c) $p_{WORLD,c} = (-2,-1,2,1)^T$

$$p_{CAM,c} = \begin{bmatrix} -0.51 & 0.51 & -0.69 & -2.1 \\ -0.75 & 0.13 & 0.65 & -1.75 \\ 0.42 & 0.85 & 0.32 & -10.28 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} -2 \\ -1 \\ 2 \\ 1 \end{bmatrix} = \begin{bmatrix} -2.9 \\ 0.9 \\ -11.3 \\ 1 \end{bmatrix}$$

d) $p_{world,d} = (1,5,-1,1)^T$

$$p_{CAM,d} = \begin{bmatrix} -0.51 & 0.51 & -0.69 & -2.1 \\ -0.75 & 0.13 & 0.65 & -1.75 \\ 0.42 & 0.85 & 0.32 & -10.28 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 \\ 5 \\ -1 \\ 1 \end{bmatrix} = \begin{bmatrix} 0.7 \\ -2.5 \\ -5.9 \\ 1 \end{bmatrix}$$

8)

a) $p_{cam,a} = \begin{bmatrix} -3.3 \\ -3.1 \\ -7.0 \\ 1 \end{bmatrix}$

$$p_{clip,a} = M_{proj} \cdot p_{cam,a} = \begin{bmatrix} 3.734 & 0 & 0 & 0 \\ 0 & 1.867 & 0 & 0 \\ 0 & 0 & -1.02 & +2.02 \\ 0 & 0 & -1 & 0 \end{bmatrix} \begin{bmatrix} -3.3 \\ -3.1 \\ -7.0 \\ 1 \end{bmatrix} = \begin{bmatrix} -12.3 \\ -5.8 \\ 9.16 \\ 7.0 \end{bmatrix}$$

b) $p_{cam,b} = \begin{bmatrix} 0 \\ -3.7 \\ -11.2 \\ 1 \end{bmatrix}$

$$p_{clip,b} = M_{proj} \cdot p_{cam,b} = \begin{bmatrix} 3.734 & 0 & 0 & 0 \\ 0 & 1.867 & 0 & 0 \\ 0 & 0 & -1.02 & +2.02 \\ 0 & 0 & -1 & 0 \end{bmatrix} \begin{bmatrix} 0 \\ -3.7 \\ -11.2 \\ 1 \end{bmatrix} = \begin{bmatrix} 0 \\ -6.9 \\ 13.44 \\ 11.2 \end{bmatrix}$$

c) $p_{cam,c} = \begin{bmatrix} -2.9 \\ 0.9 \\ -11.3 \\ 1 \end{bmatrix}$

$$p_{clip,c} = M_{proj} \cdot p_{cam,c} = \begin{bmatrix} 3.734 & 0 & 0 & 0 \\ 0 & 1.867 & 0 & 0 \\ 0 & 0 & -1.02 & +2.02 \\ 0 & 0 & -1 & 0 \end{bmatrix} \begin{bmatrix} -2.9 \\ 0.9 \\ -11.3 \\ 1 \end{bmatrix} = \begin{bmatrix} -10.8 \\ 1.7 \\ 13.55 \\ 11.3 \end{bmatrix}$$

d) $p_{cam,d} = \begin{bmatrix} 0.7 \\ -2.5 \\ -5.9 \\ 1 \end{bmatrix}$

$$p_{clip,c} = M_{proj} \cdot p_{cam,d} = \begin{bmatrix} 3.734 & 0 & 0 & 0 \\ 0 & 1.867 & 0 & 0 \\ 0 & 0 & -1.02 & +2.02 \\ 0 & 0 & -1 & 0 \end{bmatrix} \begin{bmatrix} 0.7 \\ -2.5 \\ -5.9 \\ 1 \end{bmatrix} = \begin{bmatrix} 2.6 \\ -4.7 \\ 8.04 \\ 5.9 \end{bmatrix}$$

9) a) $p_{NDC,a} = p_{clip,a} / p_{clip,a}[3]$ — LAST ELEMENT OF $p_{clip,a}$

$$p_{NDC,a} = \frac{1}{7.0} \begin{bmatrix} -12.3 \\ -5.8 \\ 9.16 \\ 7.0 \end{bmatrix} = \begin{bmatrix} -1.8 \\ -0.8 \\ 1.31 \\ 1 \end{bmatrix}$$