

1. standard

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

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

Link	$\theta_i$	$d_i$	$a_i$	$\alpha_i$	$G_i$
1	0	$d_1$	0	$q_0$	P
2	$q_0$	$d_2$	0	$q_0$	P
3	$\theta_3$	0	<del>0</del> 0	0	R

2. modified.

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

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

Link	$\alpha_{i-1}$	$a_{i-1}$	$d_i$	$\theta_i$	$G_i$
1	0	0	$d_1$	0	P
2	$q_0$	0	$d_2$	$q_0$	P
3	$q_0$	0	0	$\theta_3$	R

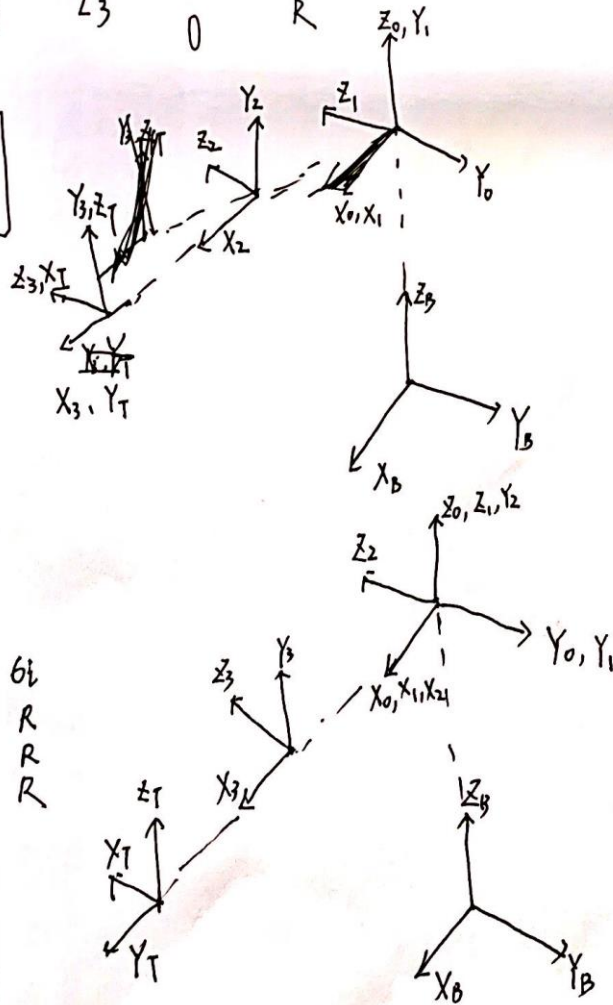
3.

a) Base = 
$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & L_1 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

standard DH parameters

Link	$\theta_i$	$d_i$	$a_i$	$\alpha_i$	$\sigma_i$
1	$\theta_1$	0	0	$q_0$	R
2	$\theta_2$	0	$L_2$	0	R
3	$\theta_3$	0	$L_3$	0	R

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

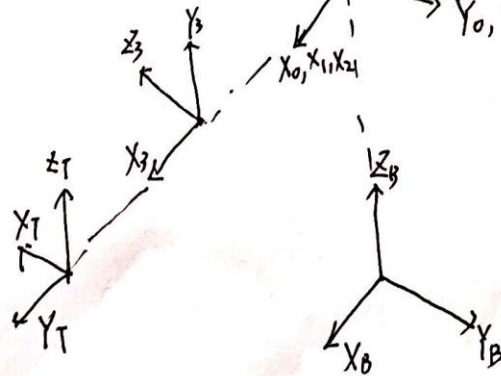


b) Base = 
$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & L_1 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

modified DH

Link	$\theta_{i-1}$	$d_{i-1}$	$d_i$	$\theta_i$	$\sigma_i$
1	$q_0$	0	0	$\theta_1$	R
2	0	0	0	$\theta_2$	R
3	0	$L_2$	0	$\theta_3$	R

Tool = 
$$\begin{bmatrix} 0 & 1 & 0 & L_3 \\ 0 & 0 & 1 & 0 \\ 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$



$$4. \quad \theta_s = \phi - 90^\circ$$

$$d_1 = x + L \sin(\phi - 90^\circ) = x - L \cos \phi$$

$$d_2 = y - L \cos(\phi - 90^\circ) = y - L \sin \phi$$