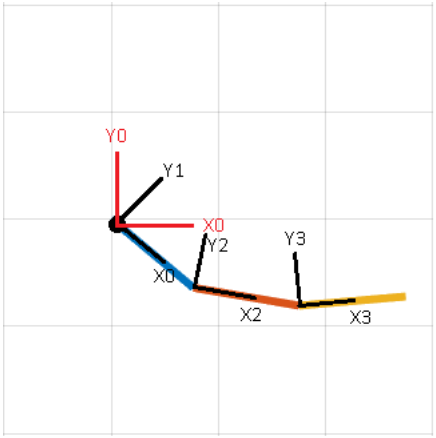
Practical Assignment -4

MEL3020: Kinematics and Dynamics of Machines

1. Simulate the following dynamic equations for 3R using MATLAB or Octave:



M =

$$\begin{pmatrix} 3\cos(\theta_2(t)) + \cos(\theta_3(t)) + \cos(\theta_2(t)+\theta_3(t)) + 4 & \sigma_1 & \sigma_2 \\ \sigma_1 & \cos(\theta_3(t)) + \frac{5}{3} & \frac{\cos(\theta_3(t))}{2} + \frac{1}{3} \\ \sigma_2 & \frac{\cos(\theta_3(t))}{2} + \frac{1}{3} & \frac{1}{3} \end{pmatrix}$$

where

$$\sigma_1 = \frac{3\cos(\theta_2(t))}{2} + \cos(\theta_3(t)) + \frac{\cos(\theta_2(t)+\theta_3(t))}{2} + \frac{5}{3}$$

$$\sigma_2 = \frac{\cos(\theta_3(t))}{2} + \frac{\cos(\theta_2(t)+\theta_3(t))}{2} + \frac{1}{3}$$

H =

$$\begin{pmatrix} \frac{981\cos(\theta_1(t))}{40} + \sigma_1 + \frac{2943\cos(\theta_1(t)+\theta_2(t))}{200} \\ \frac{991\cos(\theta_1(t)+\theta_2(t)+\theta_3(t))}{200} + \frac{2973\cos(\theta_1(t)+\theta_2(t))}{200} \\ \sigma_1 \end{pmatrix}$$

where

$$\sigma_1 = \frac{981\cos(\theta_1(t)+\theta_2(t)+\theta_3(t))}{200}$$

C =

$$\begin{pmatrix} \sigma_2\left(\sin(\theta_1(t))+\frac{\sin(\sigma_6)}{2}+\sin(\sigma_{10})\right)-\left(\cos(\theta_1(t))+\frac{\cos(\sigma_6)}{2}+\cos(\sigma_{10})\right)\sigma_1-\left(\cos(\theta_1(t))+\frac{\cos(\sigma_{10})}{2}\right)\sigma_4+\left(\sin(\theta_1(t))+\frac{\sin(\sigma_{10})}{2}\right)\sigma_3 \\ \left(\frac{\sin(\sigma_6)}{2}+\sin(\sigma_{10})\right)\sigma_2-\left(\frac{\cos(\sigma_6)}{2}+\cos(\sigma_{10})\right)\sigma_1+\frac{\sin(\sigma_{10})\,\sigma_3}{2}-\frac{\cos(\sigma_{10})\,\sigma_4}{2} \\ \frac{\sin(\sigma_6)\,\sigma_2}{2}-\frac{\cos(\sigma_6)\,\sigma_1}{2} \end{pmatrix}$$

where

$$\sigma_1 = \sigma_8+\frac{\sin(\sigma_6)\,\sigma_5}{2}+\sin(\sigma_{10})\,\sigma_9$$

$$\sigma_2 = \frac{\cos(\sigma_6)\,\sigma_5}{2}+\cos(\sigma_{10})\,\sigma_9+\sigma_7$$

$$\sigma_3 = \frac{\cos(\sigma_{10})\,\sigma_9}{2}+\sigma_7$$

$$\sigma_4 = \sigma_8+\frac{\sin(\sigma_{10})\,\sigma_9}{2}$$

$$\sigma_5 = \left(\dot{\theta}_1(t)+\dot{\theta}_2(t)+\dot{\theta}_3(t)\right)^2$$

$$\sigma_6 = \theta_1(t)+\theta_2(t)+\theta_3(t)$$

$$\sigma_7 = \cos(\theta_1(t))\,\dot{\theta}_1(t)^2$$

$$\sigma_8 = \sin(\theta_1(t))\,\dot{\theta}_1(t)^2$$

$$\sigma_9 = \left(\dot{\theta}_1(t)+\dot{\theta}_2(t)\right)^2$$

$$\sigma_{10} = \theta_1(t)+\theta_2(t)$$

$$\ddot{\theta} = M^{-1}(\tau - C - G)$$

m 1=1 kg, m2=1kg, m3 = 1kg, L1= 1m, L2= 0.75 m, L3 = 0.5m, g=9.8 m/s2, τ=0 Nm, Simulate for 10 seconds with time step 0.05 s, with θ1 initial pi/3, θ2 initial pi/4, θ3 initial pi/2. **initial** $\dot{\theta}=0$