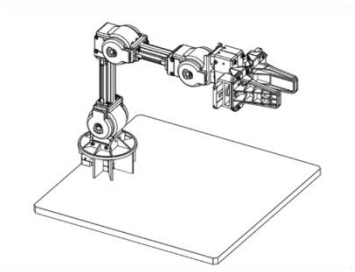
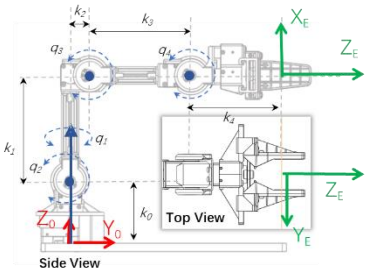
ECE 470: Introduction to Robotics Homework 2

Question 1. *(12 marks)*

A 4-DOF (excluding gripper) robotic serial manipulator arm is shown in Figure 1.





Using the D-H convention learned in class,

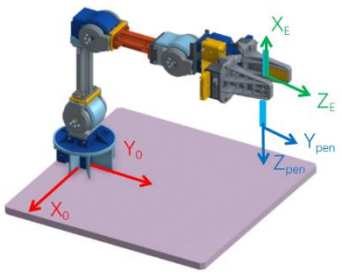
a) Assign frames to the links on a schematic diagram that represents the robot arm

b) Tabulate the D-H parameters

c) Obtain the forward kinematics representing the pose of end-effector frame {E} referenced from base frame {0}.

Question 2. *(8 marks)*

The serial manipulator arm is tasked to write on the board plane Z_o, with a pen attached to the gripper {E}. For the ink to flow, ${}^0Z_{pen}$ has to be $(0\ 0\ -1)^T$ i.e. vertically downwards. As shown in the diagram, axis X_E and Z_E are parallel to Z_{pen} and $Y_{pen.}$ respectively. The distance between Z_E and Y_{pen} is k_0.



State any assumption or condition while working on the following:

a) Write down the transformation matrix ${}^{E}_{pen}T$

b) If the pen tip is to be place on the board with coordinates ${}^0(u,v)$, find the expressions describing the joint variable $\boldsymbol{q}$ in terms of $k_{0\text{-}4}$, u and v.

c) Describe the workspace of the writing task if the distance between Z_E and Y_{pen} is now change to $k_0/2$. Assume that q_2 can only move its link in a range of 0 to 180° from the plane.