



Review Sheet I

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1. What are the homogeneous coordinates and why are they used in computer graphics?
2. Triangle ABC has vertices at (1,1), (2,3), and (3,1). Find the matrix that performs a scale of this triangle by 2 in the x direction while keeping vertex (2,3) fixed. Apply this matrix to the vertices and find the new vertices of ABC.
3. Suppose I have an object that is moved using the transformation M. The viewing transformation is given by the matrix P. And the camera is moved using the transformation matrix C. In what order should these transformations be applied to a vertex v? Express your answer as a matrix equation.
4. What is a *shear* transformation? Give a matrix for a general 2D y-shear, and explain why that matrix produces the desired result.
5. For each sequence of OpenGL like commands, sketch the resulting figure knowing that the function drawSquare() draws a square at origin with a width of 1.

a.

```
drawSquare();  
glTranslate(0,1,0);  
glScale(0.5,0.5,1);  
drawSquare();  
glTranslate(0,1,0);  
glScale(0.5,0.5,1);  
drawSquare();
```

b.

```
drawSquare();  
glPushMatrix();  
    glTranslate(0,1,0);  
    glScale(0.5,0.5,1);  
    drawSquare();  
glPopMatrix();  
glPushMatrix();  
    glTranslate(0,2,0);  
    glScale(0.5,0.5,1);  
    drawSquare();  
glPopMatrix();
```

6. Here is the syntax for gluLookAt.

```
gluLookAt(eyex, eyey, eyez, centerx, centery, centerz, upx, upy, upz)
```

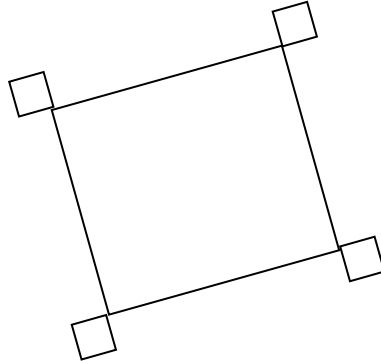
Suppose that the eye is located at the origin and the center point is (0,0,1) and up is (0,1,0) and we render a scene. Describe what would happen if up is changed to (0,0.9,0).

7. True or False: straight lines remain straight lines after a perspective projection.
8. Sketch the openGL pipeline and label the coordinate system involved.
9. Give the 3D homogeneous matrix for translation by (3, -4, 2). Then, give its inverse transformation matrix.
10. Show that the multiplication of two successive scalings is commutative.



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11. Suppose you have a function called drawSquare() that renders a 2D square centered at location (0,0) with a width and height of 1. Using OpenGL commands and the function drawSquare() show how to render the figure below



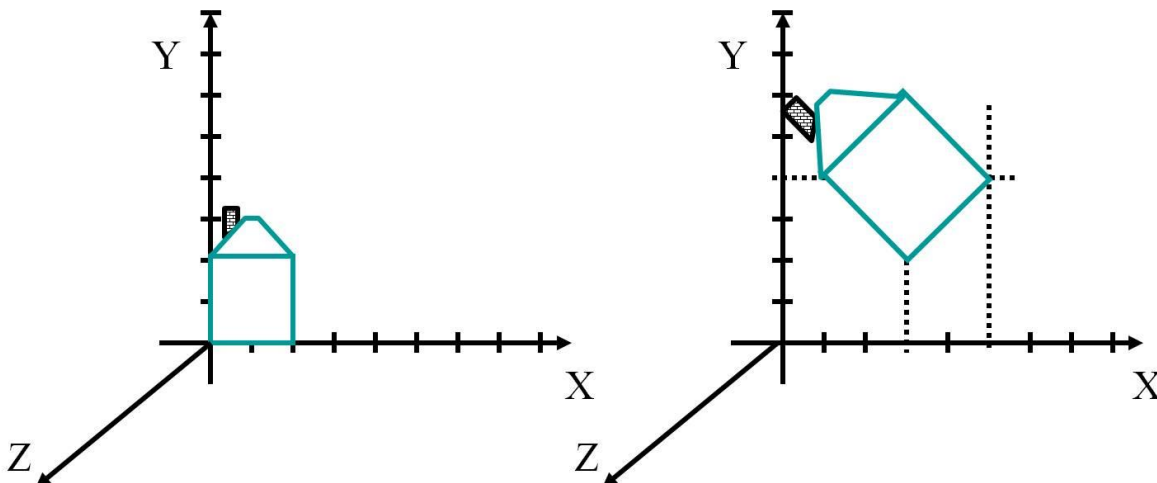
The figure should be centered at the position (5,5) and the width and height of the small squares is 1 and the large square has width and height of 6. The entire figure is rotated 15 degrees. Here is the syntax for the basic OpenGL transformations

glTranslate(tx,ty,tz)      glRotate(theta,vx,vy,vz)      glScale(sx,sy,sz)

12. Describe in words what the following matrix does and be specific about the order of operations:

$$\begin{bmatrix} 0.707 & 0 & 0.707 & 0 \\ 0 & 7 & 0 & 0 \\ -0.707 & 0 & 0.707 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

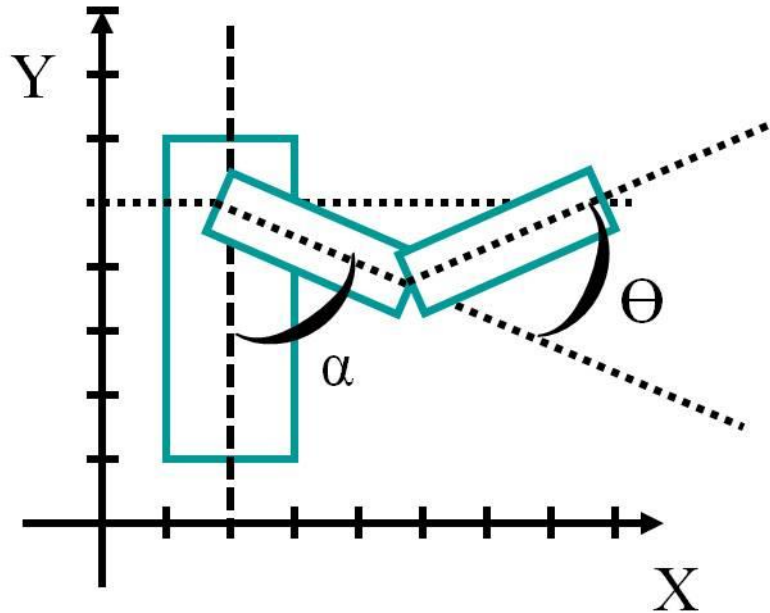
13. Give the series of affine transformations (assuming post-multiplying) needed to create the picture on the right hand side assuming the house started from the position shown on the left hand side. Give the OpenGL commands





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14. Give the code necessary to draw the following robotic arm, using OpenGL function calls and calls to a draw-block routine, DB(). The DB() procedure draws a block of unit size having vertices at (0,0), (1.0), (1,1), and (0,1). You can assume that the model view matrix has been appropriately initialized to reflect the given XY coordinate system. Your code should leave the modelview matrix unaltered upon completion. The blocks that compose the arm are both 3x1 in size.



15. Express the homogeneous point  $P(x,y,z,w) = P(2,1,3,0.5)$  in Cartesian coordinates.

**Best of Luck!**