

SUGGESTED SOLUTION (ODD)

CHAPTER 19

NOTE: Use three-digit precision for all calculations unless otherwise stated or implied.

19-1. A building is located in a grassy field. Assume that the emissivity of grass is 1.0 for all wavelengths in the LWIR and that of the building material is 0.9 for all wavelengths in the LWIR. Consider a time just before sunrise when the temperature of both the building and the grass is 300 K. Consider a sensor looking directly down at the building.

- A. What is the spectral radiance of the grass at 10 μm ? (You can use the graph given for homework problem 16-1 or the value given in homework problem 16-2.)
- B. What is the spectral radiance of the building's roof at 10 μm because of its thermal emission?
- C. There will also be a non-zero reflective contribution to the spectral radiance. What is the source of this radiation? Will reflective radiation be a significant contribution to the total spectral radiance? WHY OR WHY NOT?
- D. The building now appears significantly cooler than the grass just before sunrise (because of its emissivity of 0.9). It is therefore easily detectable just before sunrise. At what other times of the day or night might there be a broadband LWIR detection problem? EXPLAIN.

SUGGESTED SOLUTION:

A)

$$B(\lambda = 10\mu\text{m}, T = 300\text{K}) \cong 30 \text{ W/m}^2\text{-}\mu\text{m}$$

$$L_{\lambda}(\lambda)_{\text{GRASS}} = \frac{\varepsilon(\lambda)_G B(\lambda, T)}{\pi} = 10 \text{ W/m}^2\text{-sr-}\mu\text{m} \text{ (the value shown on HW 1 graph)}$$

B)

$$\begin{aligned} L_{\lambda}(\lambda)_{\text{TANK}} &= \frac{\varepsilon(\lambda)_{\text{TANK}} B(\lambda, T)}{\pi} = (0.9)(10 \text{ W/m}^2 \text{ sr} \cdot \mu\text{m}) \\ &= 9 \text{ W/m}^2\text{-sr-}\mu\text{m} \end{aligned}$$

- C) It is downwelling radiance from sky (atmospheric layers above) characterized by $T_{\text{eff}} \ll 300\text{K}$, so it is $\ll 10 \text{ W} / \text{m}^2 \text{ sr } \mu\text{m}$.
- D) The thermal cross-over is shifted back a few hours to $\sim 2\text{-}3\text{am}$ and forwarded a few hours past sunrise.

