ECE 478 Computer Graphics

Mid-Term Examination

28th February 2012

1 hour

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.

Question 1

Assume a post-multiplication-based system, such as OpenGL, for this question.

a) We need to set the transformation matrix **M** to:

$$\mathbf{M} = \mathbf{S}(3,2,4)\ \mathbf{R_x}(45)\ \mathbf{R_y}(20)\ \mathbf{T}(1,1,1)\ \mathbf{R_z}(90)$$

so that we may transform any vertex **v** to **v'** i.e. **v'** = **Mv**; Using the commands **scale(x,y,z)**, **rotate_x(angle)**, **rotate_y(angle)**, **rotate_z(angle)**, **translate(x,y,z)** and assuming **M** is the currently active matrix, write pseudo-code which would set **M** to the above transformation. **(2 marks)**

b) Using similar notation to (a), write down the matrix transformations (*not* pseudo-code) required to **rotate 60 degrees clockwise around the x-axis** and **scale to double size** an object at position **(x,y,z)** in the world. (*The order of transformations is important.*) **(4 marks)**

c) Given a projection matrix **P** containing camera projection parameters, a model matrix **M** containing object transformations into the world and a view matrix **V** containing a world transformation into the camera's field of view, what is the order of multiplication of these three matrices to form the current transformation matrix to apply to all vertices of the current object? **(2 marks)**

Question 2

Show your work: most marks are available for the work you show.

a) Given two nonparallel, three-dimensional vectors *u* and *v*, how can we form an orthogonal coordinate system in which *u* is one of the basis vectors? **(3 marks)**

b) Why is it important that the vectors *u*,*v* from (a) be non-parallel? **(1 mark)**

c) Three vertices describe a triangle if they are not on the same line – devise a test for collinearity of three vertices. (Provide an example of your test.) **(4 marks)**

d) Given a polygon made up of a set of more than three 3D vertices, devise a test to determine if the polygon they represent is planar. (Provide an example of your test.) **(3 marks)**

Question 3

a) Assuming an OpenGL-like system, describe the coordinate system used to index textures (provide the origin, axes and values). **(1 mark)**

b) Describe the approaches of point sampling and linear filtering for applying textures. **(1 mark)**

c) Pixels and texels rarely map one-to-one: for this case, which two operations must be defined for textures to render correctly? **(2 marks)**

d) In which case is mip-mapping applied? How is a mip-map constructed? **(2 marks)**