CPSC 314
Assignment 3

Due Fri Apr 11, 2008

Answer the questions in the spaces provided on the question sheets. If you run out of space for an answer, use separate pages and staple them to your assignment.

Name: _____

Student Number: _____

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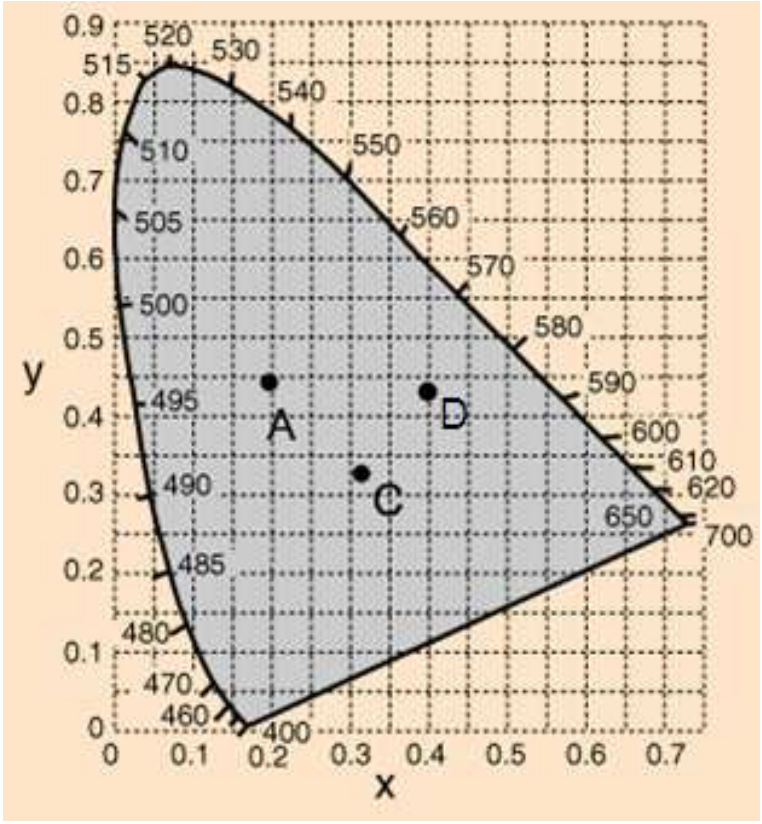
1. Colour Representation



(a) (2 points) Sketch a typical RGB monitor gamut on the CIE chromaticity diagram shown above. Label each of the R, G, and B locations.

(b) (2 points) What is the dominant wavelength of the colour D on the chromaticity diagram? Which spectral colour is complementary to D?

(c) (1 point) Compute and illustrate where the colour $(X, Y, Z) = (10, 20, 10)$ would be located on the CIE chromaticity diagram.

(d) (2 points) Visible light consists of a continuous spectrum in the range $400 - 700nm$. Describe in simple terms why we can represent colour, as perceived by humans, using only 3 values, e.g., RGB or XYZ values. Would the same be true for animals?

(e) (2 points) Yellow is a spectral colour, i.e., a colour on the rainbow, and it cannot be reproduced by mixing other colours. Is this true or false? Why or why not?

(f) (1 point) What are metamers?

(g) (2 points) It can sometimes be difficult to print a colour image on paper that looks just like the same colour image on a screen. Why?

2. (6 points) Local Illumination

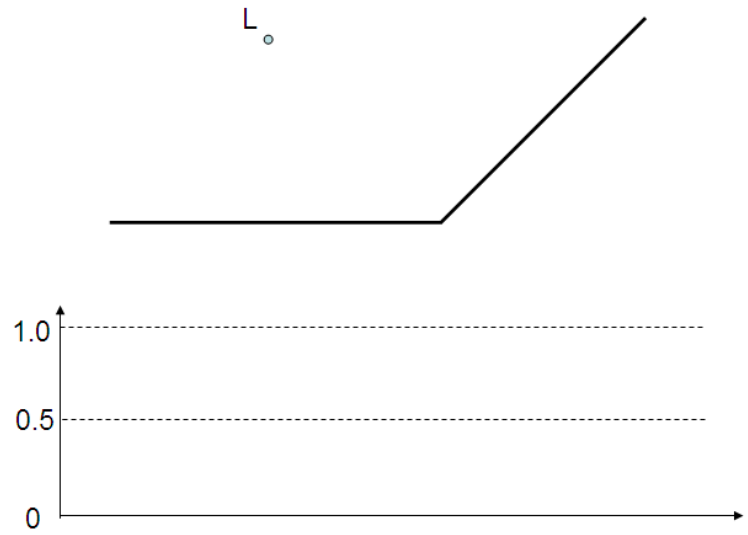
Sketch the illumination that would be computed for the following scene using the Phong illumination model. The scene is viewed from above using an orthographic projection, i.e., the eye is infinitely far above the scene. The scene is lit by the single light source L. Sketch a graph for each of the ambient, diffuse, specular, and total illumination.

The Phong illumination model is given by:

$$I = k_a I_a + k_d I_d (N \cdot L) + k_s I_s (R \cdot V)^n$$

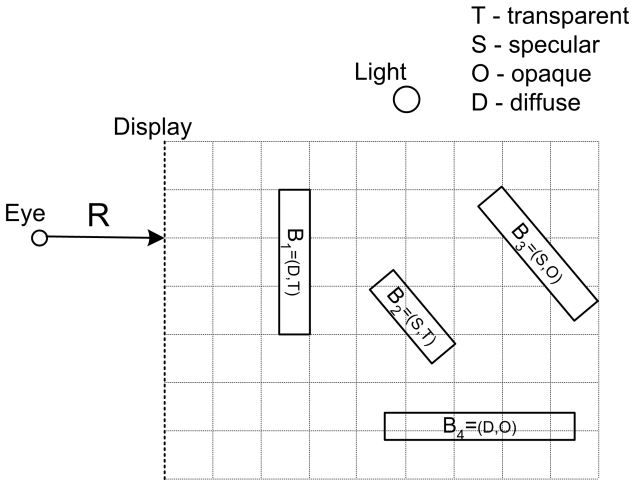
and the values of the various parameters are:

$$I_a = I_d = I_s = 1.0, k_a = 0.2, k_d = 0.8, k_s = 0.7, n = 200.$$



3. Ray-Tracing

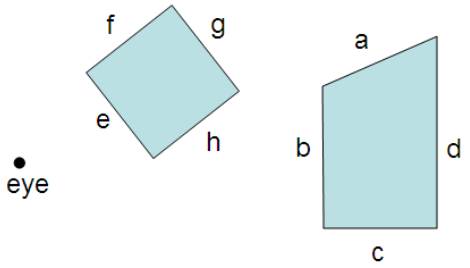
(a) (3 points) Draw the ray tree for the ray R shown below. Assume index of refraction c_1 for air is 1 and index of refraction for all the transparent objects in the scene is $c_2 = \frac{1}{\sqrt{2}}$. Use Snell's law to obtain refraction angles.



(b) (2 points) Assume the transparency coefficient α for the transparent objects is .5, the light intensity is $I_p = (1, 1, 1)$ (no other lights), and the diffuse/specular coefficients for the objects are $k_d^1 = (1, 0, 0), k_s^1 = (0, 0, 0), k_d^2 = (0, 0, 0), k_s^2 = (1, 1, 1), k_d^3 = (0, 0, 0), k_s^3 = (1, 1, 1), k_d^4 = (0, 1, 0), k_s^4 = (0, 0, 0)$. What is the color returned by the ray tracing algorithm for ray R?

4. Visibility

(a) (2 points) For the following scene, the polygons forming a closed solid object are represented by edges. Circle all the faces that would be removed by back-face culling. Show your work for borderline cases.



(b) (1 point) Suppose you have a 10000 polygon Buddha statue that you need rendered. You would like to quickly determine if you can skip rendering the statue because it is not within the current field of view. Describe how you would do this. English or pseudocode is fine.

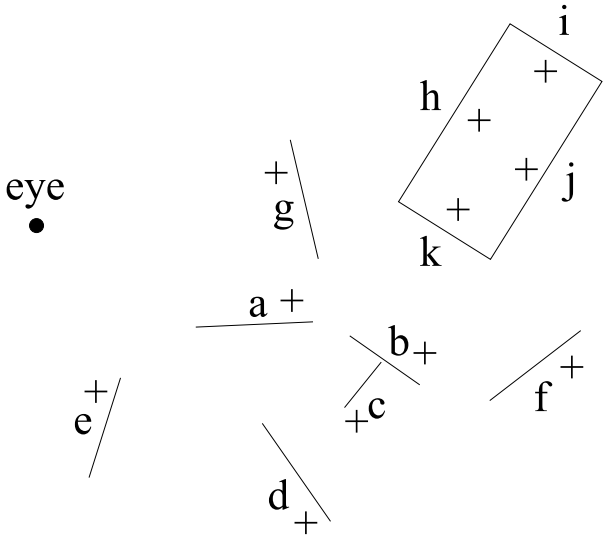
(c) (1 point) The rendered image produced with a Z-buffer algorithm is always the same for all orderings of rendering the polygons. Is this true or false? Justify your answer.

(d) (1 point) Describe a scene for which ray-tracing would be much more efficient than a z-buffer rendering in terms of efficiently computing which surfaces are visible to the eye.

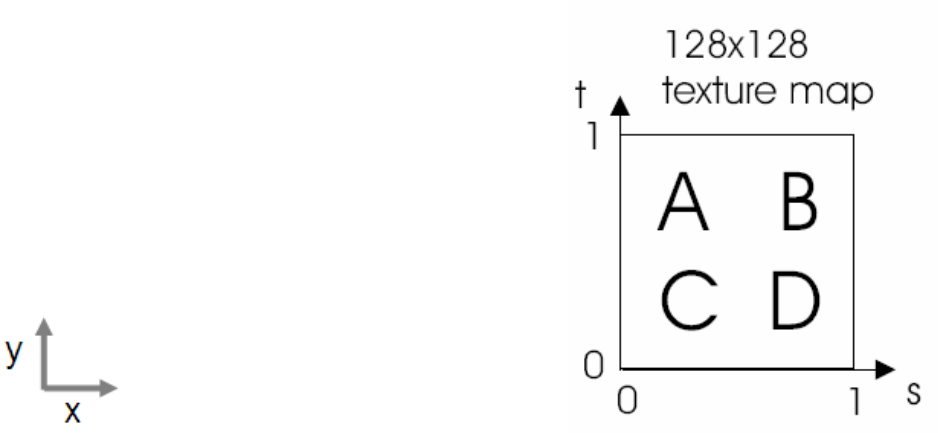
(e) (2 points) Sorting triangles from from the largest z values to the smallest, based on the minimal (closest to the eye) z value for each of the triangle vertices, will always gives a correct back-to-front ordering for use in a painter's algorithm for handling

visibility. Is this true or false? If false, illustrate a counter example.

(f) (3 points) Create a BSP tree for the following scene by inserting the polygons, represented here by lines, in alphabetical order into an initially empty BSP tree. Using this tree, then determine a back-to-front ordering for rendering the polygons from the given eye point. Show your work.



5. Texture Mapping



(a) (2 points) A texture map with the letters "ABCD" is mapped onto a triangle using the following OpenGL calls:

```
glTexCoord2f(0.3,1);
glVertex3f(40,60,0);
glTexCoord2f(0,0.5);
glVertex3f(40,10,0);
glTexCoord2f(0.5,0.5);
glVertex3f(10,30,0);
```

Sketch the triangle in the space above, assuming that the scene is being viewed from above, i.e., +z. Sketch the texture details (i.e., the letters) as they would appear on the texure-mapped triangle.

(b) (1 point) What are MIP-maps and why are they useful ?

(c) (1 point) Texture coordinates for pixels in the interior of a triangle should be linearly interpolated from the texture coordinates at the vertices. Is this true or false? Justify your answer.