UNIVERSITY OF CALIFORNIA
College of Engineering
Department of Electrical Engineering and Computer Sciences

EE290D — Handout #15
Spring 1999 — T.-J. King

HOMEWORK ASSIGNMENT #2
Due Tuesday, February 23 (in class)

Problem 1: Photometry
The basic relationships between various photometric quantities are given here:

$$I = L/\Omega$$

where I is luminous intensity (candlepower), and L is the luminous flux (power) emitted into solid angle Ω;

$$E = I\omega/S^2$$

where E is the illumination (luminous flux density) incident on a surface a distance S from a point source of intensity I, and ω is the solid angle subtended by a unit area of the surface from the source;

$$B = E \cos\theta / \omega = I \cos\theta / S^2$$

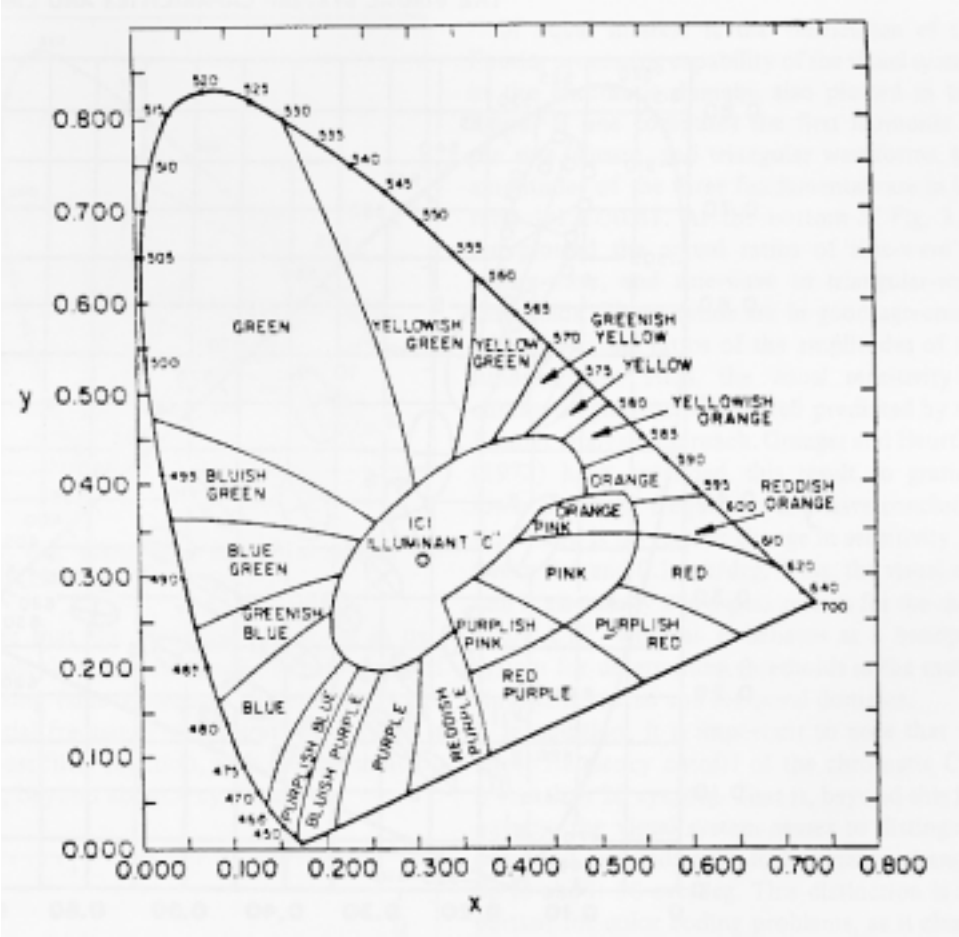
where B ("brightness") is the luminous flux emitted from a surface per unit solid angle per unit of area (projected onto a plane normal to the line of sight to the source), and θ is the angle at which the surface is tilted from the line of sight to the source.

a) A 10-candlepower light source illuminates a perfectly diffusing surface which is normal to the line of sight to the source. What is the brightness of the surface if it is 10 ft from the source?
b) A 10-candlepower light source illuminates a perfectly diffusing surface which is tilted at 45^o to the line of sight to the source. What is the brightness of the surface if it is 1 ft from the source?

Problem 2: The Human Visual System
a) Why does visual acuity (the ability of the eye to recognize small, fine details) decrease at low illuminations?
b) A frame rate of 20 frames/second is sufficient to show continuous motion in movie theatres, but it is not generally sufficient to show continuous motion on a television set. Explain why this is the case.

Problem 3: Display Greyscale Requirements
a) The Contrast Threshold Function (CTF) is the minimum amount of modulation required by the human visual system to detect an excitation at a given spatial frequency. The Contrast Sensitivity Function is simply the inverse of the CTF (CSF=1/CTF). The bits of grayscale which can be detected by the eye (as a function of the spatial frequency) is derived directly from the CTF, and is given in the Lecture #4 Notes as well as in the Lecture #6 Notes for a display of luminance 77 cd/m^2=22 fL viewed at a distance of 60 cm. Reproduce this grayscale sensitivity plot and qualitatively sketch the grayscale sensitivity curve for a low-luminance (1 cd/m^2) display.
b) For a SXGA display of luminance 77 cd/m^2 designed for 60 cm viewing distance, how many bits of grayscale are detectable?

Problem 4: Colorimetry
a) Calculate the luminous flux (power) of a 5 mW, 530 nm laser pointer.
b) Calculate the luminous flux (power) of a 5 mW, 650 nm laser pointer.
c) Plot the colors of the laser pointers in (a) and (b) on the CIE diagram.
d) Plot the sum of these two colors on the CIE diagram (1931).



<u>Problem 5</u>: FPD Design Issues

a) Why is STN-LCD the leading display technology used in "portable digital assistant" devices today?

b) Why are AMLCDs the leading display technology used in portable (laptop) computers today?