MCE4101
Robotic Engineering

Assignment 1
Due: 15 July 2021 (9.00am)

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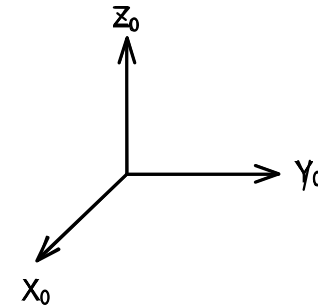
Assumption University

Faculty of Engineering

Assignment1

Q1.

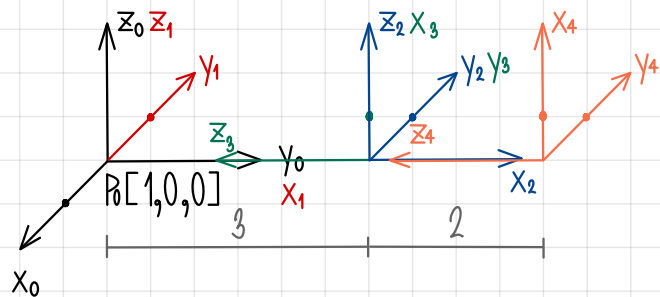1. Rotate 90° in the current z axis then

2. Translate 3 in the current x axis then

3. Rotate 90° in the current y axis

4. Translate -2 in the current z axis then

Z_0

Y_0

X_0

Find H_4^0

Draw all the frames axes. If a point is fixed on the x axis at (1,0,0), find the coordinate of this point when reference to origin.

Q_1

$T_1^0 = Rot(z, 90°)$

$T_2^1 = D(x, 3)$

$T_3^2 = Rot(y, 90°)$

$T_4^3 = D(z, -2)$

$T_{C4}^0 = T_1^0 T_2^1 T_3^2 T_4^3$

$$= \begin{bmatrix} \cos(90°) & -\sin(90°) & 0 & 0 \\ \sin(90°) & \cos(90°) & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 3 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \cos(90°) & 0 & -\sin(90°) & 0 \\ 0 & 1 & 0 & 0 \\ \sin(90°) & 0 & \cos(90°) & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & -2 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

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

$P_{C5} = T_{C5}^0 P_0$

$$= \begin{bmatrix} 0 & -1 & 0 & 0 \\ 0 & 0 & 1 & 1 \\ -1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 \\ 0 \\ 0 \\ 1 \end{bmatrix} = \begin{bmatrix} 0 \\ 1 \\ -1 \\ 1 \end{bmatrix}$$
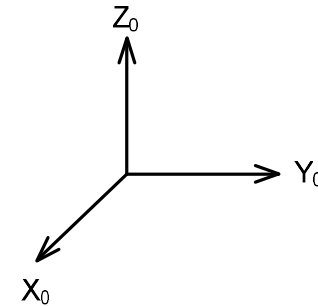
Q1.

1. Rotate 90° in the current z axis then

2. Translate 3 in the current x axis then

3. Rotate 90° in the current y axis

4. Translate -2 in the current z axis then

Assignment1

Q2.

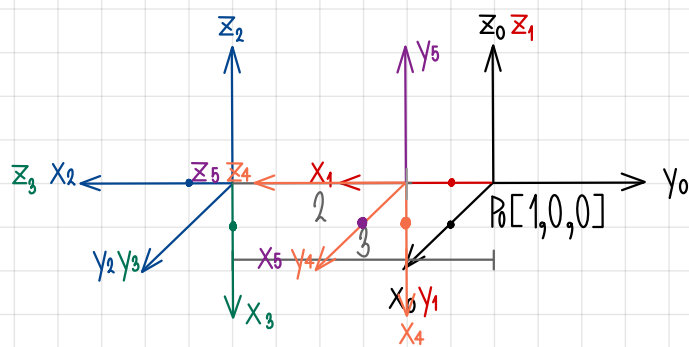1. Rotate -90° in the current z axis then

2. Translate 3 in the current x axis then

3. Rotate 90° in the current y axis

4. Translate -2 in the current z axis then

5. Rotate -90° in the current z axis

Z_0

Y_0

X_0

Find H_5^0

Draw all the frames axes. If a point is fixed on the x axis at (1,0,0), find the coordinate of this point when reference to origin.

Q_2

$$T_1^0 = Rot(z, -90°)$$

$$T_2^1 = D(x, 3)$$

$$T_3^2 = Rot(y, 90°)$$

$$T_4^3 = D(z, -2)$$

$$T_5^4 = Rot(z, -90°)$$

$$T_{c5}^0 = T_1^0 T_2^1 T_3^2 T_4^3 T_5^4$$

$$= \begin{bmatrix} \cos(-90°) & -\sin(-90°) & 0 & 0 \\ \sin(-90°) & \cos(-90°) & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 3 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \cos(90°) & 0 & -\sin(90°) & 0 \\ 0 & 1 & 0 & 0 \\ \sin(90°) & 0 & \cos(90°) & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & -2 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \cos(-90°) & -\sin(-90°) & 0 & 0 \\ \sin(-90°) & \cos(-90°) & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

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

$$P_{c5} = T_{c5}^0 P_0$$

$$= \begin{bmatrix} -1 & 0 & 0 & 0 \\ 0 & 0 & -1 & -1 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 \\ 0 \\ 0 \\ 1 \end{bmatrix} = \begin{bmatrix} -1 \\ -1 \\ 0 \\ 1 \end{bmatrix}$$
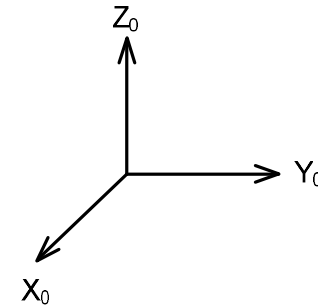
Q2.

1. Rotate -90° in the current z axis then

2. Translate 3 in the current x axis then

3. Rotate 90° in the current y axis

4. Translate -2 in the current z axis then
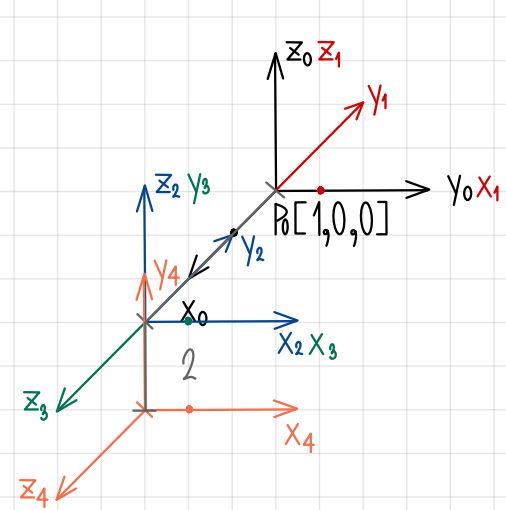
5. Rotate -90° in the current z axis

Q3.

1. Rotate 90° in the fixed z_0 axis then

2. Translate 3 in the fixed x_0 axis then

3. Rotate 90° in the fixed y_0 axis

4. Translate -2 in the fixed z_0 axis then

Z_0

Y_0

X_0

Find H_4^0

Draw all the frames axes. If a point is fixed on the x axis at (1,0,0), find the coordinate of this point when reference to origin.

Q3

$$T_1^0 = Rot(z, 90°)$$

$$T_2^1 = D(x, 3)$$

$$T_3^2 = Rot(y, 90°)$$

$$T_4^3 = D(z, -2)$$

$$T_{F4}^0 = T_4^3 T_2^1 T_3^2 T_1^0$$

$$= \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & -2 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 3 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \cos(90°) & 0 & -\sin(90°) & 0 \\ 0 & 1 & 0 & 0 \\ \sin(90°) & 0 & \cos(90°) & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \cos(90°) & -\sin(90°) & 0 & 0 \\ \sin(90°) & \cos(90°) & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

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

$$P_{F5} = T_{F5}^0 P_0$$

$$= \begin{bmatrix} 0 & 0 & 1 & 3 \\ 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & -2 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 \\ 0 \\ 0 \\ 1 \end{bmatrix} = \begin{bmatrix} 3 \\ 1 \\ -2 \\ 1 \end{bmatrix}$$
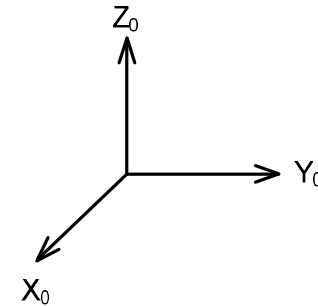
Q3.

1. Rotate 90° in the fixed z_0 axis then

2. Translate 3 in the fixed x_0 axis then

3. Rotate 90° in the fixed y_0 axis

4. Translate -2 in the fixed z_0 axis then

Assignment1

Q4.

1. Rotate -90° in the fixed z axis then

2. Translate -3 in the fixed x axis then

3. Rotate -90° in the fixed y axis

4. Rotate 90° in the fixed x axis then

5. Rotate -90° in the fixed z axis

Find H_5^0

Draw all the frames axes. If a point is fixed on the x axis at (1,0,0), find the coordinate of this point when reference to origin.
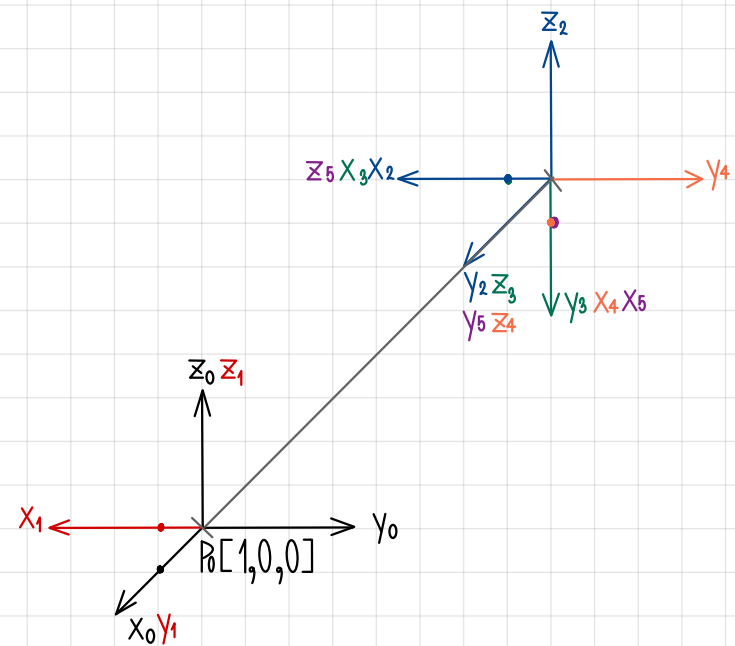
Q4

$$T_1^0 = Rot(z, -90°)$$

$$T_2^1 = D(x, -3)$$

$$T_3^2 = Rot(y, -90°)$$

$$T_4^3 = Rot(x, 90°)$$

$$T_5^4 = Rot(z, -90°)$$

$$T_{c5}^0 = T_2^1(T_5^4 T_4^3 T_3^2 T_1^0) =$$

$$\begin{bmatrix} 1 & 0 & 0 & -3 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \cos(-90°) & -\sin(-90°) & 0 & 0 \\ \sin(-90°) & \cos(-90°) & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos(90°) & -\sin(90°) & 0 \\ 0 & \sin(90°) & \cos(90°) & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \cos(-90°) & 0 & -\sin(-90°) & 0 \\ 0 & 1 & 0 & 0 \\ \sin(-90°) & 0 & \cos(-90°) & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \cos(-90°) & -\sin(-90°) & 0 & 0 \\ \sin(-90°) & \cos(-90°) & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

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

$$P_{c5} = T_{c5}^0 P_0$$

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

Q4.

1. Rotate -90° in the fixed z axis then

2. Translate -3 in the fixed x axis then

3. Rotate -90° in the fixed y axis

4. Rotate 90° in the fixed x axis then

5. Rotate -90° in the fixed z axis