

ECE 111 - Homework #3

Math 105: Trigonometry.

Due Monday, February 3rd. Please submit via email or on BlackBoard

Polar to Rectangular Conversions

1) Determine the final position of A: (x,y)

$$A = (6\angle -93^0) + (11\angle 70^0) + (8\angle 87^0)$$

2) Determine final position of B: (x,y)

$$B = (5\angle -22^0) + (22\angle 31^0) + (20\angle -66^0)$$

3) Where is B relative to A (i.e. what is $C = B - A$)?

- In (x,y) coordinates
- In polar coordinates

Plotting Polar Functions

4) Plot the following functions in Matlab for $-2\pi < \theta < 2\pi$

- Note: plot() plots in cartesian coordinates. Each function needs to be converted from polar to rectangular.

a) $r = 2 \sin(\theta) + 3 \cos(\theta)$

b) $r = (2\pi - \theta)(2\pi + \theta)$

c) $r = \theta^2$

Robot Tip Position (Forward Kinematics)

A 2D robot has three arms with lengths of {3.0, 2.0, 1.0} meters. The final tip position is

$$x_1 = 3 \cos(\theta_1)$$

$$y_1 = 3 \sin(\theta_1)$$

$$x_2 = x_1 + 2 \cos(\theta_1 + \theta_2)$$

$$y_2 = y_1 + 2 \sin(\theta_1 + \theta_2)$$

$$x_3 = x_2 + \cos(\theta_1 + \theta_2 + \theta_3)$$

$$y_3 = y_2 + \sin(\theta_1 + \theta_2 + \theta_3)$$

5) Plot the tip position (x3, y3) for

$$\theta_1 = 41^0 \quad \theta_2 = -94^0 \quad \theta_3 = -45^0$$

6) Plot the tip position (x3, y3) for

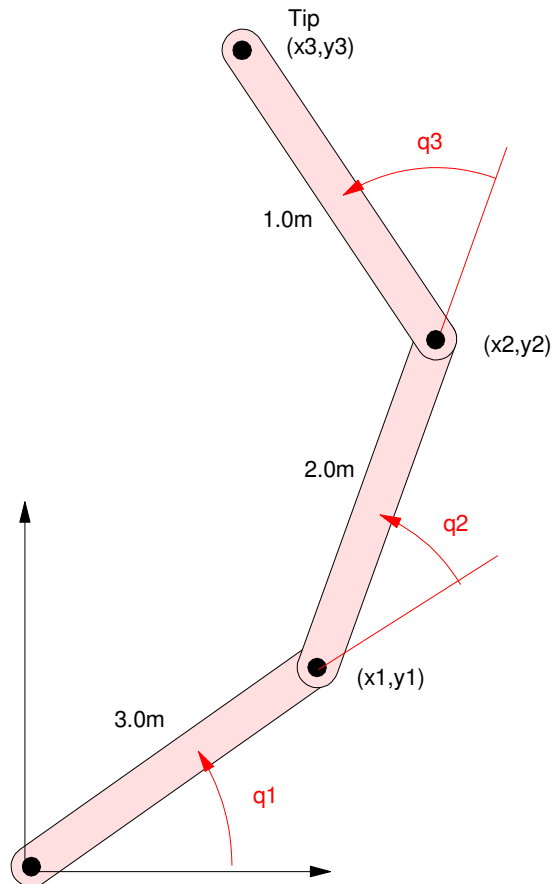
$$\theta_1 = -91^0 \quad \theta_2 = -81^0 \quad \theta_3 = 65^0$$

Robot Tip Position (Inverse Kinematics & fminsearch())

7) Write a Matlab function which

- Is passed the angles $(\theta_1, \theta_2, \theta_3)$,
- Computes the tip position, and
- Returns the distance from the tip position and point $(x = 2.0, y = 0.0)$

8) Use the `fminsearch()` to determine the joint angles which place the robot at $(x_3 = 2.0, y_3 = 1.0)$



Problem 5-8: 2D Robotic Arm