

ECE 111 - Make-Up Homework #3

Week #3: Trigonometry

Polar to Rectangular Conversions

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

$$A = (16\angle 35^0) + (6\angle 81^0) + (1\angle -11^0)$$

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

$$B = (8\angle 48^0) + (16\angle -56^0) + (10\angle -10^0)$$

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) $r = 5 \sin(\theta) - 2 \cos(\theta)$

b) $r = \cos(2\theta) + 0.5 \cos(3\theta)$

c) $r = \sin(\theta) + \frac{1}{3} \sin(3\theta) + \frac{1}{5} \sin(5\theta) + \frac{1}{7} \sin(7\theta)$

Robot Tip Position (Forward Kinematics)

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

$$x_1 = 2 \cos(\theta_1)$$

$$y_1 = 2 \sin(\theta_1)$$

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

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

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

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

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

$$\theta_1 = 26^0 \quad \theta_2 = 38^0 \quad \theta_3 = 46^0$$

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

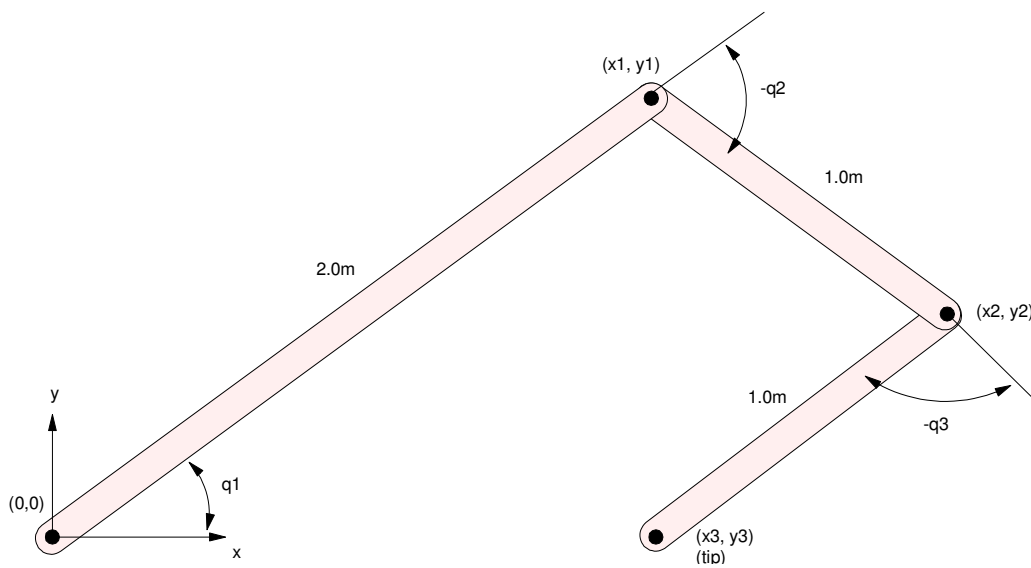
$$\theta_1 = -40^0 \quad \theta_2 = 32^0 \quad \theta_3 = 28^0$$

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 $(x = 1.0, y = 2.0)$

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



Problem 5-8: 2D Robotic Arm