CS 112: Introduction to Computer Graphics (Winter 2016)
Written Assignment 2 (Total Points = 84)
Due: Monday, Feb 1 - 1:30pm PST

1. Consider a 2D square on the XY plane with side 2 units, the center at the origin and four sides parallel or perpendicular to the coordinate axes. Draw the picture of the transformed square after performing the following sequence of OpenGL commands. (Remember OpenGL post-multiplies the matrices in the order it is received, and finally the point is also post-multiplied.) (1.414 is the approximation of sqrt(2).)
   glRotatef(45,0,0,1);
   glTranslatef(1.414,0,0);
   glRotatef(45,0,0,1);
   Reduce the number of OpenGL function calls and thus give the new sequence of OpenGL function calls to effect the same transformation. [3+4=7]

2. Consider the same square as in Question 1 at the initial position. Draw the picture of the transformed square after performing the following sequence of OpenGL operations. [3+3+4=10]
   Case 1:
   glScalef(3,2,1);
   glTranslatef(2,2,0);
   Case 2:Draw the picture of the transformed square if the above operations were swapped.
   To make results of Case 2 and Case 1 same, fill blanks with correct parameters:
   glTranslatef(____ , ____ , 0);
   glScalef(___ , ___ , 1);
   a. 1
   b. 2
   c. 3
   d. 4
   e. 6
   f. 9

3. The inverse R^{-1} of a rotation matrix R is its transpose R^{T}. For R, the inter-relationship between different row vectors is ___ , and the inter-relationship between different column vectors is ___ . [2+2=4]
   a. Parallel
   b. Linear scaling
   c. Orthogonal
   d. Identical

4. In 3D, show $R_z(\theta 1).\ R_z(\theta 2) = R_z(\theta 2).\ R_z(\theta 1)$. What does this tell about the properties of rotation around coordinate axes? Show that $R_z(\theta 1 + \theta 2) = R_z(\theta 1).\ R_z(\theta 2)$. Using this property show that rotation about any arbitrary axis denoted by R_a also follows the property, $R_a(\theta 1).R_a(\theta 2) = R_a(\theta 2).R_a(\theta 1) = R_a(\theta 1 + \theta 2)$. [10]

5. Given notation a_{ij} means the entry of a matrix at ith row and jth column, the scaling matrix for scaling an object by a scale factor 3 along an arbitrary direction given by vector $u = (1, 2, 1)$ rooted at $(5, 5, 5)$ will be a_{00} = ___ , a_{01} = ___ , a_{02} = ___ , a_{03} = ___ , a_{10} = ___ , a_{11} = ___ , a_{12} = ___ , a_{13} = ___ , a_{20} = ___ , a_{21} = ___ , a_{22} = ___ , a_{23} = ___ , a_{30} = ___ , a_{31} = ___ , a_{32} = ___ , a_{33} = ___ .[16]

    a. 0
    b. 1
    c. 2
    d. 3
    e. 5
    f. -5
    g. 6
    h. 7
    i. 10
    j. -10
    k. 25
    l. -25

6. A viewer is defined by the following. (a) Eye position: $(0, 0, 0)$, (b) View Up Vector: $(0, 2, 0)$, (c) Equation of the image plane: $x+y+z = 6$. Find the matrix that will be generated by the function call **gluLookAt.** Let the left, right, top and bottom planes be at -2, +2, 4, and 8 respectively. Let the far plane be at 10. Find the perspective projection matrix given by the function call **glFrustum**. Find what would be projected coordinates of a point $P = (10, 4, 6)$ for this viewer. [10+10+2=22]

7. The model transformation for our scene is a rotation R about the Y axis in the counter clockwise direction by 90 degrees, followed by a translation T in the positive X direction by 20 units. What is the resulting transformation? [3+3=6]

8. Choose the correct answer: If V is a vertex in our scene mentioned in Question 8, then after model transformation, the transformed vertex is computed as (a) RxTxV (b) TxRxV.[4]

9. The view transformation for our scene is the identity matrix. What is the position and orientation of the OpenGL camera? [5]