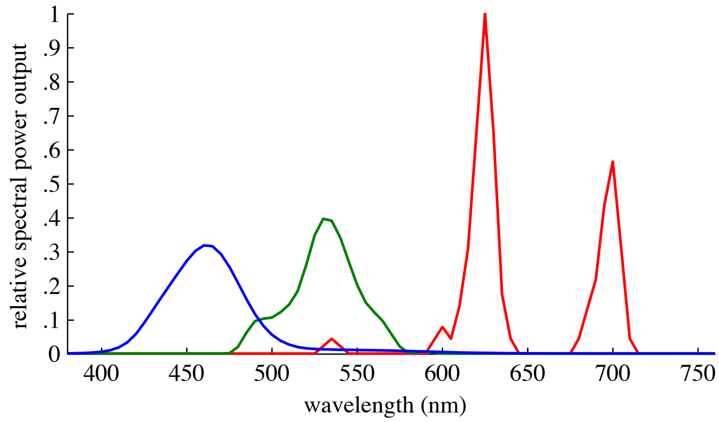
CS 465 Homework 10

out: Monday 20 November 2006
due: Friday 1 December 2006

Note: You are encouraged to use mathematical tools like MATLAB, Excel, graphing caluclators, or small programs in Java to come up with the answers for this homework.

Consider a CRT monitor M_1 with the following primary color spectra:



(The data for this plot are available in `m-rgb.txt`.) The maximum luminance of this monitor is 100; that is, the Y tristimulus value when the monitor is displaying pure white is 100. We consider this monitor to be an ideal monitor; that is, the gamma value is 1 and it accepts floating point numbers of arbitrary precision so that there are no quantization artifacts.

Part A

1. What is the RGB-to-XYZ transformation matrix for M_1?
2. What are the chromaticities of the primaries?
3. The white point of a monitor is the chromaticity of the displayed color when the monitor is outputting all white ($R_{M_1} = G_{M_1} = B_{M_1} = 1.0$). What is the white point of monitor M_1?

Part B

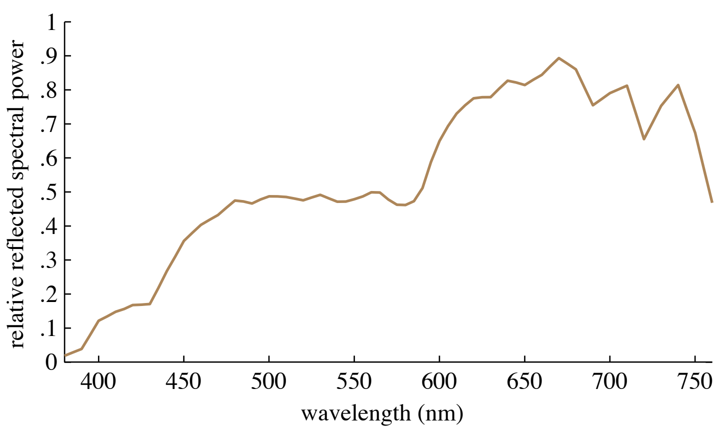
Now consider a second LCD monitor M_2, again with maximum luminance of 100. Rather than measure the spectra, we have obtained from the manufacturer the chromaticities of the primaries as well as the white point, which are:

Red primary	$x = 0.640$	$y = 0.330$
Green primary	$x = 0.300$	$y = 0.600$
Blue primary	$x = 0.150$	$y = 0.060$
White point	$x = 0.313$	$y = 0.329$

(These are the values for the Dell 2407WFP display, as reported by the display's firmware.) Again, treat this as an ideal monitor with a gamma of 1 and no quantization performed.

1. What is the RGB-to-XYZ transformation matrix for M_2? *Hint:* With just the chromaticities given, there is an unknown scale factor for each of the primaries. The white point determines these factors, which you can recover using some linear equations.

2. Consider the spectrum below, which is a medium skin tone under daylight illumination.



   (The data for this plot are available in `skin-d65.txt`.) The plot gives the relative spectral distribution, and the luminance of the color is 50. What RGB values are needed to produce a metamer (in the XYZ color space) of this spectrum for monitor M_1? For monitor M_2?

3. Because these are all linear transformations, we can compute an RGB transformation matrix through matrix products that, given an RGB triplet $(R_{M_1}, G_{M_1}, B_{M_1})$ to be displayed on monitor M_1, will produce the RGB triplet $(R_{M_2}, G_{M_2}, B_{M_2})$ that should be displayed on monitor M_2 in order to produce the same color response. Compute this matrix for transforming from M_1 to M_2, and show that it works as expected by plugging in your answers to (2).