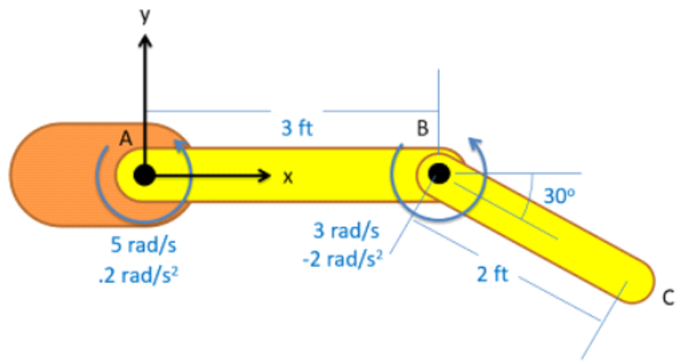
Problem 1

The robotic arm shown below has a fixed orange base at A and fixed length members AB and BC. Motors at A and B allow for rotational motion at the joints. Based on the angular velocities and accelerations shown at each joint, determine the velocity and the acceleration of the end effector at C.



$\theta_A = 0^\circ$

$\dot{\theta}_A = 5 \text{ rad/s}$

$\ddot{\theta}_A = .2 \text{ rad/s}^2$

$\theta_B = -30^\circ$

$\dot{\theta}_B = 3 \text{ rad/s}$

$\ddot{\theta}_B = -2 \text{ rad/s}$

$$X_c(t) = 3\cos(\theta_A) + 2\cos(\theta_B)$$

$$Y_c(t) = 3\sin(\theta_A) + 2\sin(\theta_B)$$

$$\dot{X}_c(t) = -3\sin(\theta_A)\dot{\theta}_A - 2\sin(\theta_B)\dot{\theta}_B$$

$$\dot{y}_c(t) = 3\cos(\theta_A)\dot{\theta}_A + 2\cos(\theta_B)\dot{\theta}_B$$

$$\dot{x}_c(t) = -3\sin(0)(5) - 2\sin(-30^\circ)(3) = 3 \text{ ft/s}$$

$$\dot{y}_c(t) = 3\cos(0^\circ)(5) + 2\cos(-30)(3) = 20.20 \text{ ft/s}$$

$$\boxed{V_c = [3, 20.2] \text{ ft/s}}$$

$$\dot{x}_c(t) = -3\sin(\theta_A)\dot{\theta}_A - 2\sin(\theta_B)\dot{\theta}_B$$

$$\dot{y}_c(t) = 3\cos(\theta_A)\dot{\theta}_A + 2\cos(\theta_B)\dot{\theta}_B$$

$$\ddot{x}_c(t) = -3\cos(\theta_A)\dot{\theta}_A^2 - 3\sin(\theta_A)\ddot{\theta}_A - 2\cos(\theta_B)\dot{\theta}_B^2 - 2\sin(\theta_B)\ddot{\theta}_B$$

$$\ddot{y}_c(t) = -3\sin(\theta_A)\dot{\theta}_A^2 + 3\cos(\theta_A)\ddot{\theta}_A - 2\sin(\theta_B)\dot{\theta}_B^2 + 2\cos(\theta_B)\ddot{\theta}_B$$

$$\ddot{x}_c(t) = -3\cos(0^\circ)(5)^2 + 3\sin(0^\circ)(.2) - 2\cos(-30^\circ)(3)^2 + 2\sin(-30^\circ)(-2) = -88.59\ ft/s^2$$

$$\ddot{y}_c(t) = -3\sin(0^\circ)(5)^2 + 3\cos(0^\circ)(.2) - 2\sin(-30^\circ)(3)^2 + 2\cos(-30^\circ)(-2) = 6.14\ ft/s^2$$

$$\boxed{a_c = [-88.59, 6.14]\ ft/s^2}$$