

Rotation Matrices

$${}^0R_3 = \begin{pmatrix} \cos \theta_1 \cos \theta_2 \cos \theta_3 - \cos \theta_1 \sin \theta_2 \sin \theta_3 & -\sin \theta_1 & \cos \theta_1 \cos \theta_2 \sin \theta_3 + \cos \theta_1 \sin \theta_2 \cos \theta_3 \\ \sin \theta_1 \cos \theta_2 \cos \theta_3 - \sin \theta_1 \sin \theta_2 \sin \theta_3 & \cos \theta_1 & \sin \theta_1 \cos \theta_2 \sin \theta_3 + \sin \theta_1 \sin \theta_2 \cos \theta_3 \\ -\sin \theta_2 \cos \theta_3 - \cos \theta_2 \sin \theta_3 & 0 & -\sin \theta_2 \sin \theta_3 - \cos \theta_2 \cos \theta_3 \end{pmatrix}$$

$${}^3R_6 = \begin{pmatrix} \cos \theta_4 \cos \theta_5 \cos \theta_6 - \sin \theta_4 \sin \theta_6 & -\cos \theta_4 \cos \theta_5 \sin \theta_6 - \sin \theta_4 \cos \theta_6 & \cos \theta_4 \sin \theta_5 \\ \sin \theta_4 \cos \theta_5 \cos \theta_6 + \cos \theta_5 \sin \theta_6 & -\sin \theta_4 \cos \theta_5 \sin \theta_6 + \cos \theta_5 \cos \theta_6 & \sin \theta_4 \sin \theta_5 \\ -\sin \theta_5 \cos \theta_5 & \sin \theta_5 \sin \theta_5 & \cos \theta_5 \end{pmatrix}$$

$${}^0R_6 = \begin{pmatrix} \sin \theta_e & \cos \theta_p \cos \theta_e & \cos \theta_p \cos \theta_e \\ \sin \theta_p \cos \theta_e & \sin \theta_e & \sin \theta_p \cos \theta_e \\ -\cos \theta_p \cos \theta_e & -\sin \theta_p \cos \theta_e & \sin \theta_e \end{pmatrix}$$