

ECE 763

Homework #5

In this homework problem, it is assumed that the homogeneous transformation relating the tool coordinate system (fixed to the end effector) $[\hat{\mathbf{X}}_T, \hat{\mathbf{Y}}_T, \hat{\mathbf{Z}}_T]$ to the workstation coordinate system $[\hat{\mathbf{X}}_S, \hat{\mathbf{Y}}_S, \hat{\mathbf{Z}}_S]$ for the MITSUBISHI is given and is equal to ${}^S T_T$. This implies that ${}^0 T_5$ is known:

$${}^0 T_5 = ({}^S T_0)^{-1} {}^S T_T ({}^5 T_T)^{-1} = \begin{bmatrix} n_x & o_x & a_x & p_x \\ n_y & o_y & a_y & p_y \\ n_z & o_z & a_z & p_z \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Assignment:

- (a) Determine expressions for $\theta_1, \theta_2, \theta_3, \theta_4$, and θ_5 , each as a function of the elements of ${}^0 T_5$.
- (b) For each of the expressions above, indicate which have multiple solutions and what their physical significance is. If an angle can be computed exactly, be sure that the expression for it has but one solution.
- (c) Show all work. Begin by giving expressions for ${}^{j-1} T_j$ and ${}^{j-1} T_5$ for $j = 1, \dots, 5$.
- (d) Use a set of link parameters which gives a zero configuration in which the arm is straight out to the right ($\hat{\mathbf{X}}$ direction) and the end effector points upward.