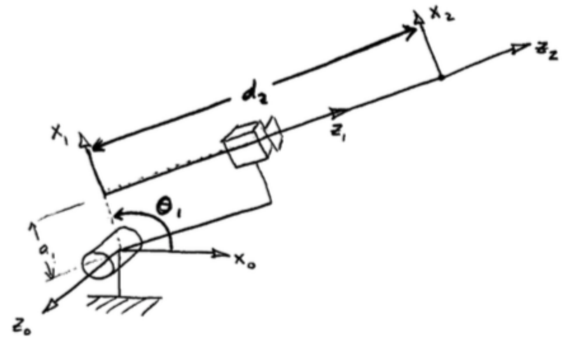
Solutions for Problems 3.4, 3.5, and 3.7

3.4. The choice of the D-H coordinate frames is shown in the figure below.



The corresponding D-H table is:

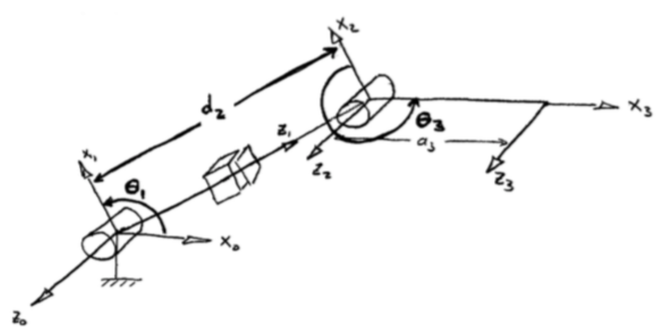
	a_i	α_i	d_i	θ_i
Link 1	a_1	90^o	0	θ_1^*
Link 2	0	0	d_2^*	0

Hence, the homogeneous transformation matrices A_1 and A_2 and the homogeneous transformation matrix H_2^0 are given as:

$$A_1 = \begin{bmatrix} c_1 & 0 & s_1 & a_1c_1 \\ s_1 & 0 & -c_1 & a_1s_1 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad ; \quad A_2 = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & d_2 \\ 0 & 0 & 0 & 1 \end{bmatrix} \tag{1}$$

$$H_2^0 = \begin{bmatrix} c_1 & 0 & s_1 & a_1c_1 + d_2s_1 \\ s_1 & 0 & -c_1 & a_1s_1 - d_2c_1 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \tag{2}$$

3.5. The choice of the D-H coordinate frames is shown in the figure below.



The corresponding D-H table is:

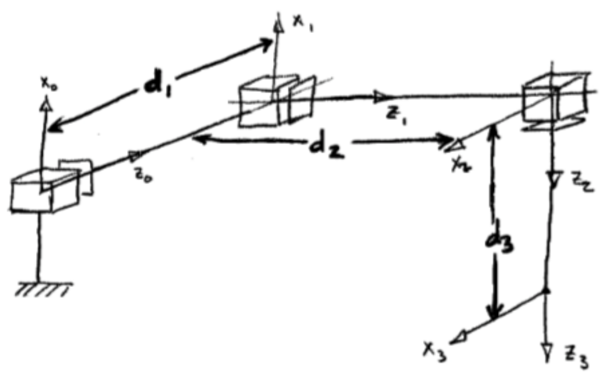
	a_i	α_i	d_i	θ_i
Link 1	0	90^o	0	θ_1^*
Link 2	0	-90^o	d_2^*	0
Link 3	a_3	0	0	θ_3^*

Hence, the homogeneous transformation matrices A_1, A_2, and A_3 and the homogeneous transformation matrix H_3^0 are given as:

$$A_1 = \begin{bmatrix} c_1 & 0 & s_1 & 0 \\ s_1 & 0 & -c_1 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad ; \quad A_2 = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & -1 & 0 & d_2 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad ; \quad A_3 = \begin{bmatrix} c_3 & -s_3 & 0 & a_3c_3 \\ s_3 & c_3 & 0 & a_3s_3 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \tag{3}$$

$$H_3^0 = \begin{bmatrix} c_1c_3 - s_1s_3 & -c_1s_3 - c_3s_1 & 0 & d_2s_1 + a_3c_1c_3 - a_3s_1s_3 \\ c_1s_3 + c_3s_1 & c_1c_3 - s_1s_3 & 0 & a_3c_1s_3 - d_2c_1 + a_3c_3s_1 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \tag{4}$$

3.7. The choice of the D-H coordinate frames is shown in the figure below.



The corresponding D-H table is:

	a_i	α_i	d_i	θ_i
Link 1	0	-90^o	d_1^*	0
Link 2	0	-90^o	d_2^*	90^o
Link 3	0	0	d_3^*	0

Hence, the homogeneous transformation matrices A_1, A_2, and A_3 and the homogeneous transformation matrix H_3^0 are given as:

$$A_1 = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & -1 & 0 & d_1 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad ; \quad A_2 = \begin{bmatrix} 0 & 0 & -1 & 0 \\ 1 & 0 & 0 & 0 \\ 0 & -1 & 0 & d_2 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad ; \quad A_3 = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & d_3 \\ 0 & 0 & 0 & 1 \end{bmatrix} \tag{5}$$

$$H_3^0 = \begin{bmatrix} 0 & 0 & -1 & -d_3 \\ 0 & -1 & 0 & d_2 \\ -1 & 0 & 0 & d_1 \\ 0 & 0 & 0 & 1 \end{bmatrix} \tag{6}$$