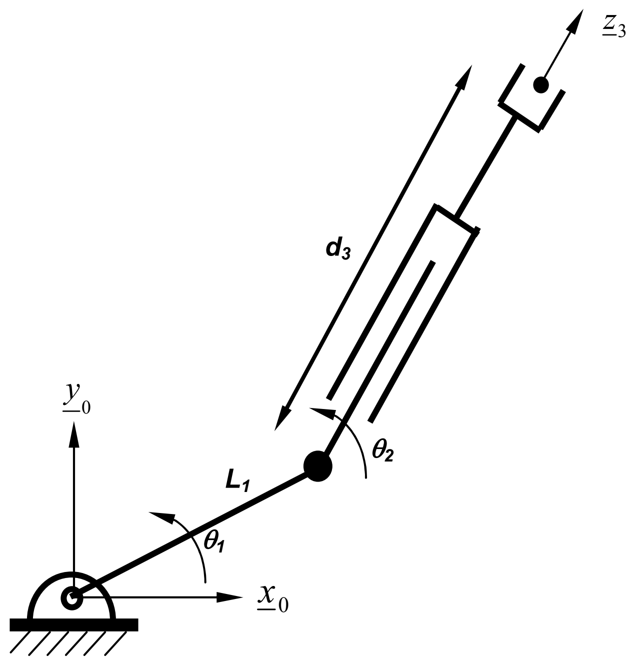
Due date: Tuesday, March 29, 2016
(Before lecture starts)

ME4524 – Robotics and Automation

Exercise # 4

1. A 3 d.o.f. planar robot is shown in the figure below. By defining suitable coordinate frames and kinematic parameters, determine the homogenous transformation matrix T_{03}.



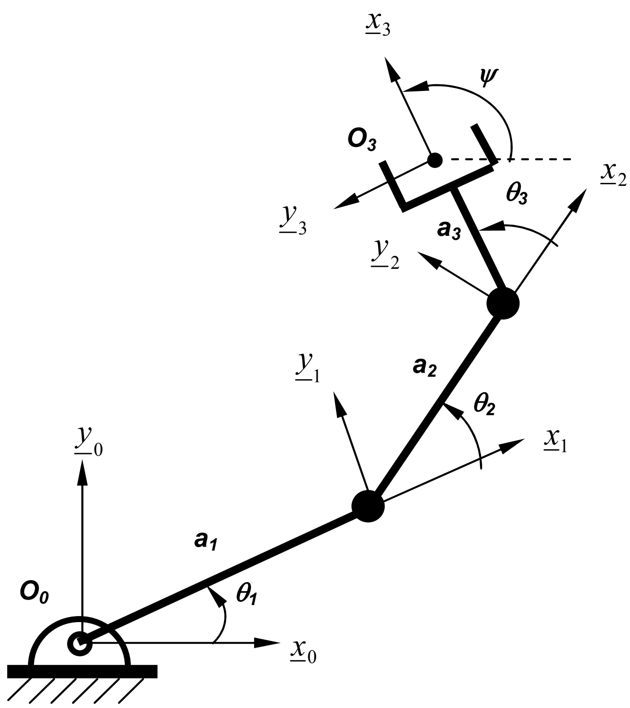
2. For the 3 d.o.f. planar manipulator shown in the figure below:

(a) Verify that the homogenous transformation matrix T_{03} is given by:

$$T_{03} = \begin{bmatrix} c\psi & -s\psi & 0 & q_x \\ s\psi & c\psi & 0 & q_y \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

where q_x is the x-coordinate of the end-effector position with respect to frame O_0, and q_y is the y-coordinate of the end-effector position with respect to frame O_0.

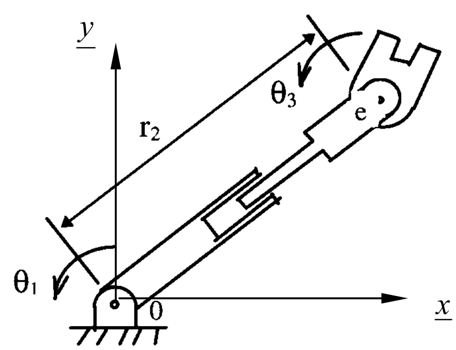
(b) Solve the inverse kinematics problem of such a manipulator. For a given end-effector location, how many solutions are there for the inverse kinematics problem? Illustrate your answer through a simple sketch.



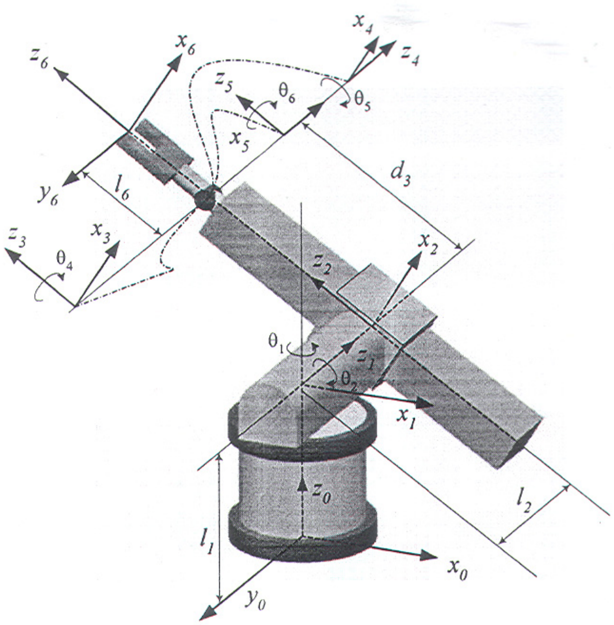
3. For the three degree of freedom planar robot manipulator shown in the figure below:

(a) Define link coordinates and link parameters using the *D-H* convention. Determine the homogenous transformation matrix T_{oe}.

(b) Solve the inverse kinematics problem for this manipulator. Assume that the task space coordinates are p_x, p_y, and ϕ; the end effector frame is located at point *e*.



4. A JPL Stanford manipulator is shown in the figure below. Using the coordinate frames given and by defining suitable links parameters; derive the Denavit Hartenberg kinematics parameters table for this manipulator.



5. For the three degree-of-freedom planar robot manipulator shown in the figure below:

(a) Define link coordinate frames and *D-H* kinematic parameters. Determine the homogenous transformation matrix T_{oe}.

(b) Solve the inverse kinematics problem for this manipulator. Assume that the task space coordinates are p_x, p_y, and ϕ (as shown in the Figure); the end effector frame is located at point *e* attached to the gripper link.