1. (15 pts) The point coordinate \( P \) can be expressed as \( P = 6i + 1j \), where \( i \) and \( j \) are basis vectors of unit length along the x and y axes, respectively, with an origin at the lower left of the grid. Describe the point \( P \) in terms of the 3 other coordinate systems given below.

2. (3 pts) Write down the 4x4 matrix for translating an object by 4 in y, 1 in x, and 2 in z.

3. (8 pts) Give the OpenGL commands required to encode \( M \). You may assume the matrix stack has been initialized with \texttt{glIdentity()}.

\[
\begin{bmatrix}
0 & 0 & 1 & 1 \\
0 & 1 & 0 & 1 \\
-1 & 0 & 0 & 1 \\
0 & 0 & 0 & 1
\end{bmatrix}
\]

4. (4 pts) Homogenize the point \((12,3,6,3)\).

5. (16 pts) Give the 4x4 OpenGL modelview matrix at the four lines A, B, C, and D below.

```plaintext
GLuint glLoadIdentity();
GLuint glRotate(90, 0,1,0);  
A
GLuint glTranslate(2,3,0);  
B
GLuint glPushMatrix();
GLuint glScale(2,1,1);     
C
GLuint glPopMatrix();
GLuint glTranslate(1,0,0);  
D
```
6. (60 pts) For each equation below, sketch the new location $L'$ of the L shape on the grid and provide the OpenGL sequence needed to carry out those operations. Use the function $\text{drawL}()$, which draws an L shape with the lower left corner at the current origin as shown below. You may assume the matrix mode is $\text{GL}_\text{MODELVIEW}$ and that the stack has been initialized with $\text{glLoadIdentity}()$. For reference, the OpenGL command syntax is $\text{glRotatef}(\text{angle}, \text{x}, \text{y}, \text{z})$, $\text{glTranslatef}(\text{x}, \text{y}, \text{z})$, $\text{glScalef}(\text{x}, \text{y}, \text{z})$.

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

a) $L' = AB \ L$

b) $L' = ACD \ L$

c) $L' = CDA \ L$

d) $L' = CBA \ L$

e) $L' = DBCA \ L$

f) $L' = CADAD \ L$