Written Assignment 2
Total Points: 85
Due: May 10

1) Supposed that you form a low-pass spatial filter $h(x,y)$ that averages all the eight immediate neighbors of a pixel (x,y) but excludes itself.
    a. Find the equivalent frequency domain filter $H(u,v)$. **[5]**
    b. Show that your result is again a low-pass filter. **[5]**

2) Any high pass filter has a strong spike at the origin. Explain the source of these spikes. **[10]**

3) You have an image of bandwidth 100Hz. What is the minimum resolution of a the display than can display this image free of artifacts? How will you process this image to make this suitable to display on a 50x50 resolution display? Justify your answers. **[5+5=10]**

4) Let $f(x,y)$ denote an image and $f_G(x,y)$ denote the image obtained by applying a Gaussian filter $g(x,y)$ to $f(x,y)$. A high pass filtered image $f_H(x,y) = f(x,y) - f_G(x,y)$, is generated from this $f_G(x,y)$.

    a. You are asked to achieve high pass filtering by using a single filter. Derive an expression, $h(x,y)$, for such a filter. **[5]**
    b. How would the frequency response, $H(u,v)$, of this filter look like? **[5]**

5) An image has a probability density function (PDF) of p(r) = 2(1-r). We want to transform this image so that its PDF becomes p(z) = 2z. Assume continuous images and find the transformation (in terms of r and z) that would achieve this goal. **[10]**

6) You want to digitize an analog signal of bandwidth 120Hz. The sampling frequency of your display is 100 Hz. The bandwidth of your reconstruction kernel is 80 Hz.

    c. Why won't you be able to sample and reconstruct this signal without artifacts using this display? **[5]**
    d. How would you process the image to reconstruct it without any artifacts? **[5]**
    e. What kind of artifacts would the reconstruction kernel generate? **[5]**
    f. How would you change the reconstruction kernel to correct it? **[5]**

7) When we mix blue paint with yellow paint we get green. But when we project blue light on yellow light, we get brown. How do you explain this contradiction? **[5]**

8) Consider a linear display whose red, green and blue primaries have chromaticity coordinates of *(0.5, 0.4)*, *(0.2, 0.5)* and *(0.1, 0.1)* respectively. The maximum intensity (defined by X+Y+Z) of white is $1000cd/m^2$ respectively. The white point of the display is (0.33,0.37) Generate the matrix that converts the RGB coordinates for this device to the XYZ coordinates. What is the XYZ coordinates of the color generated by the RGB input (0.5, 0.75, 0.2) on this device? **[10]**

9) The spectrum of color $C_1 = (X_1,Y_1,Z_1)$ and $C_2 = (X_2,Y_2,Z_2)$ are given by $s_1(\lambda)$ and $s_2(\lambda)$ respectively. Let the color formed by multiplications of the spectrums s_1 and s_2 be s_3, i.e. $s_3(\lambda) = s_1(\lambda) * s_2(\lambda)$. Is it true that the XYZ coordinate corresponding to s_3, denoted by C_3, is (X_1X_2,Y_1Y_2,Z_1Z_2)? Justify your answer with calculations. **[5]**

10) C_1 and C_2 are colors with chromaticity coordinates *(0.33, 0.12)* and *(0.66, 0.66)* respectively. In what proportions should these colors be mixed to generate a color C_3 of chromaticity coordinates *(0.55, 0.48)*? If the brightness of C_3 is *90*, what are the brightness of C_1 and C_2? **[10]**