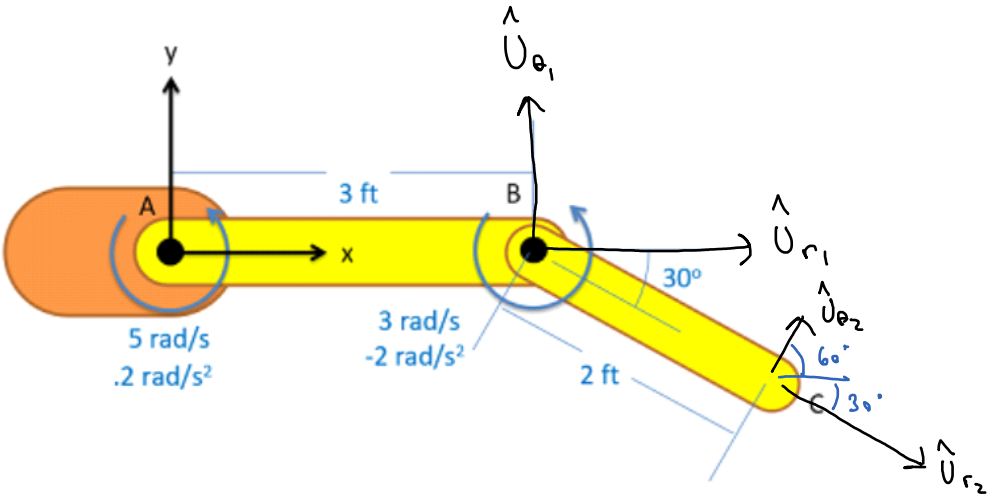
Problem 1

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.



$$\vec{V}_C = \vec{V}_{A\,B/A} + \vec{V}_{C/B}$$

$$\vec{V}_{C/A} = r_1 \dot{\theta}_1 \hat{u}_{\theta_1} + r_2 \dot{\theta}_2 \hat{u}_{\theta_2}$$

$$\vec{V}_{C/A} = (3\,ft)(5\,rad/s)\uparrow + (2\,ft)(3\,rad/s)\angle 60^\circ$$

$$V_{Cx} = 0 + 6\cos(60) = 3\ ft/s$$

$$V_{Cy} = 15 + 6\sin(60) = 20.2\ ft/s$$

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

$$\vec{a}_{C/A} = \vec{a}_{B/A} + \vec{a}_{C/B}$$

$$\vec{a}_{C/A} = -r_1 \dot{\theta}_1^2 \hat{u}_{r_1} + r_1 \ddot{\theta}_1 \hat{u}_{\theta_1} - r_2 \dot{\theta}_2^2 \hat{u}_{r_2} + r_2 \ddot{\theta}_2 \hat{u}_{\theta_2}$$

$$a_{C/A} = -(3)(5)^2 \rightarrow + (3)(.2) \uparrow - (2)(3)^2 \swarrow_{30^\circ} + (2)(-2) \nearrow_{60^\circ}$$

$$a_{Cx} = -75 + 0 - 18\cos(30) - 4\cos(60) = -92.6 \text{ ft/s}$$

$$a_{Cy} = 0 + .6 + 18\sin(30) - 4\sin(60) = 6.1 \text{ ft/s}$$

$$\boxed{a_C = [-92.6, 6.1] \text{ ft/s}}$$