

CS174A Assignment 1 - Part 1

Written Section: Transformations

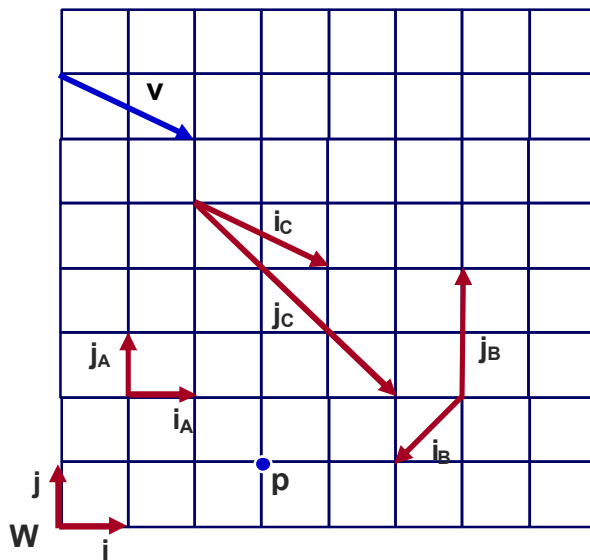
Out: Fri 6 Oct 2017

Due: Fri 20 Oct 2017 12pm

Value: 5% of final grade

Total Points: 137

1. (45 pts) The point coordinate \mathbf{p} can be expressed as $\mathbf{p} = 0 + 3\mathbf{i} + 0\mathbf{j}$, where \mathbf{i} and \mathbf{j} are basis vectors of unit length along the x and y axes, respectively.
 - a. (6pts) Describe the point \mathbf{p} in terms of the 3 other coordinate systems given below.
 - b. (18pts) How many points does one need to describe a vector? Describe the vector \mathbf{v} in terms of the 3 other coordinate systems given below.
 - c. (3pts) How is a coordinate frame represented?
 - d. (18pts) Give the three coordinate frame representations, \mathbf{M}_A , \mathbf{M}_B , \mathbf{M}_C , that relate each of the coordinate frames, A, B, C to the world coordinate frame W
 - e. (6pts) Given the position of \mathbf{p} in each of the three coordinate frames computed in (a), show that each of the coordinate frame representations from (b) can be used as transforms to compute the position of \mathbf{p} in the world coordinate frame.



2. (3 pts) Write down the affine matrix for scaling an object by 2 in y and 3 in z .
3. (10 pts) Give the OpenGL Shader commands required to create \mathbf{M} using elementary transformations . You may assume the matrix stack has been initialized with `modelMatrix.setAsIdentity();`.

$$\begin{bmatrix} 1 & 0 & 0 & 1 \\ 0 & 1 & 0 & 1 \\ 0 & 0 & 2 & 1 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

4. (6 pts) Homogenize the point $[2 \ 10 \ 8 \ 4]^T$.

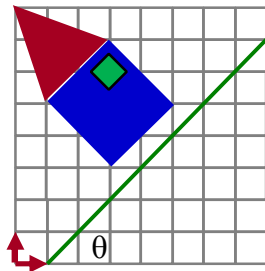
5. (20 pts) Write down the 4x4 OpenGL modelview matrix at the four lines A, B, C, and D below.

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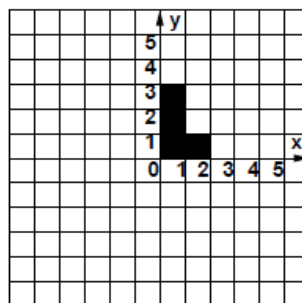
modelMatrix.setAsIdentity();
modelMatrix = modelMatrix * Translate(2,3,0);
//A
modelMatrix = modelMatrix * RotateY(90);
//B
matrixStack.push(modelMatrix);
modelMatrix = modelMatrix * Scale(1,.5,1);
modelMatrix = modelMatrix * Translate(1,1,0);
//C
modelMatrix = matrixStack.pop();
modelMatrix = modelMatrix * Scale(2,1,1);
//D

```

6. (24pts) Write the composite 2D matrix \mathbf{M} that performs a reflection about an arbitrary tilted line using the elementary transformations and write the equivalent OpenGL Shader code that generates \mathbf{M} .

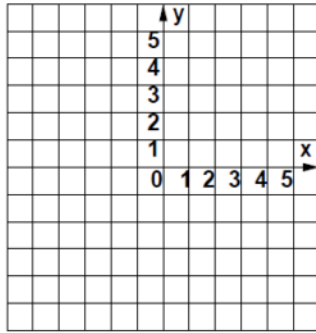


7. (26 pts) For each equation below, sketch the new location L' of the L shape on the grid and provide the sequence of commands needed to carry out those operations. Use the function `drawL()`, which draws an L shape with the lower left corner at the current origin as shown below. You may assume the matrix mode is `matrixStack.push(modelMatrix)` and that the stack has been initialized with `modelMatrix.setAsIdentity()`.

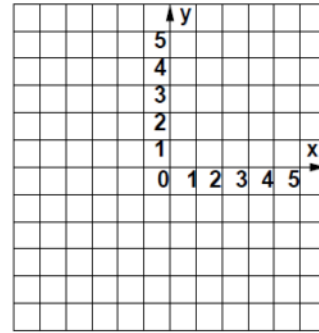


$$\mathbf{A} = \begin{bmatrix} 2 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}, \mathbf{B} = \begin{bmatrix} 1 & 0 & 0 & 1 \\ 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}, \mathbf{C} = \begin{bmatrix} 0 & -1 & 0 & 0 \\ 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \\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

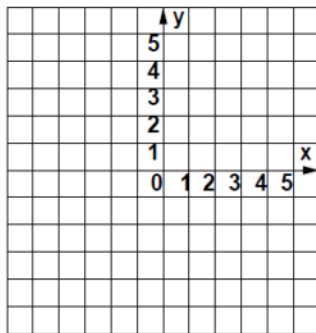
a) $L' = ABC L$



b) $L' = CAD L$



c) $L' = CBD L$



d) $L' = DCCAD L$

