ECE 478 Computer Graphics

Mid-Term Examination

March 1st 2011

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:
$$M = S(2,2,2) \ R_x(45) \ R_y(20) \ T(1,1,1) \ R_z(90)$$
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 loaded 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 45 degrees around the x-axis** and **scale to half size** an object at position **(x,y,z)** in the world. (*The order of transformations matters.*) **(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)**

d) Is it possible to construct a translation matrix for 3D objects using a 3x3 matrix? Give an explanation for your answer. **(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? **(4 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. **(4 marks)**

Question 3

a) How does OpenGL determine whether a triangle should be removed when back-face culling is enabled? **(1 mark)**

b) Explain why ray tracing is not easily implemented using a pipeline model. **(1 mark)**

c) Give one difference between the lighting model used in a local system (e.g. OpenGL) and a global system (e.g. ray tracing) **(1 mark)**

d) What is the difference between the Phong lighting model and the Modified Phong lighting model? **(1 mark)**

e) What vectors are required in order to use the Modified Phong lighting model? **(2 marks)**