

Homework 5: Color Vision
10 Points: Due at beginning of class, Thursday, 28 February 2008

There are two parts to this homework assignment. Each part counts 5 points. Late homework will receive a grade of zero.

Part 1: Three colors are each matched by the following three color-equations using the C.I.E. Tristimulus primaries:

$$C_1 \equiv 0.45X + 1.05Y + 0.50Z$$

$$C_2 \equiv 1.35X + 3.15Y + 1.50Z$$

$$C_3 \equiv 3.20X + 1.85Y + 0.95Z$$

The C.I.E. chromaticity coordinates x , y , z , are computed from the Tristimulus values:

$$x = \frac{X}{X+Y+Z}, \quad y = \frac{Y}{X+Y+Z}, \quad z = \frac{Z}{X+Y+Z}$$

Compute the chromaticity coordinates of each color (small x , y , and z). Construct a chromaticity graph by plotting x -chromaticity against y -chromaticity (make the axis scales go from 0.0 to 1.0). Compare the chromaticity of the three colors: are they the same or different? Will these colors exactly match each other in appearance? If not, how do they differ? Finally, what C.I.E. primaries X , Y , and Z , will match the color C_4 produced when C_2 is added to C_3 ? Plot C_4 on your chromaticity graph.

Part 2: There are three processes in color vision: two chromatic channels and one achromatic channel. These three processes receive input from the three types of cones according to these three equations:

$$(+r - g) = 1.89L - 2.79M + 0.45S \quad \text{Red - Green}$$

$$(+y - b) = 0.85L + 0.22M - 1.72S \quad \text{Yellow - Blue}$$

$$L = 0.85L + 0.15M + 0.015S \quad \text{Luminance}$$

where S , M , and L are the short, medium, and long wavelength cone types. Assume that two colors activate the cones by the following amounts:

	L	M	S
C_5	22.0	8.8	2.2
C_6	5.0	20.0	5.0

Make a graph of the opponent process color space with the x -axis representing $(+r-g)$ and the y -axis representing $(+y-b)$. The scales should run from -50.0 to +50.0. Compute the activation of the three channels to C_5 , to C_6 , and to a mixture of C_5 and C_6 ($C_5 + C_6$). Plot each of the three colors as points on the graph (C_5 , C_6 , and C_5+C_6). What is the color appearance of C_5 and of C_6 ? What is the color **appearance** of the mixture of C_5 and of C_6 ?