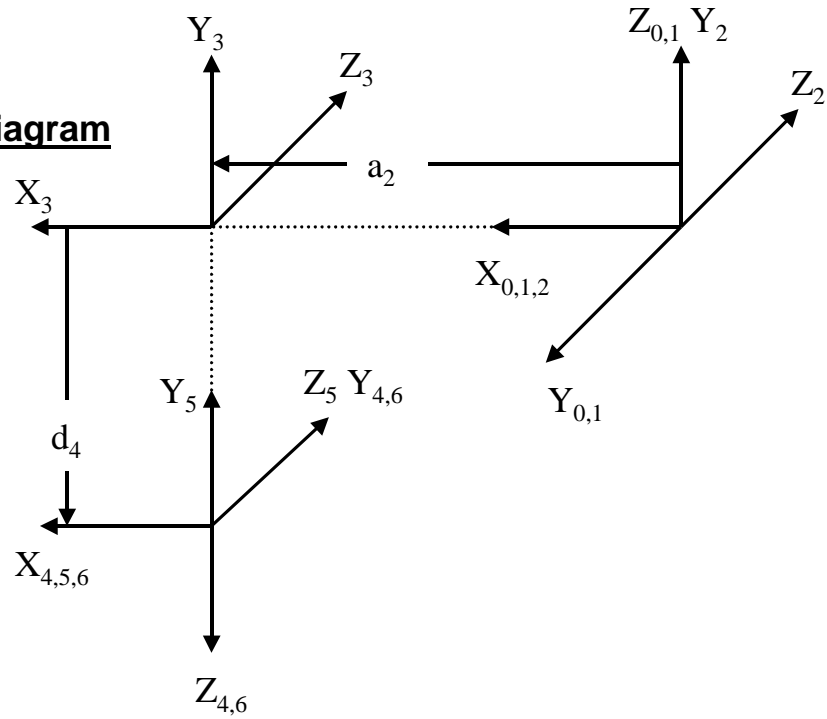


Quiz 3 solutions:

1. (a)

Frame diagram



Quiz 3 solutions (continued):

1. (b) NR robot link parameter table

i	α_{i-1}	a_{i-1}	d_i	θ_i	Variable
1	0	0	0	θ_1	θ_1
2	90	0	0	θ_2	θ_2
3	0	a_2	0	θ_3	θ_3
4	90	0	d_4	θ_4	θ_4
5	-90	0	0	θ_5	θ_5
6	90	0	0	θ_6	θ_6

Quiz 3 solutions (continued):

1. (c) NR robot link transformation matrices

$$\begin{aligned}
 {}^0_1T &= \begin{bmatrix} c_1 & -s_1 & 0 & 0 \\ s_1 & c_1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} & {}^1_2T &= \begin{bmatrix} c_2 & -s_2 & 0 & 0 \\ 0 & 0 & -1 & 0 \\ s_2 & c_2 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} & {}^2_3T &= \begin{bmatrix} c_3 & -s_3 & 0 & a_2 \\ s_3 & c_3 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \\
 {}^3_4T &= \begin{bmatrix} c_4 & -s_4 & 0 & 0 \\ 0 & 0 & -1 & -d_4 \\ s_4 & c_4 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} & {}^4_5T &= \begin{bmatrix} c_5 & -s_5 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ -s_5 & -c_5 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} & {}^5_6T &= \begin{bmatrix} c_6 & -s_6 & 0 & 0 \\ 0 & 0 & -1 & 0 \\ s_6 & c_6 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}
 \end{aligned}$$

Quiz 3 solutions (continued):

1. (d) Forward kinematics equations

See Mathematica file nrforkin.nb.