ECE 111 - Make-Up Homework #3

Week #3: Trigonometry - Due Friday, December 12th

Polar to Rectangular Conversions

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

$$A = (7\angle 85^0) + (3\angle -22^0) + (6\angle 47^0)$$

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

$$B = (11\angle 138^0) + (7\angle -67^0) + (10\angle 57^0)$$

3) Where is A relative to B (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) $r = \cos(\theta) + \sin(3\theta)$

c) $r = \cos(\theta) + \frac{1}{2}\cos(2\theta) + \frac{1}{3}\cos(3\theta) + \frac{1}{4}\cos(4\theta)$

Robot Tip Position (Forward Kinematics)

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

$$x_1 = 2\cos(\theta_1) \qquad y_1 = 2\sin(\theta_1)$$

$$x_2 = x_1 + \cos(\theta_1 + \theta_2) \qquad y_2 = y_1 + \sin(\theta_1 + \theta_2)$$

$$x_3 = x_2 + 2\cos(\theta_1 + \theta_2 + \theta_3) \qquad y_3 = y_2 + 2\sin(\theta_1 + \theta_2 + \theta_3)$$

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

$$\theta_1 = 40^0 \quad \theta_2 = 50^0 \quad \theta_3 = 60^0$$

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

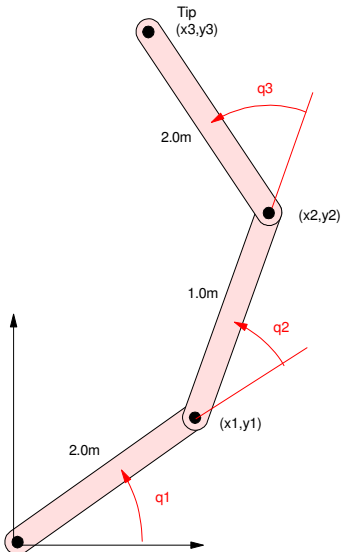
$$\theta_1 = 140^0 \quad \theta_2 = -80^0 \quad \theta_3 = -70^0$$

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 = 3.0, y = 2.0)

8) Use the fminsearch() to determine the joint angles which place the robot at (x3 = 3.0, y3 = 2.0)



Problem 5-8: 2D Robotic Arm