Handed out September 6, 2000
Due back September 11, 2000

Light and Color

1. A surface of 1 square meter receives around 1000 Watts of solar power on a sunny day. Use the average wavelength of the solar spectrum and the energy of a photon at that wavelength to calculate a rough estimate of the number of photons the surface receives per second. (see lecture notes for any data needed)

2. Imagine a room 10 by 20 meters with a ceiling 5 meters high. The room has no windows, and there is a light bulb shining at one corner of the ceiling. The light bulb has a radiant intensity of 10 W/sr. Consider a circular patch at the center of the floor with a 10 cm diameter.
   a. What is the solid angle from the bulb to the patch?
   b. What is the irradiance of the patch of floor? (Assume there is no reflection from the wall and from the ceiling.)

3. We mix blue paint and yellow paint.
Blue reflects only blue, and yellow absorbs all blue. What should be the color of the mixed paint?
Typically, however, the mixed paint is green. Explain this.

4. One term we did not discuss is albedo. Explore this concept using the web or a textbook and provide a mathematical definition.

5. Open the Image Processing Toolbox User's Guide in pdf format (on the web at `http://www.mathworks.com/access/helpdesk/help/fulldocset.shtml`, or locally from your Matlab package).
Read:
- Chapter 1, Introduction, about two formats of color images used in Matlab, indexed images and "truecolor" RGB images. Indexed images are more compact, but information is lost.
- Chapter 2, about displaying RGB images and indexed images.
- Chapter 10, Color.

Read the RGB image called `flowers.tif` (available with all Matlab packages) using `imread('flowers.tif')`.
Display the red, green and blue components of this image as 3 gray level images on the same figure (using `subplot`) and print the result.

6. Transform the flowers image to HSV color space using the Matlab function `hsv2rgb`. Display and print a single figure showing the H,S,V components of this image as 3 gray level images.

7. Transform the flowers image to YIQ color space using the transformation

$$\begin{pmatrix} Y \\ I \\ Q \end{pmatrix} = \begin{pmatrix} 0.299 & 0.587 & 0.114 \\ 0.596 & -0.275 & -0.321 \\ 0.212 & -0.523 & 0.311 \end{pmatrix} \cdot \begin{pmatrix} R \\ G \\ B \end{pmatrix}$$

Again using `subplot`, display and print a single figure showing the Y, I, Q components of this image as 3 gray level images.

8. Transform the RGB flowers image into a gray level image using the function `rgb2gray`. Compare with the images constructed above. What method was used?

9. Look at the Matlab code for `rgb2ntsc` and `ntsc2rgb` by using the function `type`. What is the relationship between the matrix T used in the code and the matrix used in the YIQ transformation above?

10. Transform the RGB flowers image into an indexed image using the function `rgb2ind`. How many indexes are used? Display and print a figure showing the index part of the image as a gray level image, with indexes mapped to the range 0 to 255.

Matlab (`http://www.mathworks.com`) is available on the UNIX workstations at CFAR and UMIACS, on some PCs in labs and on the PCs in the Jasmine Laboratory (Room 2446 A.V. Williams)

Print out your images and any script files for all these problems and submit them. Color printouts are not required.