CS 174A Assignment 1

1. $p = 0 + 3i + 1j = \begin{bmatrix} 3 \\ 1 \\ 1 \end{bmatrix}$

a) $p = 0 + 2i_A - 1j_A = \begin{bmatrix} 2 \\ -1 \\ 1 \end{bmatrix}$ $\quad p = 0 + \frac{7}{3} j_C - 3i_C = \begin{bmatrix} -3 \\ 7/3 \\ 1 \end{bmatrix}$

$p = 0 + 3i_B + 1j_B = \begin{bmatrix} 3 \\ 1 \\ 1 \end{bmatrix}$

b) A vector can be described by 2 points;

$$V = \begin{bmatrix} 2i_A \\ -j_A \end{bmatrix} = \begin{bmatrix} i_C \\ 0 \end{bmatrix} = \begin{bmatrix} -2 i_B \\ -\frac{3}{2} j_B \end{bmatrix}$$

c) A coordinate frame is represented by matrices, composed of basis vectors and an origin.

d) $M_A = \begin{bmatrix} 1 & 0 & 1 \\ 0 & 1 & 2 \\ 0 & 0 & 1 \end{bmatrix}$ $\quad M_B = \begin{bmatrix} -1 & 0 & 6 \\ -1 & 2 & 2 \\ 0 & 0 & 1 \end{bmatrix}$ $\quad M_C = \begin{bmatrix} 2 & 3 & 2 \\ -1 & -3 & 5 \\ 0 & 0 & 1 \end{bmatrix}$

e) $\underset{M_A}{\begin{bmatrix} 1 & 0 & 1 \\ 0 & 1 & 2 \\ 0 & 0 & 1 \end{bmatrix}} \underset{p_A}{\begin{bmatrix} 2 \\ -1 \\ 1 \end{bmatrix}} = \begin{bmatrix} 3 \\ 1 \\ 1 \end{bmatrix}_A$ $\quad \underset{M_B}{\begin{bmatrix} -1 & 0 & 6 \\ -1 & 2 & 2 \\ 0 & 0 & 1 \end{bmatrix}} \underset{p_B}{\begin{bmatrix} 3 \\ 1 \\ 1 \end{bmatrix}} = \begin{bmatrix} 3 \\ 1 \\ 1 \end{bmatrix}_B$

$\underset{M_C}{\begin{bmatrix} 2 & 3 & 2 \\ -1 & -3 & 5 \\ 0 & 0 & 1 \end{bmatrix}} \underset{p_C}{\begin{bmatrix} -3 \\ 7/3 \\ 1 \end{bmatrix}} = \begin{bmatrix} 3 \\ 1 \\ 1 \end{bmatrix}_C$

2) $\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 \\ 0 & 0 & 3 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$

3)
```
modelMatrix.setAsIdentity();
modelMatrix = modelMatrix * Scale(1, 1, 2);
modelMatrix = modelMatrix * Translate(1, 1, 1);
```

4) $\begin{bmatrix} 2 & 10 & 8 & 4 \end{bmatrix}^T = \begin{bmatrix} \frac{2}{4} & \frac{10}{4} & \frac{8}{4} & 1 \end{bmatrix}^T$

$= \begin{bmatrix} 0.5, & 2.5, & 2, & 1 \end{bmatrix}^T$

5) A) $\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 2 \\ 0 & 1 & 0 & 3 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 2 \\ 0 & 1 & 0 & 3 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$

B) $\begin{bmatrix} 1 & 0 & 0 & 2 \\ 0 & 1 & 0 & 3 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 0 & 0 & 1 & 0 \\ 0 & 1 & 0 & 0 \\ -1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 1 & 2 \\ 0 & 1 & 0 & 3 \\ -1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$

c) $\begin{bmatrix} 0 & 0 & 1 & 2 \\ 0 & 1 & 0 & 3 \\ -1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & .5 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 1 & 2 \\ 0 & .5 & 0 & 3 \\ -1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$

$\begin{bmatrix} 0 & 0 & 1 & 2 \\ 0 & .5 & 0 & 3 \\ -1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 1 \\ 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 1 & 2 \\ 0 & .5 & 0 & 3.5 \\ -1 & 0 & 0 & -1 \\ 0 & 0 & 0 & 1 \end{bmatrix}$

d) $\begin{bmatrix} 0 & 0 & 1 & 2 \\ 0 & 1 & 0 & 3 \\ -1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 2 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 1 & 2 \\ 0 & 1 & 0 & 3 \\ -2 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$

#6 Assume arbitrary line intersects the x-axis at a distance "d" from the origin.

^ positive

Code:
```
modelMatrix.setAsIdentity();
modelMatrix = modelMatrix * Translate(-d, 0)
    "       =      "      * Rotate(-θ)
    "       =      "      * Scale(1, -1)
    "       =      "      * Rotate(θ)
    "       =      "      * Translate(+d, 0)
```

$$\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & -d \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & -d \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} * \begin{bmatrix} \cos(-\theta) & -\sin(-\theta) & 0 \\ \sin(-\theta) & \cos(-\theta) & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$\to \begin{bmatrix} \cos(-\theta) & -\sin(-\theta) & -d \\ \sin(-\theta) & \cos(-\theta) & 0 \\ 0 & 0 & 1 \end{bmatrix} * \begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$\to \begin{bmatrix} \cos(-\theta) & \sin(-\theta) & -d \\ \sin(-\theta) & -\cos(-\theta) & 0 \\ 0 & 0 & 1 \end{bmatrix} * \begin{bmatrix} \cos(\theta) & -\sin(\theta) & 0 \\ \sin(\theta) & \cos(-\theta) & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$\to \begin{bmatrix} \cos(-\theta)\cos(\theta) + \sin(-\theta)\sin(\theta), & -\sin(\theta)\cos(-\theta) + \cos(-\theta)\sin(-\theta) & -d \\ \cos(\theta)\sin(-\theta) - \sin(\theta)\cos(-\theta) & -\sin(\theta)\sin(-\theta) - \cos(-\theta)\cos(-\theta) & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

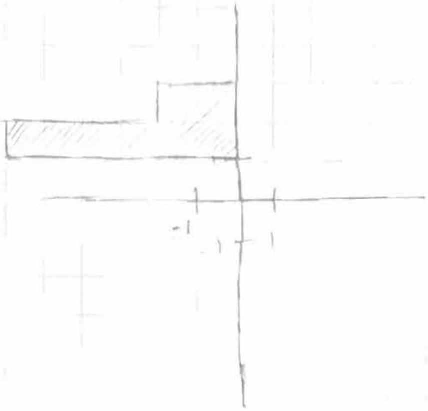
$$* \begin{bmatrix} 1 & 0 & +d \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} =$$

#7 on back

#7

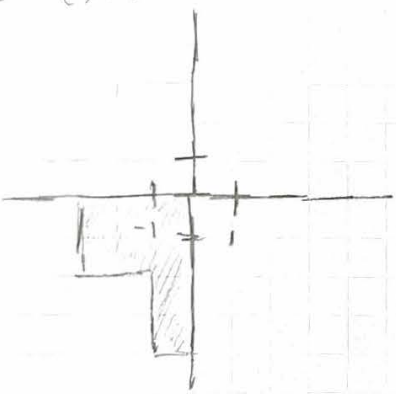
a) $L' = ABC\,L$

modelMatrix * RotateZ(90)
modelMatrix * Translate(1, 1, 0)
modelMatrix * Scale(2, 1, 1)



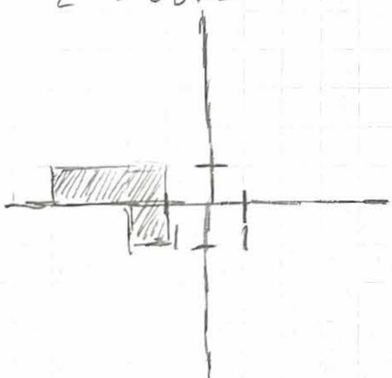
b) $L' = CAD\,L$

modelMatrix * Scale(-1, 1, 1)
modelMatrix * Scale(2, 1, 1)
modelMatrix * RotateZ(90)



c) $L' = CBD\,L$

modelMatrix * Scale(-1, 1, 1)
modelMatrix * Translate(1, 1, 0)
modelMatrix * RotateZ(90)



d) $L' = DCCAD\,L$

modelMatrix * RotateZ(90)
modelMatrix * Scale(-1, 1, 1)