

# QArm Recommended Assessment

## Workspace Identification

1. Provide the completed DH Table for the QArm manipulator.

$i$	$a_i$	$\alpha_i$	$d_i$	$\theta_i$
1				
2				
3				
4				

2. From the completed DH table and the general transformation matrix  ${}^{i-1}T_i$ , derive the matrices  ${}^0T_1$ ,  ${}^1T_2$ ,  ${}^2T_3$ , and  ${}^3T_4$ .
3. Derive the matrices  ${}^0T_2$ ,  ${}^0T_3$ , and  ${}^0T_4$ .
4. Provide expressions for the position and orientation of the end-effector frame with respect to the base frame.
5. Can you provide an example of the joint states  $\vec{\theta}$  where the task space position of the end-effector is  ${}^0p_4 = [0 \ 0 \ 0.5]^T$ . The end-effector in this configuration is directly above the base, hence the  $x$  and  $y$  positions being 0. Are there other solutions for this position?
6. Open MATLAB and load the data you saved by double-clicking on myData.mat in the Folder Browser. What is the maximum reach of the manipulator  $r_{max}$  in your case? You can calculate this by running the following command in the Command Window.

```
>> r_max = max(sqrt(x.^2 + y.^2 + z.^2))
```

Note the dot between the variable and the power symbol to denote an element-wise exponent. What is the theoretical length of the manipulator when completely stretched out? Compare the theoretical result to your  $r_{max}$  value.

7. Comment on any discrepancy between the theoretical workspace volume and the one you measured in this lab.