JORDAN UNIVERSITY OF SCIENCE & TECHNOLOGY
MECHANICAL ENGINEERING DEPARTMENT
ME 774 Programming Tools & Methods for Mechatronics Engineers
Spring Semester, 2014-2015

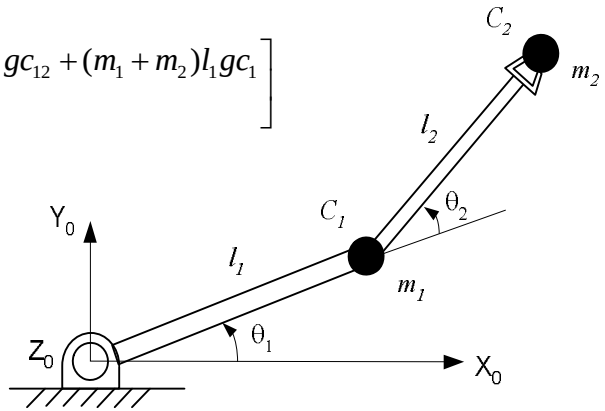
Assignment # 8

Due date: May 14th 2015 (slip underneath my office door please)

The dynamics equations of a 2-axis planar manipulator in joint space are as following:

$$\boldsymbol{\tau} = \begin{bmatrix} m_2 l_2^2(\ddot{\theta}_1 + \ddot{\theta}_2) + m_2 l_1 l_2 c_2(2\ddot{\theta}_1 + \ddot{\theta}_2) + (m_1 + m_2) l_1^2 \ddot{\theta}_1 - m_2 l_1 l_2 s_2 \dot{\theta}_2^2 - 2 m_2 l_1 l_2 s_2 \dot{\theta}_1 \dot{\theta}_2 + m_2 l_2 g c_{12} + (m_1 + m_2) l_1 g c_1 \\ m_2 l_1 l_2 c_2 \ddot{\theta}_1 + m_2 l_2^2(\ddot{\theta}_1 + \ddot{\theta}_2) + m_2 l_1 l_2 s_2 \dot{\theta}_1^2 + m_2 l_2 g c_{12} \end{bmatrix}$$

Assume that $m_1 = 1.5\,\text{kg},\ m_2 = 0.5\,\text{kg},\ l_1 = 0.3\,\text{m},\ l_2 = 0.1\,\text{m},\ g = 9.81\,\text{m/s}^2$



(1) Given the following joint trajectories

$$\boldsymbol{\theta}(t) = \begin{bmatrix} \frac{\pi}{2}\sin\left(\frac{\pi}{8}t\right) \\ \frac{\pi}{4}(t-2) \end{bmatrix}$$

Compute the required joint control torques for time t from 0 to 4 seconds. Plot the torques versus time.

(2) Use the torques computed from (1) as input, simulate the motion of the end point of the manipulator for 4 seconds. Use the modified Euler integration method and set the time step to 0.01 seconds. Please plot the simulation results:

$\theta_1(t),\ \theta_2(t),\ \dot{\theta}_1(t),$ and $\dot{\theta}_2(t)$ versus time.

$x(t),\ y(t),\ \dot{x}(t),$ and $\dot{y}(t)$ versus time.

(3) Compute the tip trajectory $x(t)$ and $y(t)$ using the forward kinematics and then compare the result to the simulated tip trajectory. Plot the errors between the kinematically computed $x(t)$ and $y(t)$ and dynamically simulated $x(t)$ and $y(t)$.

** Important note: please clearly index and label your axes and units in your plots, otherwise the plots are meaningless