ECE 478 Computer Graphics

Mid-Term Examination

February 12th 2009

1 hour 15 minutes

Name:

Student Number:

Marks will be given for demonstrating your thought processes as well as the correct answer. Make sure you show all the steps you use for each of your answers.

1a) Give two reasons to provide a stack for the built-in matrices in graphics systems. (**4 marks**)

1b) Write an example in pseudo-code which illustrates one of your reasons. The pseudo-code should use the methods **push()** and **pop()** for the matrix stack. For simplicity assume there is only one matrix stack. (**4 marks**)

1c) For an object with an arbitrary orientation, size and position in the world, write down the operations required to rotate, scale and then translate the object to a new position (operations must be in the correct order). (**6 marks**)

2a) Derive the 2x2 matrix which represents a rotation in two dimensions. (Hint: draw a diagram for rotation and use geometry to present equations for the individual components of a point, then transfer this to matrix notation.) (**8 marks**)

2b) Assuming a right-handed coordinate system with the z-axis coming out of the page, when extended to a 3x3 matrix this is a rotation around the z-axis. Derive the three dimensional rotation matrices around the x and y axes with a similar method. (For these matrices don't worry about the direction of rotation. If you did not finish (a) then describe how you think the three dimensional matrices would be derived.) (**4 marks**)

3a) Describe the difference between local and global models for computer graphics. How do these relate to a computer graphics pipeline approach? (**4 marks**)

3b) Describe the operations performed in a typical graphics pipeline. Use a high-level approach, splitting the pipeline into 4 separate components. (**4 marks**)

3c) Assuming a pinhole camera with the origin as the centre of projection, write down the perspective projection equations. Give a matrix which would produce the projected point $u_p = (x_p, y_p, z_p, w)$ given the original point $u = (x, y, z, 1)$. (**4 marks**)

4a) Give a reason why using lighting and shading in computer graphics is important. (**2 marks**)

4b) Lighting and shading representations in computer graphics often do not represent physical reality. Give an example of this from the lighting model used in OpenGL. (**2 marks**)

4c) Describe the vectors which must be known in order to calculate the correct intensity value at a point on a surface when using a Phong lighting model. For each vector label it as "User" or "System" to indicate whether the User has to supply it or it is worked out by the System. (**8 marks**)