ME-84 Final Exam

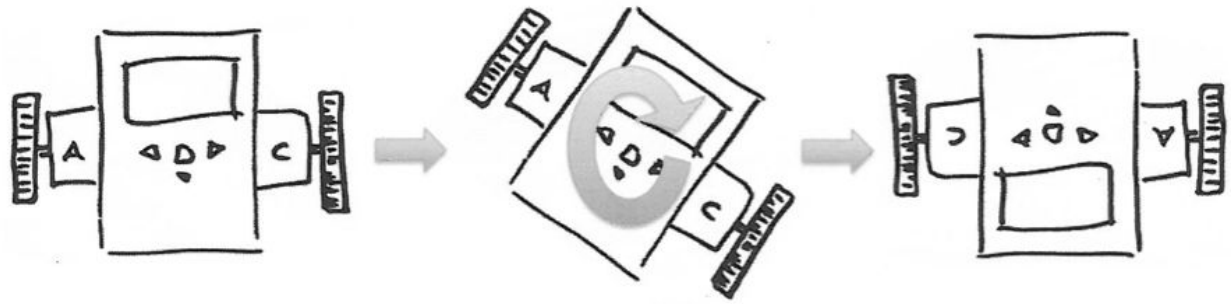
Spring 2018

This is a take-home exam, to be completed individually. You *ARE* allowed to use external resources (e.g. all the lecture notes, help videos, and submitted projects to the class website, etc), but please complete the questions ***independent*** of other students in the class. Please upload all "exam answers" (and supporting documents) to the class website; mark your post "Private" so that only you (and the instructor/TAs) can see the content.

Note that this exam is two pages and worth 20 points total (four questions, five points each).

Question 1 (5 points):

When building a robot with the LEGO MINDSTORMS robotics kit, with motors plugged into ports A and C (in the configuration shown below), if you want a robot to spin exactly 180-degrees clockwise, what power values would you suggest sending to the "A" motor and to the "C" motor? Include any assumptions you are making (e.g. which direction the motors move when powered), the values you selected, and a short explanation of why you chose the values you did.



Question 2 (5 points):

In robotics, a Proportional Controller can be implemented to control location.

- Describe (conceptually) what a Proportional Controller is and give a robotics example of when it could be used. (Do not use, as your example, an assignment from this class.)
- Write some simple Python code (or pseudo code) to demonstrate an implementation of a Proportional Controller in the context of your example. You do not have to test/run your code on an actual device; we will not be grading it based on exact/specific syntax (indentation, etc), but the general form should be correct, both in terms of algorithm and Python convention.
- Describe the methodology of how you would "tune" the Proportional Controller to match your scenario. Give some specific starting values and indicate the steps you would take (and decisions you would make). Including what kind of data or observations you would collect/take and how you would use it to refine your controller.

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Question 3 (5 points):

Given a two-linkage robotic arm (see diagram to the right), with arm lengths L_1 = 30cm and L_2 = 50cm, what arm angles $Theta_1$ and $Theta_2$ should the arm be positioned at to achieve end-effector (x,y) positions, relative to base, of (-10cm, 25cm) and also (15cm, 30cm). Include any assumptions you make, sketches to help illustrate your calculations. If either position is impossible to achieve for some reason, give appropriate explanation and evidence of that fact.

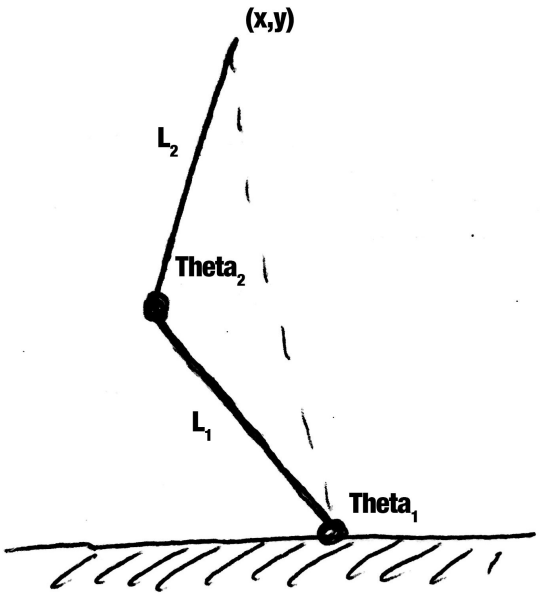

Image Credit: Ipek and Peter

Question 4 (5 points):

If you were to build a robot to solve the following open-ended design challenge (*"Crossing the Gap Challenge"*), how you would do it? Walk through your design decisions (platform choice, sensor(s)/actuator(s) choice, hardware design, software design, etc). All of these should be based on the types of things we've seen/experienced in this class. Provide details (text, sketches, etc) to demonstrate feasibility; you do NOT need to actually build anything, code anything, etc. But please describe the building and coding you *would* do; if creating "pseudocode" or actual code (in part or in full) helps you explain and demonstrate your thinking, then please feel free to include.

Crossing the Gap Challenge

There is a gap, and you must create a robot to cross it! The gap will start at 10cm big, and your robot must drive up to the edge of the gap, cross the gap, and continue safely on the other side. This challenge will be run in "rounds" and each at the conclusion of each round the gap will increase by 10cm. If a robot fails to successfully cross the gap, it is eliminated. The last robot left standing, that can cross the largest gap without "falling in" (or falling apart), will be declared the winner.