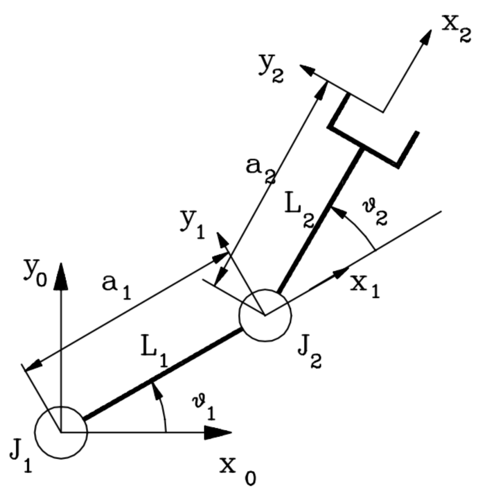
Problem 1

(20pt: Person in a project team will receive the same grade.) Consider the twolink robotic arm (not a planar):



Using the provided matlab code for a two-link arm manipulator.
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

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

Using the provided matlab code, which include the symbolic expressions for matrices $M(\cdot)$, $C(\cdot)$, $N(\cdot)$.
Each project team (with ≥ 3 team members) works on developing all these controllers (1-5):
Each project team (with $= 2$ team members) works on developing all these controllers (3,4,5):
Each project team (with $= 1$ team members) works on developing control (1-2):

1. A PD+gravity compensation control for set point tracking.
2. An iterative learning control for set point tracking (assuming no knowledge about the robot dynamics).
3. inverse dynamic control
4. lypunov-based control
5. passivity-based control

For trajectory tracking control, please also test your controllers with and without initial error. Please conclude your finding, if any, about the input trajectories given inverse dynamic control, lypunov-based control, and passivity-based control.
You are expected to implement: ode functions for simulating the system dynamics under the closed loop control and demonstrate the performance of controllers. NOTE: The following codes in matlab are provided:

- TwoLinkArm.m: main file.
- TwoLinkArmTraj.m: Trajectory generation using 3rd order polynomials.
- ode2linkTracking.m: An example of ode file to simulate the closed loop system (incomplete and need to be modified based on the control design methods.)