University of Delaware
Department of Electrical and Computer Engineering
ELEG620: Solar Electric Systems

Homework #1
Solar Radiation

1. A light source consists of monochromatic light with energy of 600 nm with a spectral irradiance of 1 x 10^{17} photons/cm²/sec. What is the power density of this light source? Is the light source visible to the human eye?

2. Diffuse radiation has a higher fraction of high energy radiation than direct radiation. Explain why this is so.

3. Assuming that the sun has a black-body spectrum with the temperature at 6000K, what is the power density reaching the atmosphere of the Earth? At what wavelength is the peak in the spectrum?

4. For a location at 25° N latitude, estimate the solar radiation at solar noon on a sunny day by calculating the Air Mass.

5. Calculate the elevation and azimuth angle at solar noon for on Jan 1, March 21st and August 1st for your hometown. You may use as a default Belle Fourche, SD (the approximate geographic center of the US, with latitude of 44° 58' N, 103 ° 46' W) if you don't have a home town.

6. On April 14th, in Newark DE, what time of day will the clocks say when it is solar noon? Calculate an estimate for the solar radiation intensity at solar noon. Use 39° 30' N and 75° 30' W for the latitude and longitude of Newark.

7. Derive an equation for the solar radiation incident on a tilted panel in terms of the solar radiation falling on a horizontal panel, the sun's elevation angle and the angle of the panel to the horizontal. Calculate the power on a module tilted at 30° at solar noon, for a location of 42° S and 147° E on Feb. 2nd if the incident radiation is 800 W/m².

8. The following questions involve calculations using the standard AM1.5G solar spectrum, available as an Appendix in the PVCDROM.

   a. For the AM1.5G solar spectrum, calculate the maximum current if every photon is absorbed and collected.

   b. A silicon solar cell has a band gap of 1.12 eV. What is the maximum current if every photon above the band gap gets absorbed and converted to current?

   c. What fraction of the total power in the AM1.5G spectrum is above the band gap of the silicon solar cell? What fraction is lost?

   (I strongly suggest using an excel spreadsheet to do this)