CPSC 314, Midterm Exam

31 May 2005

Closed book, one single-sided sheet of handwritten notes allowed. Answer the questions in the space provided. If you run out of room for an answer, continue on the back.

Name: ____________________________________________________________

Student Number: __________________________________________________

<table>
<thead>
<tr>
<th>Question</th>
<th>Points Earned</th>
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<td><strong>Total</strong></td>
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1. (24 pts) Using the matrices

\[
A = \begin{bmatrix}
0 & -1 & 0 & 0 \\
1 & 0 & 0 & 0 \\
0 & 0 & 1 & 0 \\
0 & 0 & 0 & 1 \\
\end{bmatrix},
B = \begin{bmatrix}
1 & 0 & 0 & 2 \\
0 & 1 & 0 & 0 \\
0 & 0 & 1 & 0 \\
0 & 0 & 0 & 1 \\
\end{bmatrix},
C = \begin{bmatrix}
1 & 0 & 0 & 0 \\
0 & 2 & 0 & 0 \\
0 & 0 & 1 & 0 \\
0 & 0 & 0 & 1 \\
\end{bmatrix},
D = \begin{bmatrix}
1 & 0 & 0 & 0 \\
0 & 1 & 0 & -1 \\
0 & 0 & 1 & 0 \\
0 & 0 & 0 & 1 \\
\end{bmatrix}
\]

Sketch a picture of the six houses \( h_1 = A \ h \), \( h_2 = A \ B \ h \), \( h_3 = A \ B \ C \ h \), \( h_4 = A \ B \ C \ D \ h \), \( h_5 = A \ B \ D \ h \), and \( h_6 = B \ A \ h \) in the six grids below that show \( h \). Make sure to label each grid with the name of the house.
2. (4 pts) Give sequence of OpenGL commands necessary to implement \( h_5 = A \ B \ D \ h \). You can draw a house with the `drawHouse()` command.

3. (8 pts) Draw houseP and houseQ transformed by the appropriate OpenGL commands. The untransformed house is below.

```c
glIdentity();
glTranslate(-3, -2, 0);
glScale(2, 1, 1);
glPushMatrix();
glRotate(-90, 0, 0, 1);
drawHouseP();
glPopMatrix();
drawHouseQ();
```
4. (12 pts) If $p' = ABp$, give the the $4 \times 4$ matrices $A$ and $B$ needed to create the picture below, assuming the house started from the initial position as shown in the above questions.

5. (10 pts) Specify the coordinates of point $P$ with respect to coordinate frames $A$ and $B$.

6. (13 pts) True/false

- Display lists can be nested hierarchically.
- The homogeneous points $(1,2,3,4)$ and $(1,4,8,16)$ map to the same Cartesian point after homogenization.
- The homogeneous points $(2,2,2,4)$ and $(4,4,4,4)$ map to the same Cartesian point after homogenization.
- Nonuniform scaling is in the class of affine transformations but is not a linear transformation.
- A normal vector to a surface transformed by a nonuniform scale is still perpendicular to that surface.
- Moving the camera 4 units forward in $z$ is indistinguishable from moving the world 4 units backward in $z$.
- An asymmetric viewing frustum has a center of projection at infinity.
- An orthographic projection has a center of projection at infinity.
- Perspective division happens after the modelview transformation and before the projection transformation.
- After perspective division, all points have been projected onto the image plane.
- `gluLookAt` can be expressed as a combination of translations, scales, and rotations.
- Perspective transformations are in the class of affine transformations.
- Cavalier projections have three vanishing points.
7. (13 pts) Derive the rotation matrix for rotating around the x axis. Your derivation should include a figure, a set of equations, and the final matrix itself. Show all steps.
Use this code to answer the following questions

```c
<coordinate system L>
glMatrixMode(GL_PROJECTION);
glLoadIdentity();
glFrustum(-5,5,-5,5,2,10)
<coordinate system M>
glMatrixMode(GL_MODELVIEW);
glLoadIdentity();
glTranslate(0,0,-5);
<coordinate system N>
glVertex(-1,-1,1);
```

8. (2 pts) If N is the world coordinate system, then name the coordinate systems L and M.

9. (4 pts) Compute the location of the vertex in the M coordinate system.

10. (10 pts) Compute the location of the vertex in the L coordinate system.