Due Wednesday, 8 September 2021 at 11:59 PM[1]

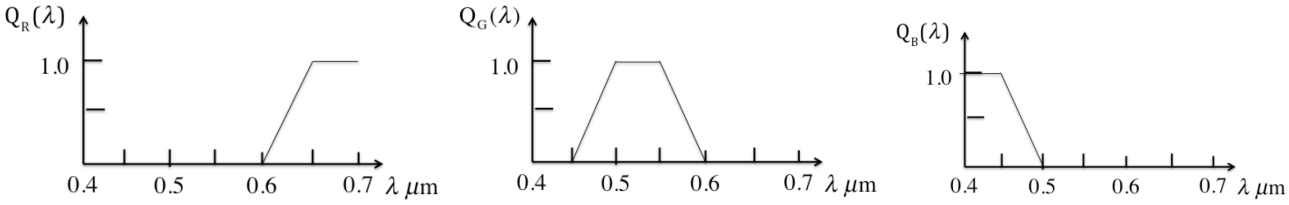
ECE 638 **Homework No. 1**[1] **Fall 2021**

Note: Some parts of the problems below require the use of Matlab or Python. In each such case, please turn in a print-out of your code. Each code file should be commented with a one-line description of what it does, your name, and the date written.

1. In class, we discussed a sensor chromaticity diagram based on a triangle with vertices that intersect the R, G, and B axes at a unit distance from the origin along each axis. We also stated that in order for the perpendicular from each vertex to the opposite side to have unit length, the R, G, and B axes would not be orthogonal.

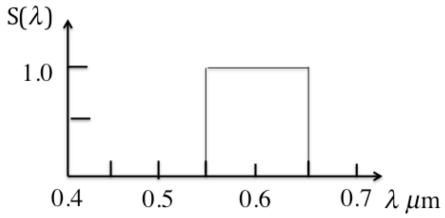
   Determine the angle between each of the three axes that will satisfy this condition.

2. Consider a trichromatic sensor with the response functions shown below:



   i. Plot the spectral locus and chromaticity gamut in the rgb *sensor* chromaticity plane.

   ii. Find the response of the sensor to the stimulus



   iii. Determine the amounts of each of three monochromatic primaries $P_B(\lambda)=\delta(\lambda-0.45)$, $P_G(\lambda)=\delta(\lambda-0.55)$, $P_R(\lambda)=\delta(\lambda-0.65)$ required to match this stimulus. Is a direct match possible? Why or why not?

3. For the sensor in Problem 2 and for the primaries in Problem 2 iii:

   a. Plot the color matching functions.

   b. Plot the spectral locus in the *primary* chromaticity plane of the chromaticity coordinates (r,g) (Cartesian coordinates).

[1] Please email your homework solution as a single file to zhan3052@purdue.edu by the time when it is due.

4. At the course website, you will find digital photographs and spectral power distributions (patches directory) for three color patches (red, green, and blue) photographed under a certain illuminant.

   a. Plot the spectral power distributions for these patches. Comment on the general shape of each one, i.e. in what wavelength ranges do we have the most power?

   b. Use the CIE color matching functions $\bar{x}(\lambda),\bar{y}(\lambda),\bar{z}(\lambda)$ that can be downloaded from the course website (CIE CMF.DAT) to compute the CIE X,Y,Z coordinates for each of the three colors.

   c. For each color, compute the CIE chromaticities (x,y), and plot these in the chromaticity diagram. Comment on the location of these three points relative to that of an equal energy stimulus and the nearest point on the spectral locus. What does this tell us about the hue and saturation of these colors?

      You should use Matlab or Python for this entire problem. Note that this data was acquired using a PhotoResearch PR-705 spectraradiometer. In addition to generating spectral power distributions of the stimuli that it sees, the instrument also directly computes CIE coordinates. For the three patches, this is what the instrument returned:

Color	x	y	Y
Red	0.5359	0.321	32.56
Green	0.3082	0.496	64.78
Blue	0.1985	0.1507	18.34

   d. Compare your computed CIE chromaticities with those returned by the PR-705.