MAE 547 Modeling and Control of Robots
Assignment #3

Due Date: Tuesday, 10/11/18 at the beginning of class.

Instructions: Unless there are extraordinary circumstances, late homework assignments will not be accepted. Some homework problems should be worked by hand, and others will require the use of Matlab (as specified in each problem). If homework problems are to be done by hand, you are allowed (and encouraged) to use software to check your answers. For problems that require Matlab, you should hand in a printout of the output as well as the code used to produce the output, including all necessary comments. Hand-written homework will be accepted provided it is legible. Use of computer software for typing answers is encouraged. However, homework is expected to be printed; homework in electronic form will not be accepted.

Q1) [30 points]

Draw the workspace of the three-link planar arm in Fig.1 with the data:

$$a_1=0.5,\ a_2=0.3,\ a_3=0.2,$$
$$-\pi/3 \le q_1 \le \pi/3,\ -2\pi/3 \le q_2 \le 2\pi/3,\ -\pi/2 \le q_3 \le \pi/2$$

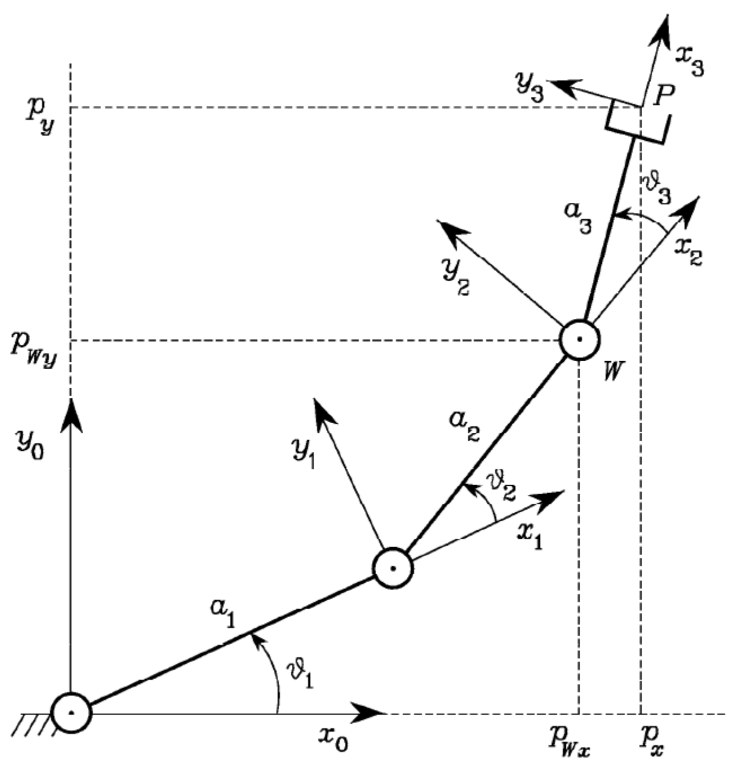

Fig.1

Q2) [20 points]
Solve the inverse kinematics for the SCARA manipulator in Fig.2

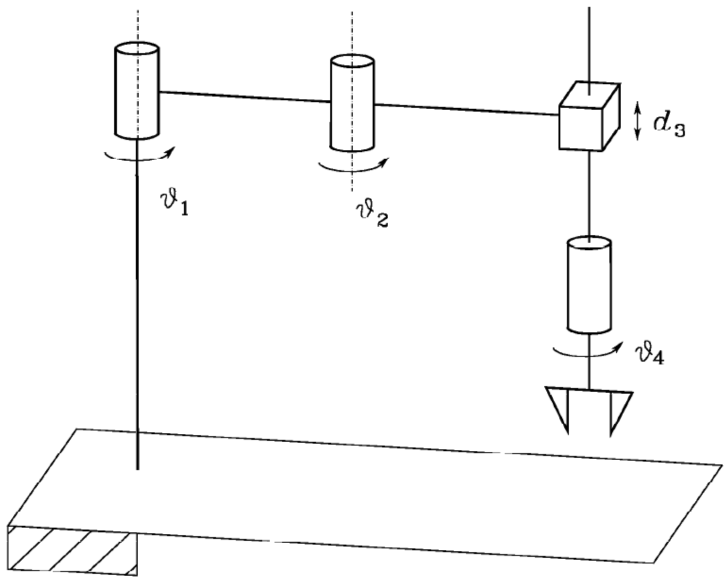

Fig.2

Q3) [10 points]
Compute the Jacobian of the cylindrical arm in Fig.3.

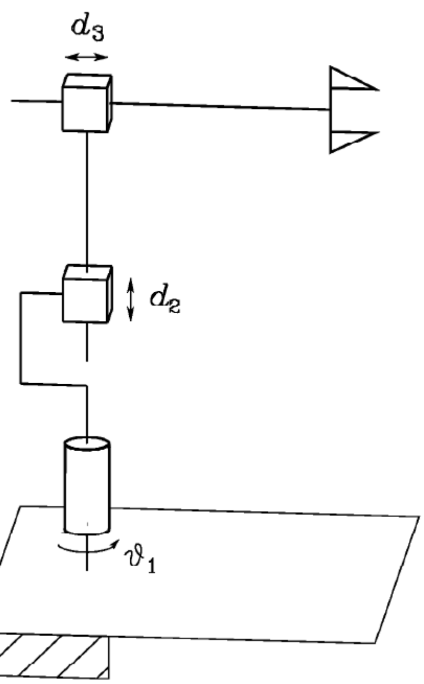

Fig.3

Q4) [40 points]
This exercise focuses on the inverse kinematics solution for the planar 3-DOF, 3R robot (See Figures 4). We have done forward and inverse kinematics of this robotic arm and found its DH parameters in the class (using the standard DH convention). The following fixed-length parameters are given: $L_1 = 4$, $L_2 = 3$, and $L_4 = 2$(m).

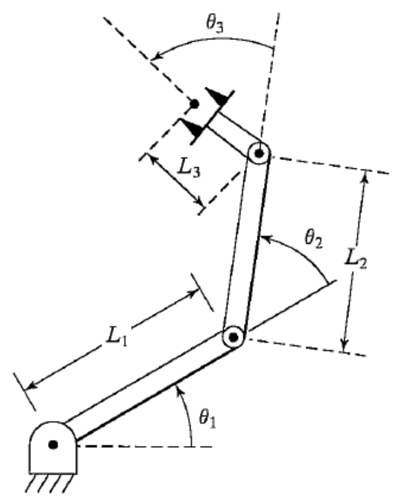

Fig.4

a) Develop a MATLAB program to solve this planar 3R robot inverse kinematics problem completely (i.e., to give all multiple solutions). Test your program, using the following input cases:

i) $$T_H^0 = \begin{matrix} 1 & 0 & 0 & 9 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{matrix}$$

ii) $$T_H^0 = \begin{matrix} 0.5 & -0.866 & 0 & 7.5373 \\ 0.866 & 0.5 & 0 & 3.9266 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{matrix}$$

iii) $$T_H^0 = \begin{bmatrix} 0 & 1 & 0 & -3 \\ -1 & 0 & 0 & 2 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

b) For all cases, plug each resulting set of joint angles (for each of the multiple solutions) back into the forward pose kinematics MATLAB program (using standard DH convention) to demonstrate that you get the originally commanded T_H^0.

c) Check all results by means of the Corke MATLAB Robotics Toolbox. Try function ikunc( ).