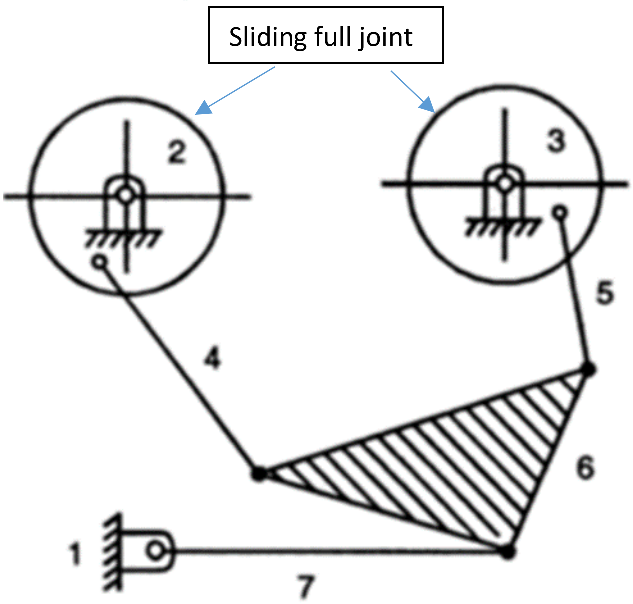
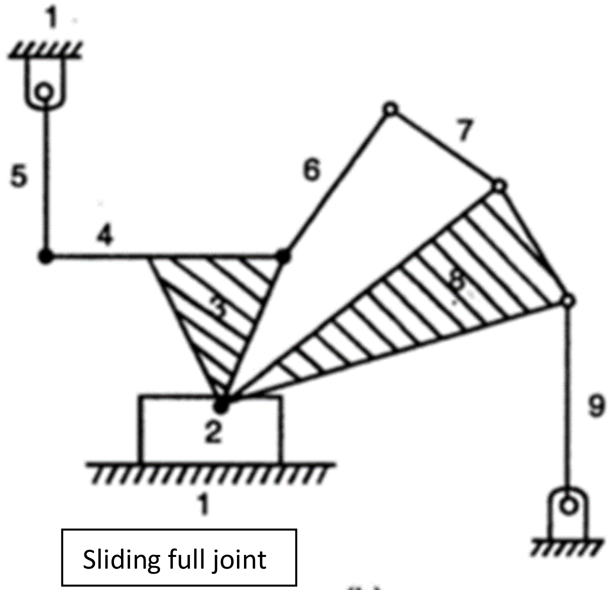
01.110: Computational Fabrication Summer 2017

Exercise 1

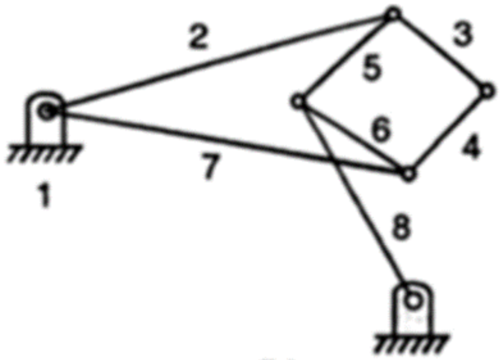
Determine the degrees of freedom for the system shown below



(a)



(b)



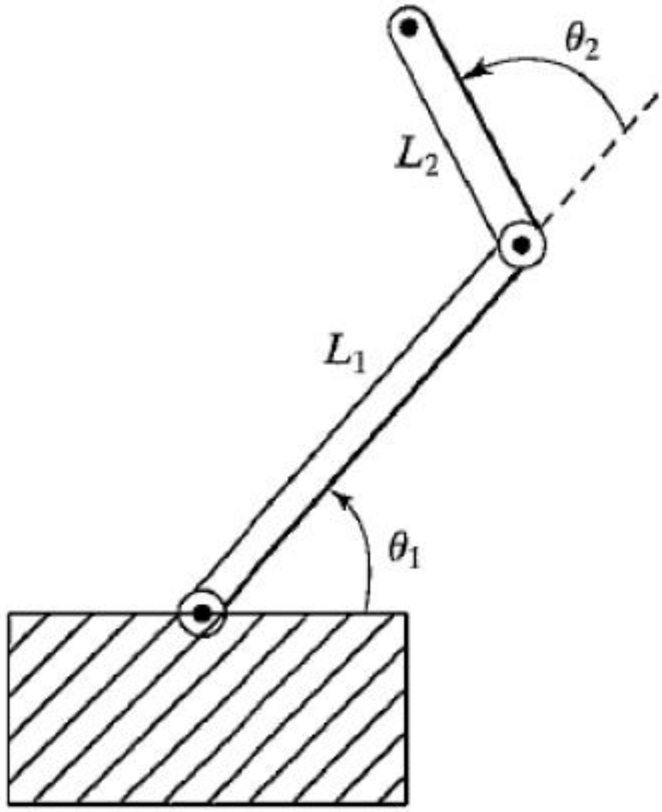
(b)

Exercise 2

The following figure shows a two-link planar arm with rotary joints. For this arm, the second link is a half long of the first. The joint limits are as follows:

$$\begin{cases} 0 < \theta_1 < \pi \\ -\pi/2 < \theta_2 < \pi \end{cases}$$

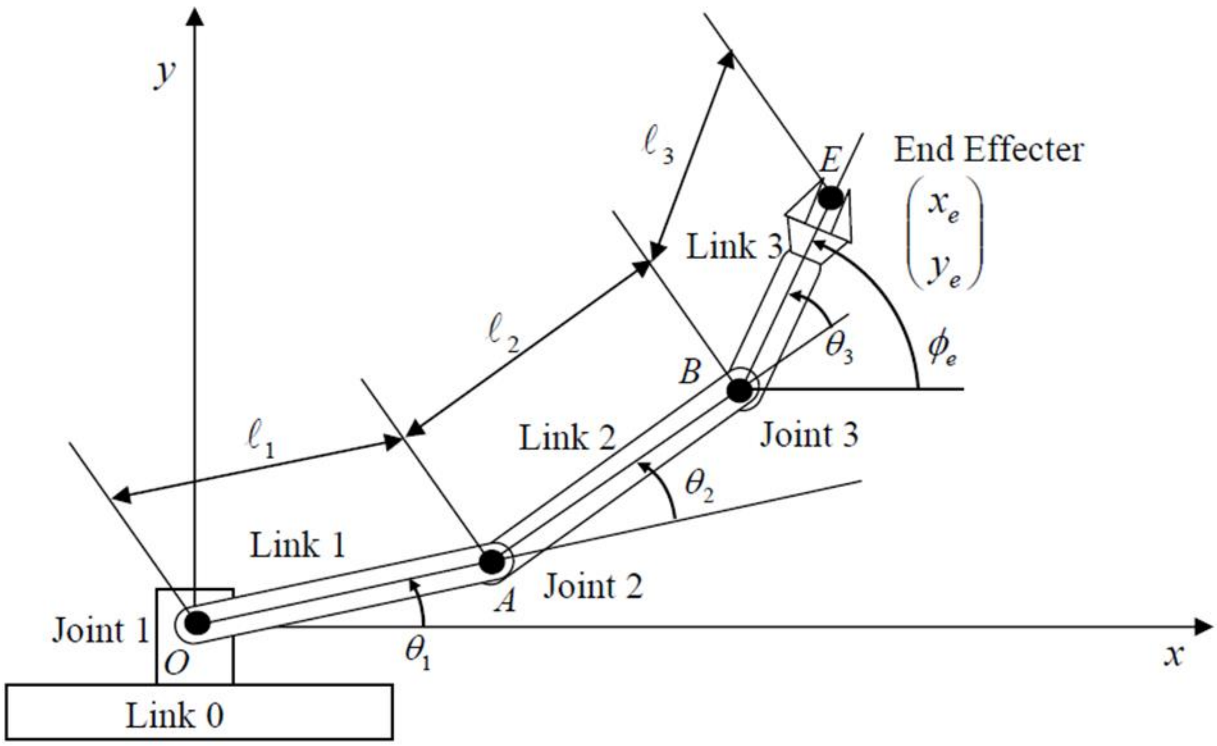
Sketch the reachable workspace (an area) of the tip of link 2. You may assume that the box will not affect the movement of the linkage [You may use Matlab or solidworks to answer this question].



Exercise 3

The RRR planar manipulator in Figure below is composed of three revolute joints, θ_1, θ_2 and θ_3 with full range of motion.

a. Find the algebraic relationship between the joint coordinates $(\theta_1, \theta_2, \theta_3)$ of the manipulator and the Cartesian coordinates (x_e, y_e, ϕ_e) of the end effector at E. Is this mapping 1 to 1? i.e, a choice of $(\theta_1, \theta_2, \theta_3)$ implies a unique (x_e, y_e, ϕ_e).
b. Sketch by hand the workspace and the dexterous workspace of the robot (case of l_1 = l_2 = l_3 and $l_1 \neq l_2 \neq l_3$)
c. Is the inverse kinematics map 1 to 1? Use a sketch argument to illustrate your answer.
d. Find the algebraic expression for the inverse kinematics and discuss the multiplicity of solutions.
e. Is there any benefit to this manipulator over RR (2 revolute joints) manipulator?



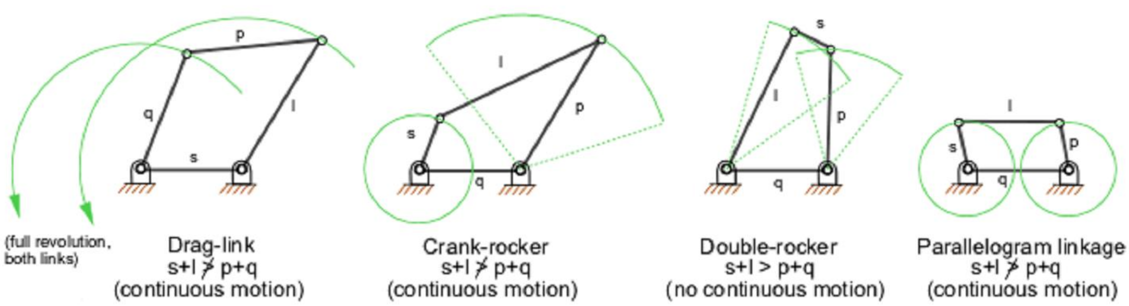
Exercise 4 Computational Linkage Design Using SolidWorks

A linkage is an assembly of bodies connected to manage forces and movement [wikipedia]. In this exercise, you will design some cool linkages, which will be physically manufactured in a later lab. We'll be only looking at kinematics and ignore forces, and furthermore, we'll limit ourselves to 2D planar structures with revolute joints.

You should provide in your report the images (shown tips trajectories) and the videos of all mechanisms that you designed.

a. Design using solidworks the family of the four-bar linkages [http://en.wikipedia.org/wiki/Four-bar_linkage]. (**option Practice: no credit**)

Case 1 **Case 2** **Case 3** **Case 4**



b. Design using solidworks a Hoekens linkage [http://en.wikipedia.org/wiki/Hoekens_linkage]. This is a crank-rocker mechanism that produces a nearly straight line. Make sure you add a tracer particle to show the trajectory of the tip.
c. Design using solidworks a Peaucellier-Lipkin linkage [http://en.wikipedia.org/wiki/Peaucellier-Lipkin_linkage]. This was the first planar linkage capable of transforming rotary motion into perfect straight-line motion, and vice versa." Again, make sure you add a tracer particle to show the trajectory of the tip.
d. Design using solidworks a Klann linkage [http://en.wikipedia.org/wiki/Klann_linkage] [http://www.mekanizmalar.com/mechanicalspider.html].
e. **<u>For extra credit</u>**, design using solidworks a scissor mechanism [http://en.wikipedia.org/wiki/Scissor_mechanism].

Feedback

- Were there any references (books, papers, websites, etc.) that you found particularly helpful for completing your assignment? Please provide a list.
- Are there any known problems with your code? If so, please provide a list and, if possible, describe what you think the cause is and how you might fix them if you had more time or motivation. This is very important, as we're much more likely to assign partial credit if you help us understand what's going on.
- Did you do any of the extra credit? If there was a substantial amount of work involved, describe what and how you did it.
- Got any comments about this assignment that you'd like to share?