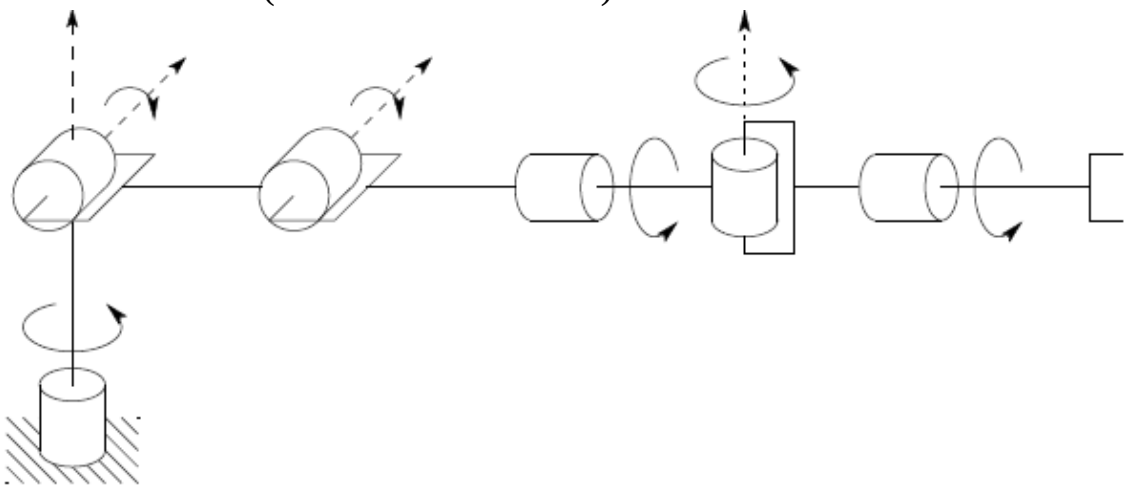
1)

a- prove : in order to represent any arbitrary homogenous transformation we need six parameters.(take a look at M.W.spong chapter 2)

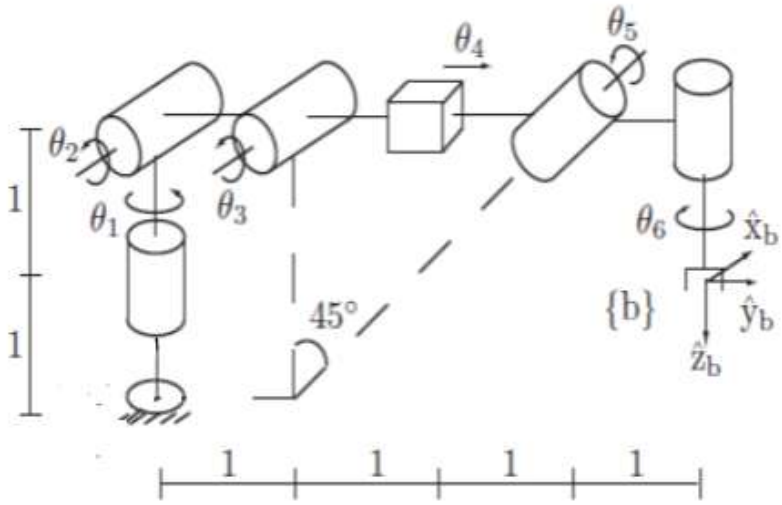
b- why in the Denavit-Hartenberg convention we only need four parameters. How is this possible? Prove mathematically.(take a look at M.W.spong chapter3)

2) for the two following robot :

- Assign coordinate frame based on D-H representation
- Fill out the D-H parameters table (design a table consist of D-H parameters ($\alpha - \theta - a - d$))
- Write all the A matrix (transformation matrix)

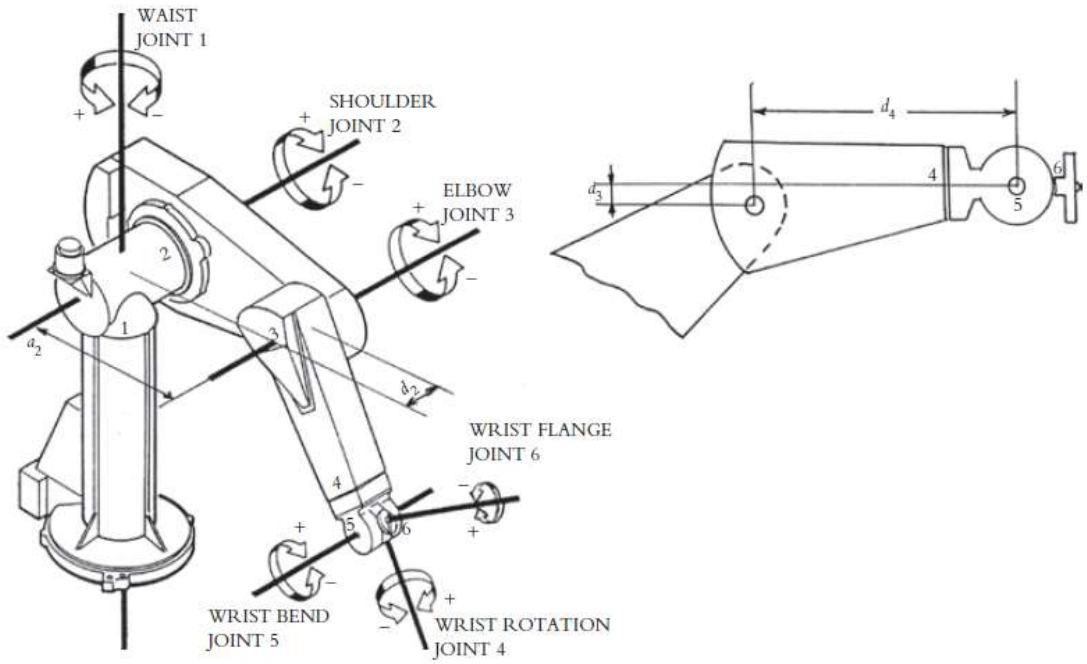


Ques 2-robot #1



Ques 2-robot #2

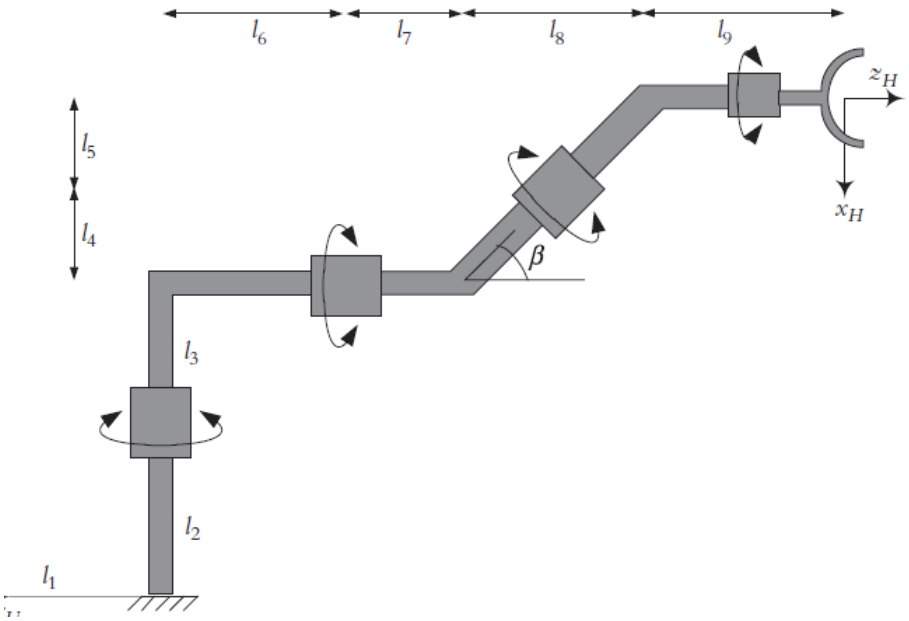
3) For the Unimation Puma 562 , 6-axis robot shown blow :



- Assign the coordinate frame based on the D-H representation.
- Fill out the D-H parameters table

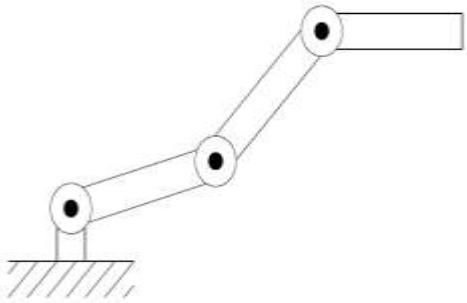
4)For the Given 4 DOF robot designed for a specific operation :

- Assign appropriate frame for the D_H representation
- Fill out the D-H parameters table
- Write an equation in term of A matrix that shows how T_H^0 can be calculated.(calculate T_H^0)
- Repeat calculation of T_H^0 using matlab or maple or…

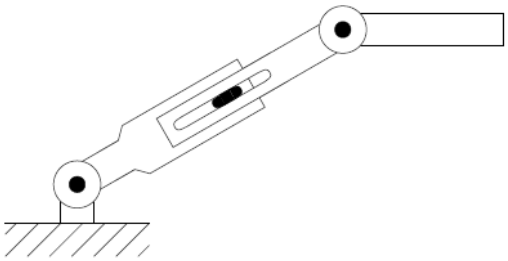


5) For the following robots manipulator

a) how many solution there exist for a given position?
b) If orientation of last link is determined and given , how many solution there exist?



robot #1



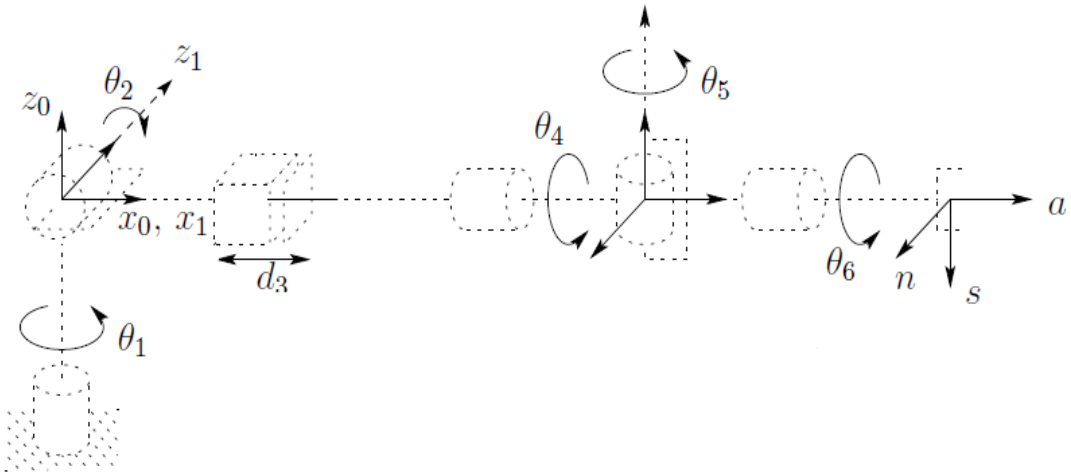
robot#2

6)The Stanford manipulator has a spherical wrist. Therefore ,given a desired position P and orientation R(rotation matrix) of the end-effector,

a) Compute the desired coordinates of the wrist center (suppose distance between wrist center and end-effector center is dw)

b) Solve the inverse position kinematics, that is, find values of the first three joint variables that will place the wrist center at Oc. Is the solution unique? How many solutions did you find?

c) Solve the inverse orientation kinematics



7) **تمرین کلاسی :** سینماتیک مستقیم بازوی ماهر اسکارا را با روش دناویت-هارتنبرگ بدست آورید: