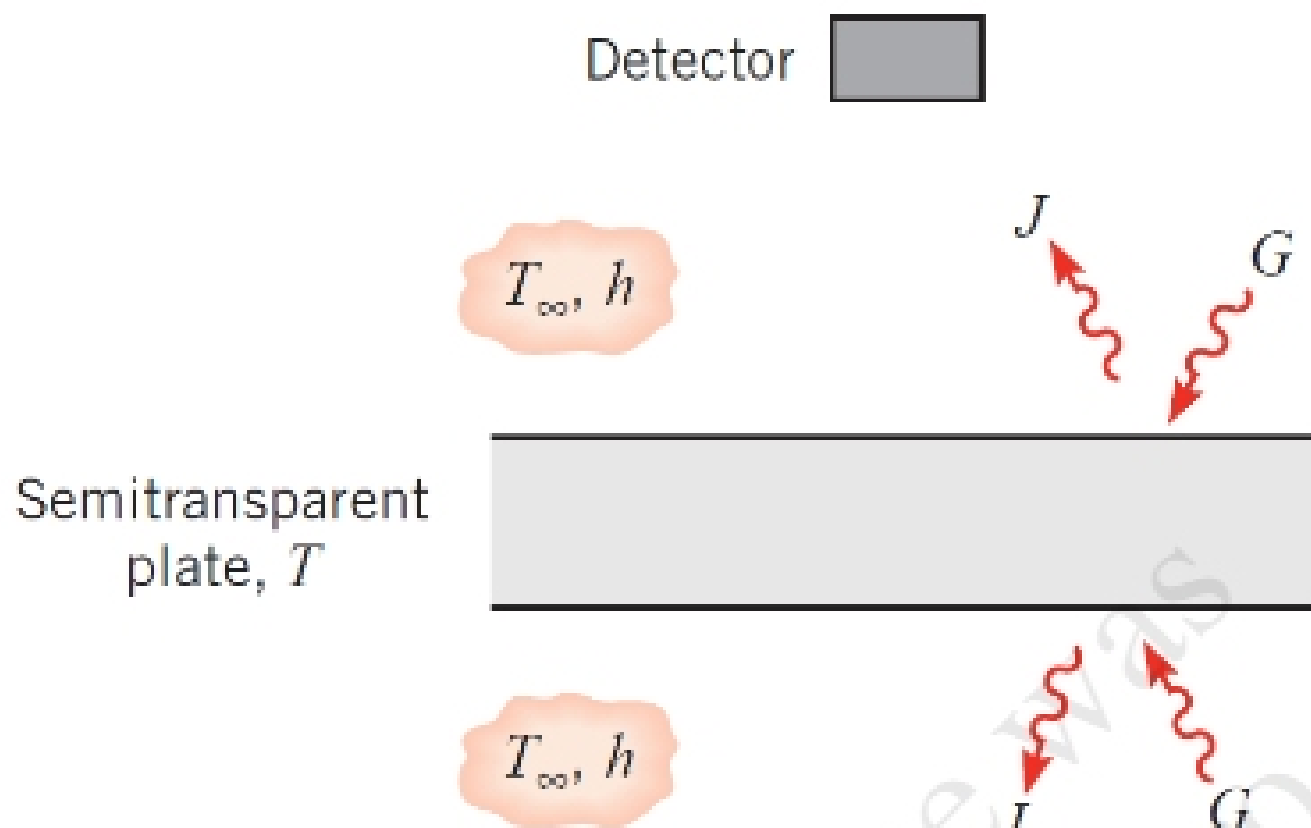


Homework 10

Due at the beginning of the class on Tuesday, November 22, 2016

- 12.1** Consider an opaque horizontal plate that is well insulated on its back side. The irradiation on the plate is 2500 W/m^2 , of which 500 W/m^2 is reflected. The plate is at 227°C and has an emissive power of 1200 W/m^2 . Air at 127°C flows over the plate with a heat transfer convection coefficient of $15 \text{ W/m}^2 \cdot \text{K}$. Determine the emissivity, absorptivity, and radiosity of the plate. What is the net heat transfer rate per unit area?
- 12.2** A horizontal, opaque surface at a steady-state temperature of 77°C is exposed to an airflow having a free stream temperature of 27°C with a convection heat transfer coefficient of $28 \text{ W/m}^2 \cdot \text{K}$. The emissive power of the surface is 628 W/m^2 , the irradiation is 1380 W/m^2 , and the reflectivity is 0.40. Determine the absorptivity of the surface. Determine the net radiation heat transfer rate for this surface. Is this heat transfer to the surface or from the surface? Determine the combined heat transfer rate for the surface. Is this heat transfer to the surface or from the surface?

- 12.3** The top surface of an $L = 5$ -mm-thick anodized aluminum plate is irradiated with $G = 1000 \text{ W/m}^2$ while being simultaneously exposed to convection conditions characterized by $h = 40 \text{ W/m}^2 \cdot \text{K}$ and $T_\infty = 30^\circ\text{C}$. The bottom surface of the plate is insulated. For a plate temperature of 400 K as well as $\alpha = 0.14$ and $\varepsilon = 0.76$, determine the radiosity at the top plate surface, the net radiation heat flux at the top surface, and the rate at which the temperature of the plate is changing with time.
- 12.4** A horizontal semitransparent plate is uniformly irradiated from above and below, while air at $T_\infty = 300 \text{ K}$ flows over the top and bottom surfaces, providing a uniform convection heat transfer coefficient of $h = 40 \text{ W/m}^2 \cdot \text{K}$. The absorptivity of the plate to the irradiation is 0.40 . Under steady-state conditions measurements made with a radiation detector above the top surface indicate a radiosity (which includes transmission, as well as reflection and emission) of $J = 5000 \text{ W/m}^2$, while the plate is at a uniform temperature of $T = 350 \text{ K}$.



Determine the irradiation G and the emissivity of the plate. Is the plate gray ($\varepsilon = \alpha$) for the prescribed conditions?

12.5 What is the irradiation at surfaces A_2 , A_3 , and A_4 of Example 12.1 due to emission from A_1 ?