assigned September 26, 2006 due October 3, 2006

HOMEWORK #3
Photometry

Questions

a. What is the relation between exitance and illuminance for an arbitrary surface of reflection coefficient ρ?

b. What is the relation between the transmission, absorption and reflection coefficients of a surface when hit by light? Can any of them be nil? Can any of them be 100%?

c. How can you determine ρ if the surface is diffuse and all you have is a luxmeter and a luminance-meter?

d. What is the relation between the intensity of a point source and the illuminance received on a table situated below it? How is this relation affected if the table is moved so that is it is 30° away from below the source?

Problems

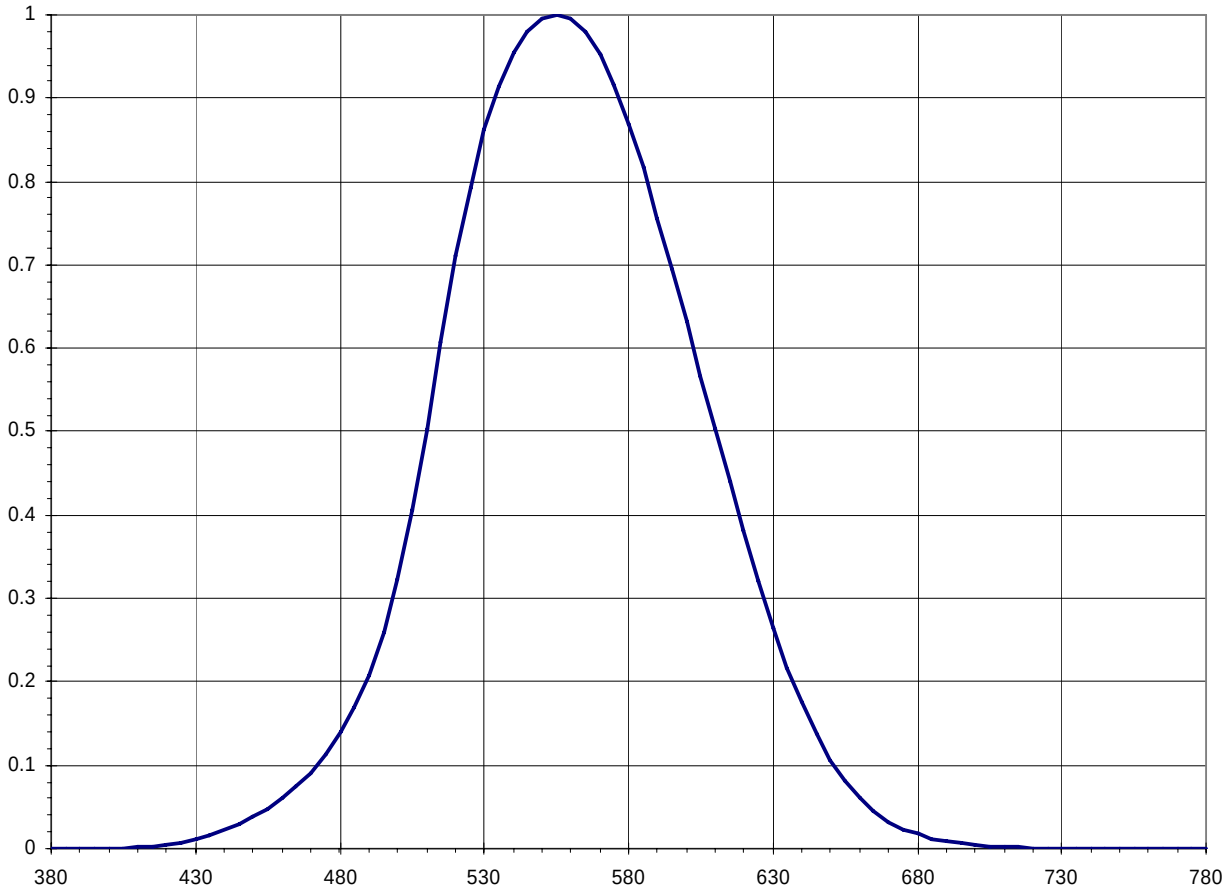
1. You are sitting at your desk, writing a letter on a white piece of paper (ρ = 75%, letter size) and wondering whether the incandescent light bulb that you use to illuminate your letter is a good choice (assuming there is no other light source in the room). You happen to have a radiometer with you and lay it on the table to take a measurement. You read (in W/m^2):

   You remember that the efficacy of incandescent sources is typically of about 25 lumens/Watt. What is the (photometric) illuminance of your paper (please specify the unit)? Does this illuminance value depend on how bright the paper is?

   What would this illuminance value become for a same radiometer reading if, instead of having a light bulb, you were sitting next to a window during the day and were benefiting from daylight as your light source (efficacy ≈ 110 lm/W)?

   Is it possible to determine the intensity of the light bulb if we assume that it is emitting light isotropically (same flux in every direction) and knowing that the bulb is placed 4 feet above the desk but 2.5 feet to the left? If so, what is this intensity (please specify units)?

   How many Watts are absorbed by the paper if we assume it's perfectly opaque?



2. You are looking at a piece of lighting artwork consisting of a white diffusing wall being illuminated by two distinct monochromatic sources S_1 and S_2, whose respective wavelengths change over time. At a given moment, you are told that each source contributes to the wall's illuminance by 320 and 800 lux and that their respective wavelengths are 450 nm and 650 nm.

   What is the color of the wall at that moment?

   Which source emits the most power (in Watts)? (use the $V(\lambda)$ curve given above)

   What is the resulting luminance of the wall if its reflection coefficient ρ is of 0.8?

3. You are trying to estimate the illuminance on your large desk in your bedroom, that has a 2 x 2 m^2, South-facing, double-pane (clear glass) window. You have no measurement equipment but found out that you could expect to get about 250 W/m^2 on your façade around solar noon time. Assuming that all this irradiation comes directly from the sun on a clear day and that the sun is 55° above the horizon the day you are thinking about this, what *average* illuminance can you expect over your whole desk area if:
   - the desk is 80 cm high and of dimensions 180 x 250 cm^2 (the long dimension being flush against the window wall, centered on the window)
   - the window sill is 1 meter above ground
   - you assume there is no other light source than the sun's rays and that these are parallel

   A friend of yours then comes in with a luxmeter, places it in the middle of the desk and tells you it reads roughly 31,500 lux. Does this make sense at all or is his luxmeter erroneous?