ECE 763
Homework #4

The purpose of this homework is to:

(a) Assign coordinate frames to the MITSUBISHI RM-501 robot,

(b) Determine its link parameters, and

(c) Derive its kinematic equations.

The basic dimensions and movement range of each of the joints of the MITSUBISHI RM-501 are shown on the following page. Also, the five joint axes $\hat{\mathbf{Z}}_1$ through $\hat{\mathbf{Z}}_5$ are shown. Note that $\hat{\mathbf{Z}}_2$, $\hat{\mathbf{Z}}_3$, and $\hat{\mathbf{Z}}_4$ are parallel and directed inward. A reference coordinate system which is fixed to the table on which the MITSUBISHI is mounted within the workstation has been defined as $[\hat{\mathbf{X}}_S, \hat{\mathbf{Y}}_S, \hat{\mathbf{Z}}_S]$. The position and orientation of the base coordinate system $[\hat{\mathbf{X}}_0, \hat{\mathbf{Y}}_0, \hat{\mathbf{Z}}_0]$ with respect to this is specified through the ${}^{S}T_0$ homogeneous transformation. A tool coordinate system $[\hat{\mathbf{X}}_T, \hat{\mathbf{Y}}_T, \hat{\mathbf{Z}}_T]$ is also shown. It is fixed to the end effector and has its origin at its center. Its position and orientation with respect to the coordinate system fixed to link 5, $[\hat{\mathbf{X}}_5, \hat{\mathbf{Y}}_5, \hat{\mathbf{Z}}_5]$, is specified through the ${}^{5}T_T$ homogeneous transformation.

Assignment:

(a) Show the coordinate frames for the MITSUBISHI, ($[\hat{\mathbf{X}}_S, \hat{\mathbf{Y}}_S, \hat{\mathbf{Z}}_S]$,$[\hat{\mathbf{X}}_0, \hat{\mathbf{Y}}_0, \hat{\mathbf{Z}}_0]$, ..., $[\hat{\mathbf{X}}_5, \hat{\mathbf{Y}}_5, \hat{\mathbf{Z}}_5]$,$[\hat{\mathbf{X}}_T, \hat{\mathbf{Y}}_T, \hat{\mathbf{Z}}_T]$), in the "zero" configuration, that is, with the angles $\theta_1 = \theta_2 = \theta_3 = \theta_4 = \theta_5 = 0$. Be sure that your definition of the coordinate frames is consistent with that given in class and also allows the "zero" configuration to be attainable (within the joint limits).

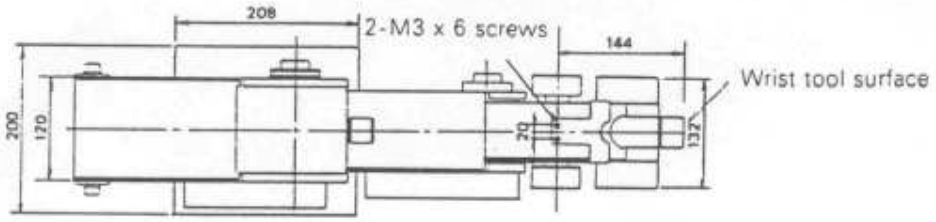
(b) Give a table specifying the link parameters for the MITSUBISHI:

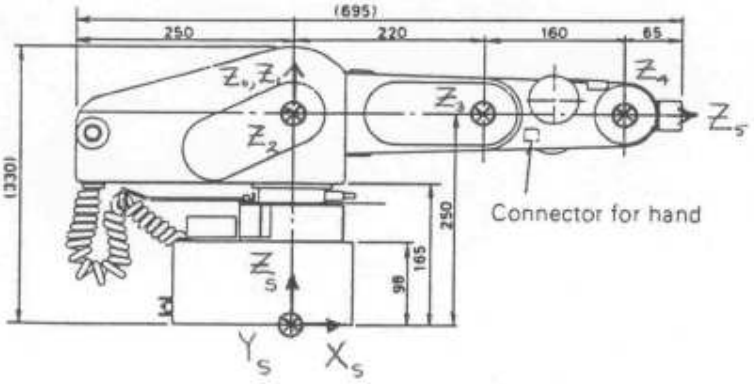
Link	α	a	d	θ
1				
2				
3				
4				
5				

(c) Determine the values for ${}^{i-1}T_i$ for $i = 1, \ldots, 5$, ${}^{S}T_0$, and ${}^{5}T_T$.

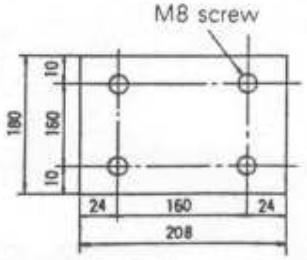
(d) Find ${}^{j}T_5$ for $j = 0, \ldots, 4$. Be sure to simplify any trigonometric equations as you are able. Use simplified notation whenever possible such as c_{12} for cosine$(\theta_1+\theta_2)$, etc.

Outer dimension diagram





Base attachment diagram



Item		Specification
Structure		Five degrees of freedom-Vertical multi-joint type
Range of movement	Waist rotation	300°
	Shoulder rotation	130°
	Elbow rotation	90°
	Wrist pitch	±90°
	Wrist roll	±180°

STANDARD HAND

Outer appearance