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CS174A → Assignment 1

1.)

a.) A: $p = 0 + 2i_A - j_A$
B: $p = 0 + 3i_B + j_B$
C: $p = 0 - 3i_c + \frac{7}{3}j_c$

b.) 2 points needed to describe a vector.
A: $v = 2i_A - j_A$
B: $v = -2i_B - \frac{3}{2}j_B$
C: $V = i_c - 0j_c$

c.) A coordinate frame is represented by basis vectors and and origin.

d.)

$$M_A = \begin{bmatrix} 1 & 0 & 1 \\ 0 & 1 & 2 \\ 0 & 0 & 1 \end{bmatrix} \qquad M_B = \begin{bmatrix} -1 & 0 & 6 \\ -1 & 2 & 2 \\ 0 & 0 & 1 \end{bmatrix}$$

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

$$w = \begin{bmatrix} 3 \\ 1 \\ 1 \end{bmatrix}$$

e.) $P_w = M_A P_A$

$$P_A = \begin{bmatrix} 2 \\ -1 \\ 1 \end{bmatrix}$$

$$\overset{M_A}{\begin{bmatrix} 1 & 0 & 1 \\ 0 & 1 & 2 \\ 0 & 0 & 1 \end{bmatrix}} \overset{P_A}{\begin{bmatrix} 2 \\ -1 \\ 1 \end{bmatrix}} = \begin{bmatrix} 2+1 \\ -1+2 \\ 1 \end{bmatrix} = \overset{P_w}{\begin{bmatrix} 3 \\ 1 \\ 1 \end{bmatrix}} \checkmark$$

$PW =$

$P_w = M_B P_B \qquad P_B = \begin{bmatrix} 3 \\ 1 \\ 1 \end{bmatrix}$

$$\begin{bmatrix} -1 & 0 & 6 \\ -1 & 2 & 2 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 3 \\ 1 \\ 1 \end{bmatrix} = \begin{bmatrix} -3+6 \\ -3+2+2 \\ 1 \end{bmatrix} = \begin{bmatrix} 3 \\ 1 \\ 1 \end{bmatrix} \checkmark$$

$P_w = M_c P_c \qquad P_c = \begin{bmatrix} -3 \\ 7/3 \\ 1 \end{bmatrix}$

$$\begin{bmatrix} 2 & -3 & 2 \\ -1 & -3 & 5 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} -3 \\ 7/3 \\ 1 \end{bmatrix} = \begin{bmatrix} -6+7+2 \\ 3-7+5 \\ 1 \end{bmatrix} = \begin{bmatrix} 3 \\ 1 \\ 1 \end{bmatrix} \checkmark$$

2.)

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

$$\begin{array}{cc} \text{Scale}(1,1,2) & \text{Trans}(1,1,1) \end{array}$$

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

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

$\therefore M = \begin{bmatrix} 1 & 0 & 0 & 1 \\ 0 & 1 & 0 & 1 \\ 0 & 0 & 2 & 1 \\ 0 & 0 & 0 & 1 \end{bmatrix}$

4.) $[2 \;\; 10 \;\; 8 \;\; 4]^T \Rightarrow [2/4 \;\; 10/4 \;\; 8/4 \;\; 4/4]^T \Rightarrow$

$\boxed{\Rightarrow [0.5 \;\; 2.5 \;\; 2 \;\; 1]^T}$

5.)

//A $\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 2 \\ 0 & 1 & 0 & 3 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} = \boxed{\begin{bmatrix} 1 & 0 & 0 & 2 \\ 0 & 1 & 0 & 3 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}}$

//B

$\begin{bmatrix} 1 & 0 & 0 & 2 \\ 0 & 1 & 0 & 3 \\ 0 & 0 & 1, & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \cos 90 & 0 & \sin 90 & 0 \\ 0 & 1 & 0 & 0 \\ -\sin 90 & 0 & \cos 90 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \Rightarrow$

sonstack

11B

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

11C

$$\begin{bmatrix} 0 & 0 & 1 & 2 \\ 0 & 1 & 0 & 3 \\ -1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0.5 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 1 & 2 \\ 0 & 0.5 & 0 & 3 \\ -1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 0 & 0 & 1 & 2 \\ 0 & 0.5 & 0 & 3 \\ -1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 1 \\ 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} = \boxed{\begin{bmatrix} 0 & 0 & 1 & 2 \\ 0 & 0.5 & 0 & 3.5 \\ -1 & 0 & 0 & -1 \\ 0 & 0 & 0 & 1 \end{bmatrix}}$$

11D

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

6.)

Let a be the y-intercept

Let θ be the angle of the tilted line back at the origin

$$M = \underbrace{\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & -b \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \cos\theta & \sin\theta & 0 \\ -\sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & b \\ 0 & 0 & 1 \end{bmatrix}}_{\text{Composite Matrix}}$$

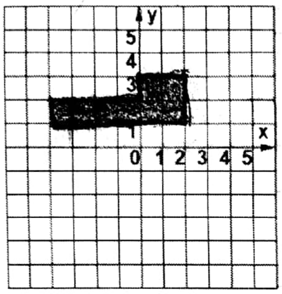
OpenGL Commands:

```
modelMatrix.setAsIdentity();
modelMatrix = modelMatrix * Translate(0, -b);
modelMatrix = modelMatrix * RotateY(-θ);
modelMatrix = modelMatrix * Scale(1, -1);
modelMatrix = modelMatrix * RotateY(θ);
modelMatrix = modelMatrix * Translate(0, b);
```

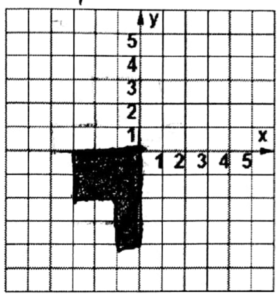
7.) On Last Page →

$$\mathbf{A} = \overset{\text{Scale}}{\begin{bmatrix} 2 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}}, \mathbf{B} = \overset{\text{Trans}}{\begin{bmatrix} 1 & 0 & 0 & 1 \\ 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}}, \mathbf{C} = \overset{\text{Rotation } 90° \text{ cc}}{\begin{bmatrix} 0 & -1 & 0 & 0 \\ 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}}, \mathbf{D} = \overset{\text{Ref. abt. } y}{\begin{bmatrix} -1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}}$$

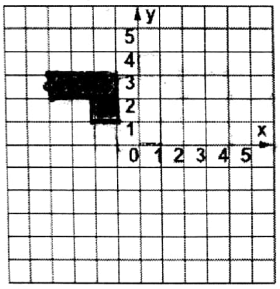
a) L' = ABC L



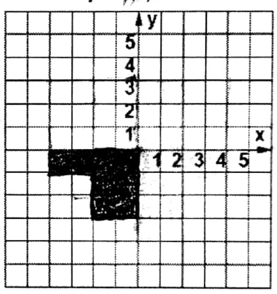
b) L' = $\cancel{C}\cancel{X}\cancel{D}$ L



c) L' = $\cancel{C}\cancel{B}\cancel{D}$ L



d) L' = D$\cancel{C}\cancel{C}\cancel{X}\cancel{D}$ L



a.) modelMatrix.setAsIdentity();
modelMatrix = modelMatrix * RotateZ(90);
modelMatrix = modelMatrix * Translate(1,1,1);
modelMatrix = modelMatrix * Scale(2,1,1);
drawL(modelMatrix);

b.) modelMatrix.setAsIdentity();
modelMatrix = modelMatrix * Scale(-1,1,1);
modelMatrix = modelMatrix * Scale(2,1,1);
modelMatrix = modelMatrix * RotateZ(90);
drawL(modelMatrix);

c.) modelMatrix.setAsIdentity();
modelMatrix = modelMatrix * Scale(-1,1,1);
modelMatrix = modelMatrix * Translate(1,1,1);
modelMatrix = modelMatrix * RotateZ(90);
drawL(modelMatrix);

d.) modelMatrix.setAsIdentity();
modelMatrix = modelMatrix * Scale(-1,1,1);
modelMatrix = modelMatrix * Scale(2,1,1);
modelMatrix = modelMatrix * RotateZ(90);
modelMatrix = modelMatrix * RotateZ(90);
modelMatrix = modelMatrix * Scale(-1,1,1);
drawL(modelMatrix);