# Intelligent Control Systems Spring 2018 – Homework 1

Due at 4:00 p.m. on January 31, 2018
100 points

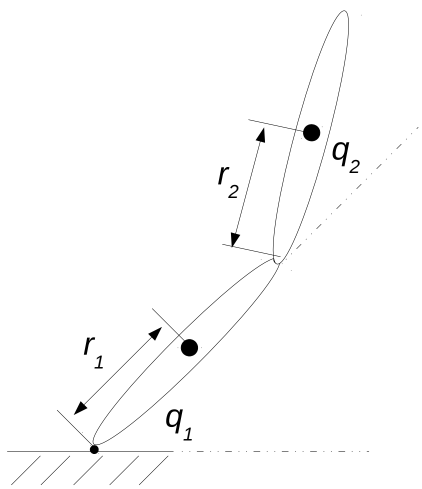
This is a Matlab homework assignment. You will create a file called "YOURLASTNAMEhw1.m" and submit that file on Blackboard. Also copy the text in your .m file into a .docx or .pdf file and submit this file that is readable by Blackboards plagarism software. Please do not submit any thing else. Your file will do everything described in the problem statement on the next page. The grading will be as follows:

- 100 points = correct solution
- 75 points = mostly correct solution
- 50 points = a good attempt, but significant improvements needed
- 25 points = a seriously flawed submission
- 0 points = no submission

If you submit your homework on time or within your remaining late homework days, you will be given the chance to resubmit your solution if you did not get a score of 100. You will receive feedback and will need to resubmit by the deadline for the next homework assignment.

**Please respect the rules on academic misconduct described in the course syllabus.**

**Problem 1: 100 points**




Consider the double pendulum above. The link connected to ground is a long thin rod with mass $m_1 = 1$ kg, length $l_1 = 1$ m, distance from the pin connecting it to ground to its center of mass $r_1$ = 0.5 m, and mass moment of inertia $I_1 = \frac{m_1 l_1^2}{12}$. The second link similarly has $m_2 = 1$ kg, $l_2 = 1$ m, $r_2 = 0.5$ m, and $I_2 = \frac{m_2 l_2^2}{12}$.

Attached to the assignment is a file called "double_pend_lagrange.m". This file derives the equations of motion of the double pendulum. It produces three files containing the Matlab functions "compute_accel.m", "compute_kinetic.m", and "compute_potential.m", which compute the angular accelerations $\ddot{q}_1$ and $\ddot{q}_2$ as a vector, the kinetic energy, and potential energy given the constants, the joint configuration, and joint velocities.

**(a) Solve equations of motion**. Use "compute_accel.m" and Euler integration to compute the joint angles $[q_1 \;\; q_2]^\top$ and velocities $[\dot{q}_1 \;\; \dot{q}_2]^\top$ as functions of time for 5 seconds. Use the initial conditions $q_1 = \pi/4$ and $q_2 = \dot{q}_1 \; \dot{q}_2 = 0$.

**(b) Animate your solution**. Animate the motion of the pedulum. You might draw the two links by creating a handle for each and using the command `line()`. You can then update the positions of the ends of the two links given your solution from (a) and the commnands `set(h,'Xdata',[])`, `set(h,'Ydata',[])`, and `drawnow` inside a loop.

**(c) Plots**. Make three plots:

1. A plot of the joint positions as functions of time with a legend labeling $q_1$ and $q_2$
2. A plot of the joint velocities as functions of time with a legend labeling $\dot{q}_1$ and $\dot{q}_2$
3. A plot of the kinetic energy, potential energy, and total energy as functions of time with a legend labelling each. Your total energy should stay roughly constant over time.