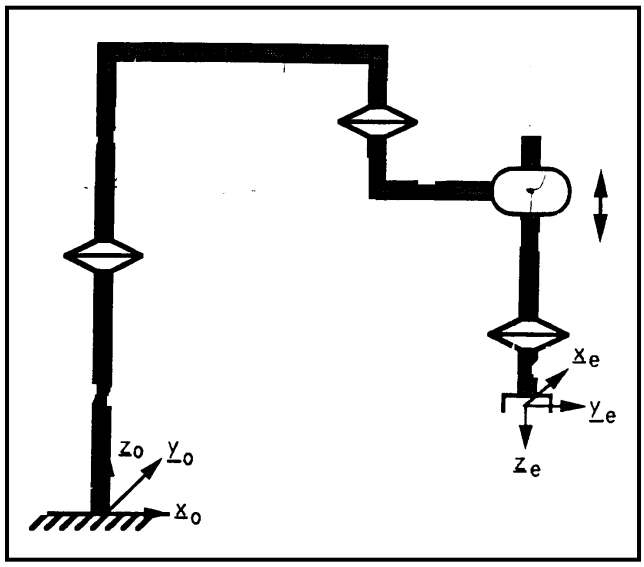
Due date: Tuesday, Feb 23, 2016
(Before lecture starts)

ME4524 – Robotics and Automation

Exercise # 2

1. Develop the kinematic model for obtaining the location of the end-effector as a function of the generalized coordinates for the SCARA-type robot shown below.

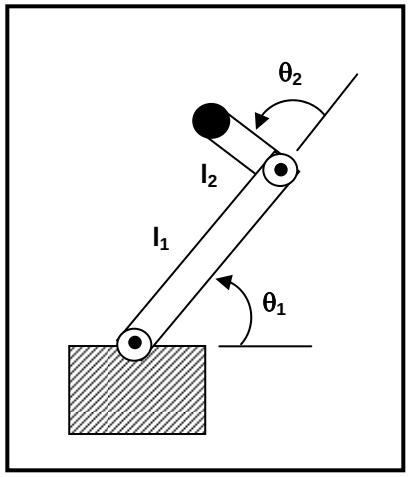


2. Given the desired position and orientation of the end effector of a 3-link planar rotary jointed manipulator, there are two possible solutions. Sketch the two solutions. If we add one more rotational joint (in such a way that it is still planar), how many solutions are there?
3. The Figure below shows a 2-link planar arm with rotary joints. For this arm, the second link is half as long as the first, that is $l_1 = 2l_2$. Also the joint limits are:

$$0 < \theta_1 < 180^0$$

$$-90^0 < \theta_2 < 180^0$$

Sketch the approximate reachable workspace of the tip of link 2.



4. Solve the inverse kinematics problem of the SCARA-type robot in problem 1. Assume that the end-effector position is given by a four-dimentional vector consisting of three dimentional position and the orientation of the end-effector about the $\underline{z}_0$ axis (or $\underline{z}_e$ axis).

5. (a) Develop the kinematic model of the manipulator in the Figure below and obtain H_{06}.

   (b) Solve the inverse kinematics for this manipulator.

   Note that the geometry of this problem is such that we cannot use any simple trigonometry to solve for the position of the manipulator. You will need to use inverse transform matrices to derive equations for the solutions of the angles. It helps to work with numbers in this example. We use the following angle vector: θ=[0 -45 0 0 -90 -90]