Visual Perception: Midterm Exam
Total Points: 75
Due Date: May 1, 11am

THIS IS A TAKE-HOME OPEN-BOOK OPEN-NOTES EXAM.
TIME= 2.5 HOURS.

1. **Read the questions carefully. The points assigned to each question are indicative of the difficulty and length of their solutions.**
2. **Precise and to-the-point answers presenting simple and elegant solutions will be given more credit.**
3. **Please try to type in as much of the answers as you can. If there are equation and illustrations which are more time consuming to do in typing, it is okay to write them in hand.**
4. **Please hand me a hardcopy on the due date in class.**

You are bound by honor code to do the following.

1. **You are expected to work alone on the midterm and should not discuss your answers with your classmates.**
2. **You are supposed to spend no longer than 2.5 hours on the exam.**
3. **You are not supposed to take a peek at the questions ahead of the 2.5 hour you spend on the exam.**

PLEDGE: I pledge to have followed all the rules mentioned above.

Signature: _____ Date: _____

Name : _____

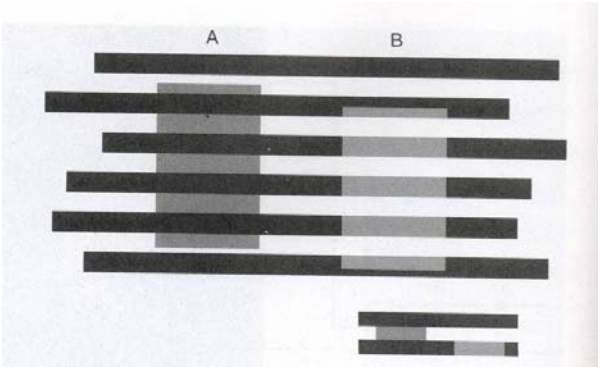
1. Explain why windows in a house, when viewed from the inside, appear transparent during the daylight hours, but act like mirrors at night. **[3]**

2. The color of the runway lights in airports is blue, and not red. Why? **[3]**

3. What will be the difference of our perception of Hermann's grid if we had lateral excitation instead of lateral inhibition (i.e a center surround receptive field that has inhibition in the center and excitation in the surround)? **[3]**

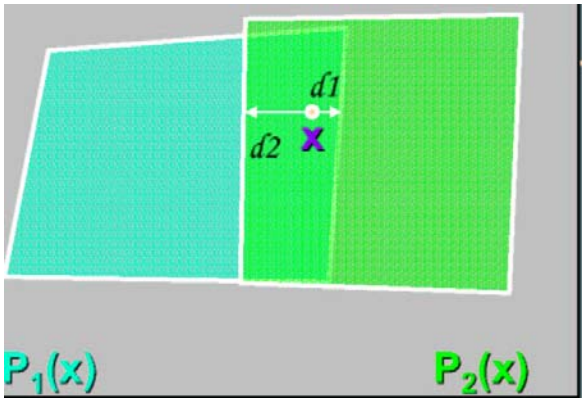
4. Why do we see better in the dark if we avert/skew our gaze a little?**[3]**

5. In the image below, the gray rectangle on the right looks lighter than the rectangle on the left. But they are actually the same gray. Can you explain this by lateral inhibition? **[4]**



6. The image below shows a display made of two projectors P_1 and P_2. At any pixel x, the contribution of the two projectors at this pixel are expressed by $P_1(x)$ and $P_2(x)$ respectively. To remove the high brightness in the overlap region, the intensity at any pixel x in this region is blended using the functions $A_1(x)$ and $A_2(x)$ from projector P_1 and P_2 respectively such that $A_1(x) + A_2(x) = 1$ and the combined intensity at pixel x from the two projectors is given by $A_1(x)P_1(x) + A_2(x)P_2(x)$. Two types of function can be used.
    a. In the first, A_1 and A_2 are assigned as follows.
       $A_1(x) = d1/(d1+d2)$
       $A_2(x) = d2/(d1+d2)$
    b. In the second, A_1 and A_2 are assigned as follows
       $A_1(x) = cos(d1/(d1+d2)*90)$
       $A_2(x) = cos(d2/(d1+d2)*90)$

    Which of these functions would look perceptually better? Why? **[4]**



7. We know that edge detection can be performed by the eye in different resolutions. Do you think that the illumination and the reflectance edges will show up in different resolutions? Justify your answer. **[4]**

8. You have your framed graduation certificate hanging on the wall. When you view if from a distance of 12 or more feet, you cannot see the letters clearly. As you approach the frame, slowly the letters become clearer and clearer. However, if you are within an inch or two, you find that the letters have again become blurred. Can you explain this with CSF? **[4]**

9. A display is specified by the following. The chromaticity coordinates of the three primaries: (0.6, 0.2), (0.2, 0.6) and (0.2, 0.1); chromaticity coordinates of the white point (0.3, 0.3); maximum intensity of the display: 1000 lumens. 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? Find the maximum luminance (Y) that can be displayed by each channel of this display. **[6+2+2=10]**

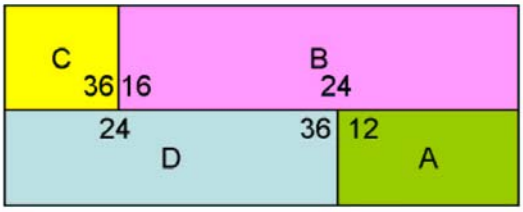
10. Let a projector coordinate system be defined by *(s,t)* with origin *(0,0)* at the center of the projector. The projector shows a symmetric fall-off in the maximum luminance for each channel from the center to the fringes. The fall off is inversely proportional to the square of the distance of *(s,t)* from the center of the projector. The black offset does not vary spatially and is defined by the XYZ vector (X_B, Y_B, Z_B). Each channel has a quadratic input transfer function. If the color with maximum luminance for red, green and blue channel at the center of the projector is defined by the vectors (X_r, Y_r, Z_r) , (X_g, Y_g, Z_g) and (X_b, Y_b, Z_b), what would be the equation defining XYZ coordinates of the color for any input (i_r, i_g, i_b) at any pixel *(s,t)* of the projector. **[7]**

11. You are working in your office which receives good sunlight in the day time. Around dusk when it is getting dark, you find that it is difficult to read the text on the book. You light your table lamp and the text is again legible again. Explain this phenomenon with CSF. **[4]**

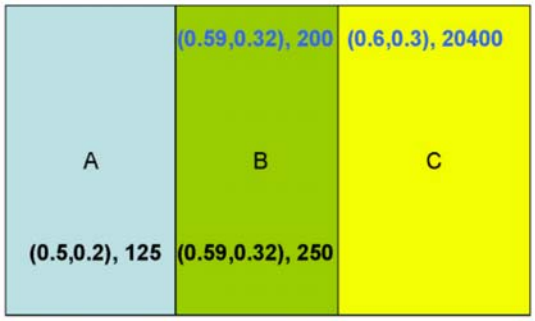
12. When we move our eye to look at a stationary scene, the objects do not seem to move around even though the image of the object on the retina moves. How can you explain this phenomenon? **[4]**

13. A person was presented an annular ring of luminance of 100cd/m^2 with a circular inset of luminance 50cd/m^2. In an adjacent region, he was presented with a circular inset of 150cd/m^2 and asked to adjust the luminance of the annular ring surrounding it so that it creates similar perception as that of the former pair. What luminance do you expect him to adjust to? **[3]**

14. The image below shows four different objects A, B, C and D, which have different reflectance. It also shows the gray scale luminance values at the edges. From this information how can you tell if the illumination is continuous or not? **[6]**



15. The figure below shows an image segmented into three parts, A, B and C, based on the detection of edges between the regions. The chromaticity coordinates and the luminance in cd/m^2 on both sides of the edge between B and C are given in blue. The same for the edge between A and B is given in red. Based on this a person comments that there are more than one reason to believe that the former edge is due to illumination and the latter is due to reflectance. Do you agree with him? Justify your answer.**[4]**



16. You have difficulty in reading very small text on the screen. However, this difficulty reduces as you increase the size of the fonts. Explain this using CSF. **[4]**

17. Kay and McDaniel categorized colors in six categories corresponding to focal colors red, green, blue, yellow, black and white. How do you think would the sets corresponding to each of these categories look on the chromaticity diagram? Can you accommodate all of them on the chromaticity diagram? If not, why? Illustrate using diagrams.**[5]**