CPSC 314
Midterm 2

November 19, 2014

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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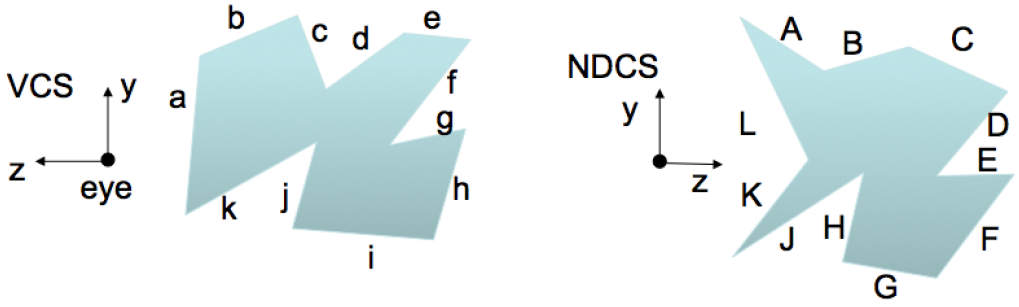
This exam has 7 questions, for a total of 47 points.

1. Lines and Barycentric Coordinates

   (a) (4 points) Develop explicit, parametric, and implicit equations for a 2D line passing through points $P_1(x_1, y_1)$ and $P_2(x_2, y_2)$.

   (b) (4 points) Sketch a triangle with vertices P_1, P_2, P_3.
   Suppose that barycentric coordinates are defined according to
   $P(\alpha, \beta, \gamma) = \alpha P_1 + \beta P_2 + \gamma P_3$.
   Label the vertices with their barycentric coordinates, i.e., $P(\alpha, \beta, \gamma)$.
   Sketch and label the lines that correspond to $\alpha = 0$, $\alpha = 0.5$, and $\alpha = 1$.

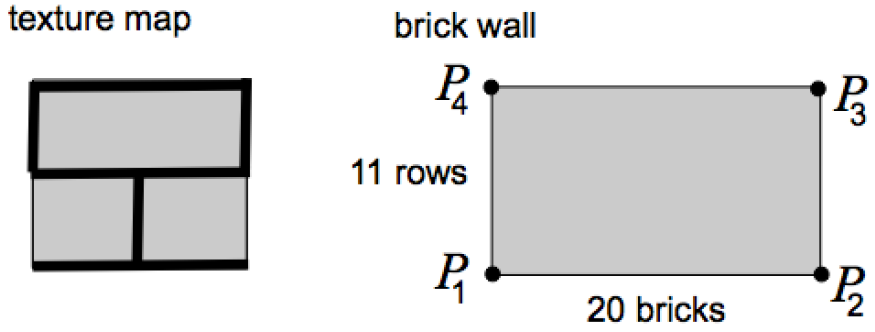
2. (4 points) For the following scene, the polygons forming a closed solid object are represented by edges. Which faces would be removed by back-face culling, in the VCS and NDCS illustrations? Note that in NDCS the z-axis points towards the back of the scene, as illustrated below.



3. (4 points) Show how to compute the implicit plane equation that embeds a triangle in 3D space, given its three vertices, P_1, P_2, and P_3. Ensure that the implicit equation returns a positive value for points that are *above* the plane. Assume that the vertices are specified in a counter-clockwise order when seen from *above*.

4. Texture Maps

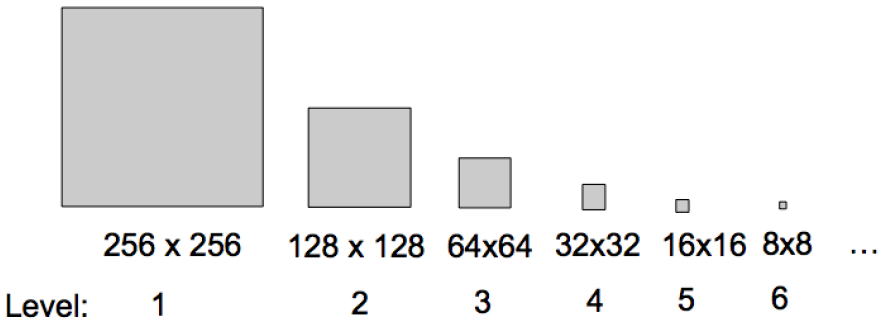
(a) (4 points) Give the texture coordinates $T(s,t)$ to be associated with each of the four vertices of the polygon below, which should model a brick wall using the given brick texture. The brick wall should be 10 bricks wide and be 11 bricks tall, i.e., has 11 rows of bricks in the vertical direction. You can assume that repeat-mode texturing is enabled. Note that the brick texture contains two half-bricks in its bottom half, which will tile correctly once multiple copies of the texture are placed adjacent to each other. It is fine if the final brick wall has rows that start and end with these half-bricks.



(b) (1 point) Storing texture MIPMAP requires _____ % additional space.

(c) (1 point) Minification describes how to handle the case when texels are:
larger or **smaller** (circle one) than pixels.

(d) (2 points) Consider the following MIPMAP pyramid. If we choose to use the *nearest* MIPMAP level, which level is used for a pixel that covers 15 texels? Show your work.



5. Shaders

(a) (6 points) For each of the following computations or steps, indicate where the computation typically happens by circling one of: VS (vertex shader); FS (fragment shader); FF (fixed function).
Use your experience from Assignment 2 to help with this, i.e., things that you have not implemented in shaders are probably part of the fixed function pipeline.

ModelView transform	`VS FS FF`
/ h	`VS FS FF`
Projection transform	`VS FS FF`
Viewport transform	`VS FS FF`
texture map lookup	`VS FS FF`
z-buffer test	`VS FS FF`
clipping	`VS FS FF`
culling	`VS FS FF`
assigning fragment color	`VS FS FF`
lighting computation	`VS FS FF`
fog computation	`VS FS FF`
transforming vertex normals	`VS FS FF`
perspective correct interpolation	`VS FS FF`

(b) (2 points) What is the purpose of `attribute` variables? Give examples of two common uses.

(c) (2 points) What is the purpose of `varying` variables? Give examples of two common uses.

(d) (2 points) What is the purpose of `uniform` variables? Give examples of two common uses.

(e) (2 points) What would be the benefit of having the z-buffer test **before** the fragment shader? **After** the fragment shader?

6. Guest Lectures

   (a) (2 points) Give an example of what can be done with the *Vector Graphics Complex* that cannot be done with current vector graphics modeling tools, such as Adobe Illustrator.

   (b) (1 point) What results after cutting a mobius strip along it's center line?

   (c) (2 points) Briefly describe the key idea(s) behind the water simulation described by Prof. Robert Bridson.

   (d) (2 points) When is visualization needed or suitable, as described by Prof. Tamara Munzner? Give an example of its use in biology.

7. (2 points) Give a topic (or topics) that you would like to see briefly covered in the last class. This could be a review topic, an aspect of graphics that we have not yet covered, or a "common practice in industry" question.