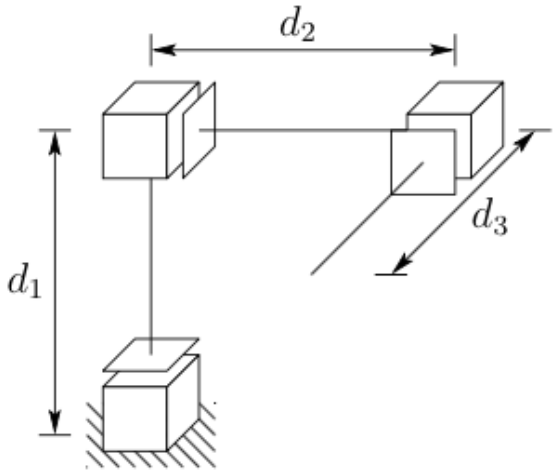
Homework 9

1. (Problem 7.7 from textbook) Consider the 3-link Cartesian manipulator (PPP) shown below:



   (a) Compute the inertia tensor (i.e., 3×3 inertia matrix) J_i for each link $i = 1, 2, 3$ assuming that the links are uniform rectangular solids of length 1, width $\frac{1}{4}$, and height $\frac{1}{4}$ and mass 1.

   (b) Compute the 3×3 inertia matrix $D(q)$ for this manipulator.

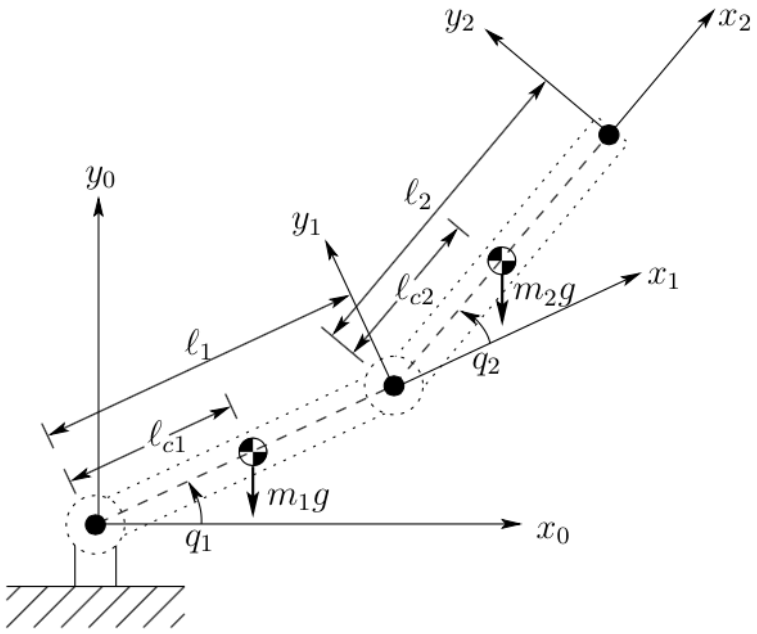
   (c) Show that the Christoffel symbols c_{ijk} are all zero for this robot. Interpret the meaning of this for the dynamic equations of motion.

   (d) Derive the dynamics equations of motion in the following form using the Euler-Lagrange method:

$$D(q)\ddot{q} + C(q, \dot{q})\dot{q} + g(q) = u$$

2. Consider the 3-link Cartesian manipulator in the question above. Derive the dynamics of the manipulator using the Newton-Euler method.

3. Consider the RR (revolute-revolute) manipulator shown below. Derive the dynamic equations of motion for this manipulator using the Euler-Lagrange method.



4. Consider the manipulator in the question above. Derive the dynamic equations of motion for the manipulator using the Newton-Euler method.