CPSC 314
Quiz 2

November 16, 2006

Answer the questions in the spaces provided on the question sheets. If you run out of room for an answer, continue on the back of the page.

Name: ______________________________

Student Number: ______________________________

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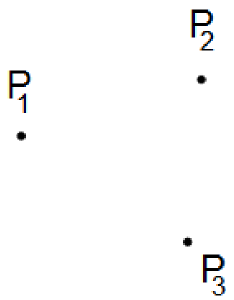
This exam has 5 questions, for a total of 40 points.

1. Implicit, Explicit, and Parametric Equations

   (a) (1 point) Give an implicit equation for a 3D sphere of radius R, centred at (x_c, y_c, z_c) and having $F(x, y, z) > 0$ inside the sphere.

   (b) (3 points) Develop implicit, explicit, and parametric equations for the 2D line passing through the points $P_1(x_1, y_1)$ and $P_2(x_2, y_2)$. Ensure that your implicit form would not be problematic to compute for any values of P_1 and P_2, aside from the degenerate case of $P_1 = P_2$.

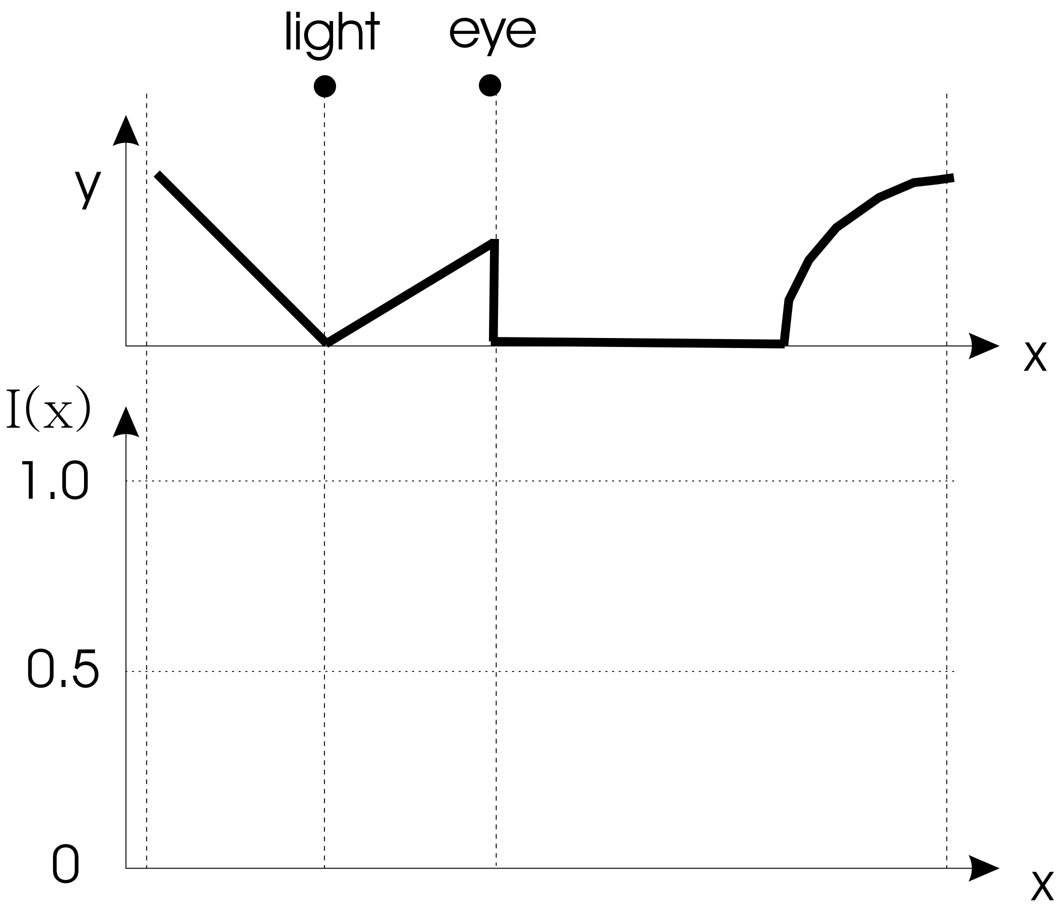


   (c) (1 point) Suppose that barycentric coordinates are defined for the above triangle such that $P(x, y) = \alpha P_1 + \beta P_2 + \gamma P_3$. In the figure of part (a), label the set or region of all points where $\gamma = 0$, $\gamma = 0.5$, and $\gamma = 1$.

   (d) (3 points) Develop an equation to compute γ for a given point $P(x, y)$, i.e., develop an expression for $\gamma(x, y)$. Also show how $\gamma(x+1, y)$ be computed efficiently knowing the value of $\gamma(x, y)$?

2. (4 points) Lighting

   Sketch the ambient, diffuse, specular, and total illumination for the following scene as a function of x. Assume the Phong illumination model,
   i.e., $I = k_a I_a + k_d I_d (N \cdot L) + k_s I_s (R \cdot V)^n$,
   where $k_a = 0.3, k_d = 0.7, k_s = 0.7, I_a = I_d = I_s = 1.0, n = 100$.



3. Short answer

   (a) (12 points) Define the following terms and give an example of a situation where it would be used in practice:

   Nyquist rate

   display list

   MIPmapping

   pixel shader

   1d texture map

   cube map

   texture management unit

   'baked' lighting

   procedural texture

   BRDF

   depth complexity

   penumbra

(b) (2 points) Give five different uses for the memory on a graphics card.

(c) (2 points) You are developing a virtual museum application using standard projective-rendering provided by OpenGL. Give four techniques that you can use (or that OpenGL may use) to address the removal of polygons or pixels that do not end up being visible.

4. Texture Mapping and Sampling

   (a) (5 points) Suppose that you have a texture map of size 128×32 pixels which models the surface of exactly one brick that has dimensions of $20 \times 5cm$. Suppose that your virtual world is modeled in units of metres, and that z is up in your world. Give the OpenGL code to draw a texure mapped polygon that models a brick wall that is $5m$ wide and $2m$ high and lies in the xz plane. You can assume that the brick texture is loaded as the current texture. You can assume that either GL_CLAMP or GL_REPEAT mode is correctly enabled for the texture parameters, but you should describe which of these you would choose.

   (b) (3 points) Unweighted area sampling assigns a pixel the "average" colour of what that pixel covers. In practice, it can be approximated by 'supersampling', i.e., sampling within a pixel using a finer grid of sample points and then taking the average of these colour samples. Will this eliminate aliasing artifacts ? If not, how can it be improved ?

5. Miscellaneous

   (a) (1 point) Suppose we wish to develop barycentric coordinates for a quadrilateral, i.e., $P(x, y) = \alpha P_1 + \beta P_2 + \gamma P_3 + \zeta P_4$, where $0 \leq \alpha, \beta, \gamma, \zeta \leq 1$ for all points inside the polygon. Show that each point in the polygon does or does not have a unique set of barycentric coordinates $(\alpha, \beta, \gamma, \zeta)$.

   (b) (1 point) Why is it difficult to correctly model the illumination of skin and marble?

   (c) (2 points) Describe some of the challenges you might encounter when using shadow maps to produce shadows.