HOMEWORK 4 - ECE 4560   ERICKSON, BRETT

HOMEWORK HOURS:
LAB HOURS:
DIFFICULTY:

1) a)
$$\hat{\xi} = \begin{bmatrix} 0 & \pi/2 & 10 \\ -\pi/2 & 0 & 2 \\ 0 & 0 & 0 \end{bmatrix}$$
BASED ON $\begin{bmatrix} [\omega]_x & v_1 \\ 0 & 0 \end{bmatrix}$ WHERE $v_1 = \begin{bmatrix} 10 \\ 2 \end{bmatrix}$

& $\omega = -\pi/2$ $[\ast]_x = \begin{bmatrix} 0 & -\ast \\ \ast & 0 \end{bmatrix}$

b)
$$\hat{\xi} = \begin{bmatrix} 0 & -\pi/2 & \pi/4 & 4 \\ \pi/2 & 0 & -\pi & 2 \\ -\pi/4 & \pi & 0 & 3 \\ 0 & 0 & 0 & 0 \end{bmatrix}$$
WHERE $\omega = \begin{bmatrix} \pi \\ \pi/4 \\ \pi/2 \end{bmatrix}$ AND $v = \begin{bmatrix} 4 \\ 2 \\ 3 \end{bmatrix}$

c) $\xi = [7, -3, \pi/8]^T$

2) a) $[v]_x = \begin{bmatrix} 0 & -3 & 2 \\ 3 & 0 & -1 \\ -2 & 1 & 0 \end{bmatrix}$ BY DEF OF SKEW SYM. MATRIX

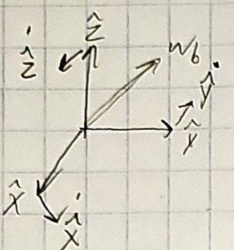
b) $v = [3, 5, 2]^T$

3) a) SPATIAL TWIST, A REPRESENTATION OF THE LINEAR VELOCITY AND ROTATION RATE OF A RIGID BODY, AS EXPERIENCED BY A POINT AT THE WORLD ORIGIN, HAD THAT POINT BEEN DEFINED AS PART OF THE RIGID BODY
FOR SE(2), REQ 3 ENTRIES
FOR SE(3), REQ 6 ENTRIES

b) BODY TWIST, SIMILAR TO ABOVE, BUT DEFINED BY A POINT WITHIN THE BODY

4) $R_{ba} = R_{ab}^T = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & -1 & 0 \end{bmatrix}$

$p_b = R_{ba} \, p_a = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & -1 & 0 \end{bmatrix} \begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix} = \begin{bmatrix} 1 \\ 3 \\ -2 \end{bmatrix}$

5) a) 

$$\dot{\hat{x}}_b = \underbrace{\begin{bmatrix} 0 & -1 & 1 \\ 1 & 0 & 0 \\ -1 & 0 & 0 \end{bmatrix}}_{[w_b]_\times} \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix} = \begin{bmatrix} 0 \\ 1 \\ -1 \end{bmatrix}$$

$$\dot{\hat{y}} = [w_b]_\times \begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix} = \begin{bmatrix} -1 \\ 0 \\ 0 \end{bmatrix}$$

$$\dot{\hat{z}} = [w_b]_\times \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix}$$

b) $R_{be} = \begin{bmatrix} 0 & 1 & 0 \\ -1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix}$ $R_{eb} = \begin{bmatrix} 0 & -1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix}$ $\Rightarrow w_e = R_{eb} w_b = \begin{bmatrix} 0 & -1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 0 \\ 1 \\ 1 \end{bmatrix} = \begin{bmatrix} -1 \\ 0 \\ 1 \end{bmatrix}$