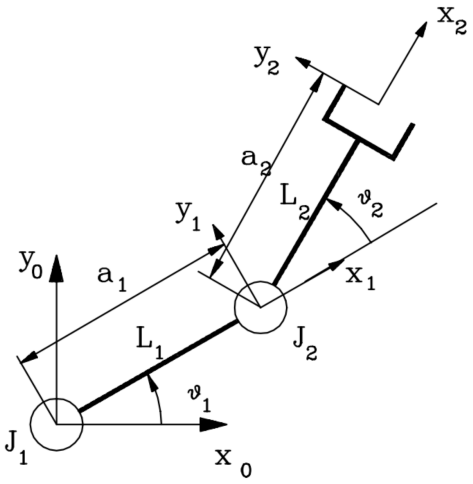
Please do your assignment independently.

Problem 1

Consider the 2D plannar robotic arm



Let $\mathbf{q} = [q_1, q_2]^\intercal$ where $q_1 = \theta_1$ and $q_2 = \theta_2$. The dynamic model of the system is given by

$$M(\mathbf{q}, \dot{\mathbf{q}})\ddot{\mathbf{q}} + C(\mathbf{q}, \dot{\mathbf{q}})\dot{\mathbf{q}} = \tau$$

Using the provided matlab code for a 2d plannar arm manipulator.

- suppose the system parameters are obtained as a gaussian estimate with mean values

```
m1 =10; m2=5; l1=1; l2=1; r1=0.5; r2 =.5; I1=10/12; I2=5/12; % parameters in the paper.
```

  yet the actual parameter the one perturbed with gaussian noise.

```
m2t = m2+
10*rand(1);% m1 true value is in [m1, m1+epsilon_m1] and epsilon_m1 a random number ...
    in [0,10];
r2t = r2 + 0.5*rand(1); I2t = I2 + (15/12)*rand(1)
```

  Design a robust controller using Lyapunov second method Chap. 8.3.1 where the upper bound on the norm of η is determined by Eq. (8.61). try different values of $\gamma_i, i = 1, 2, 3$ till you find a set achieving good perfermance.

- To avoid chattering, implement the controller in Eq. (8.68) and compare the performance with the previous one. State your observation of the performance: Plot both state trajectories and the input trajectories. and reason with these trajectories.

There are three documents in the zip package:
- test1.m for running the robust control.
- robustControl.m for designing two controllers.
- planarArmTraj.m for generation the trajectory.