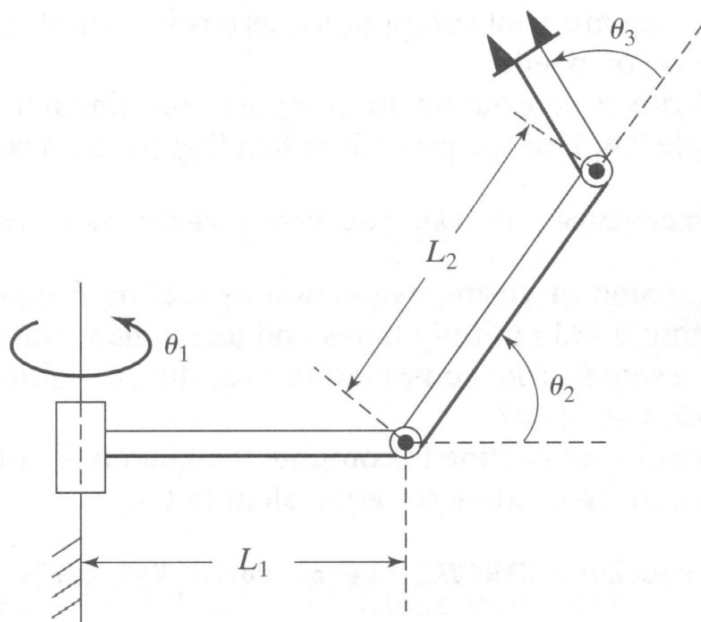# Assignment no. 2

due: Monday, November 15th, 2021

Part I

The goal of this part of the assignment is to get acquainted with the basics of robot kinematics. Exercises 2.1 and 2.2 relate to the following robot arm with three rotational degrees of freedom (3R for short; the figure is taken from Craig's *Introduction to Robotics: Mechanics and Control*, Chapter 3):

Exercise 2.0   Read Chapters 3 (forward kinematics) and 4 (inverse kinematics) of Craig's book, *Introduction to Robotics: Mechanics and Control*.

Exercise 2.1 (2)   Assign coordinate frames to the links of the 3R arm and extract the Denavit-Hartenberg parameters of it. Then write the direct kinematics equations for the arm.

Exercise 2.2 (2)   Solve the inverse kinematics problem for the 3R arm as above.

Notice that there is an additional exercise on the other side of the page.

Part II

Exercise 2.3 **(a)** What is the maximum combinatorial complexity (give asymptotic lower and upper bounds) of the free space of the following planar motion-planning problem. A robot arm with two degrees of freedom moving in the plane among polygonal obstacles with a total of n vertices. The arm consists of a line segment that passes through a point p in the plane. It can rotate around p and translate through p, but at all times it coincides with p. See the following figure for an illustration.
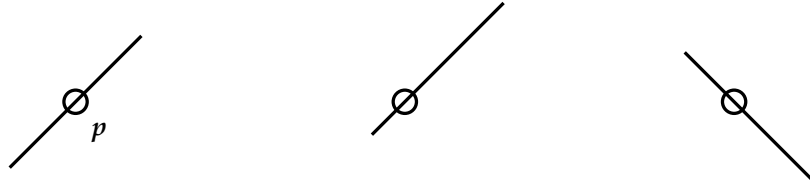
(b) Devise an efficient algorithm to compute the free space.