BME 590
Hwk #4
Due: 3/29/22

1. Use the Jacobian method to perform inverse kinematics for the 3R leg from Hwk #3a. The desired trajectory will move the ankle from a starting position with the leg straight down along an upward diagonal pathway ($\Delta x=-30$, $\Delta y = 30$ cm) in one second. The ankle will also rotate.

   i. Use the MATLAB program *create_traj.m* to compute the pathway for your leg. Customize for your leg by entering values for your leg in the code and run the program.
   ii. The program will create a file consisting of the (x,y) location of the ankle with respect to the pelvis and the orientation (φ) of the foot with respect to the pelvis for each point in time. Compute the ${}^{0}J$ Jacobian relating linear and rotational velocity of coordinate frame {3} on the ankle, as written with respect to the base coordinate frame.
   iii. In MATLAB, use the function *deriv3pt.m* to compute $v = \begin{bmatrix} \dot{x} \\ \dot{y} \end{bmatrix}$ and $\omega = \dot{\varphi}$. Employ the Jacobian to compute the corresponding $\dot{\theta}_1, \dot{\theta}_2, \dot{\theta}_3$ at each time step. Use numerical integration to find the next $\theta_1, \theta_2, \theta_3$. Use these values for the next iteration. Write time, $\theta_1, \theta_2, and\ \theta_3$ to a text file.
   iv. Upload your MATLAB code and text file to Moodle

2. Create a Working Model simulation to test your answer to problem 1.
   i. Create the 3 links (upper leg, lower leg, foot) scaled to your leg lengths
   ii. Pin consecutive links together at ends with motors
   iii. Create rotational inputs for the motors
   iv. Set the inputs to read from your text file from problem 1
   v. Attach a point on the foot at the ankle
   vi. Create a position meter for this point
   vii. Run the simulation
   viii. Create a video of your simulation
   ix. Export the meter data to a file. Create plot(s) showing the desired x,y, and φ and the x,y and φ from the simulation
   x. Upload your model, video, and plots (the last in *.pdf format) to Moodle