Robot Locomotion Control: ECE 594D

ENROLL CODE:	**13276 (4 units)**
TIME:	TR 12-1:50 PM
PLACE:	PHELPS 1431
INSTRUCTOR:	Prof. Katie Byl (katiebyl@ece.ucsb.edu)
OFFICE HOURS:	T/R 2-3pm, or **email to arrange**

Course Description: Robot locomotion often involves nonlinear, underactuated dynamics, which can in turn make control quite challenging. At present, roboticists often address this by limiting their approach to conservative motion planning, but this generally limits speed, agility and energetic efficiency. This course covers methods for analyzing and developing control policies relevant for dynamic robot locomotion.

Topics: Course topics include

- nonlinear and hybrid dynamics (impact dynamics, return maps, Lagrangian method)
- locomotion models (walking, running, hopping, fixed- and flapping-wing flight)
- underactuation (definition of, partial feedback linearization, ZMP planning)
- motion planning (rapidly-exploring randomized trees [RRTs], A*, D*, Dijkstra's)
- dynamic programming and value iteration
- local optimization (gradient descent)

Prerequisites: A strong (undergrad) background in both **System Dynamics** and **Controls**.

Required Text/Readings: There is **no text** for this course. Instead, we will be reading a combination of course notes and academic publications.

Grading: 3-4 Homework assignments (30%), a midterm exam (30%), and a final project (short paper and 5-10-minute in-class presentation) in simulation and control (40%).

Website: We will use GauchoSpace, which allows students to track grades. I plan to post assignments and readings on a mirror site with public access, as well. Extension Students should bring permission forms to Prof. Byl next week (or outside of class) to get permission for access to the GauchoSpace site.

To find the mirror site once it is up (note: it is NOT up yet…), go first to my homepage:
http://www.ece.ucsb.edu/~katiebyl/
…which can also be found by googling "Katie Byl".

Suggested readings for Week 1 (**Dickinson00** and **Spong97**, only) can be found here:
http://people.csail.mit.edu/katiebyl/ucsb/ece594d/papers/ece594d_W10_papers.html

(Google: "ECE594D Readings CSAIL" and look for the above link…)

NOTES:

I will be teaching TWO DIFFERENT COURSES on Robotics this year. Please look at the table below to compare the content of each!

The listing "**ECE 594D**" simply indicates that this is considered a "Special Topic in Controls". Thus, there are MULTIPLE courses offered by the department with this not-very-helpful course number…

ECE 594D Robot Locomotion Fall 2013	ECE 179D / ME 179D / ECE 594D Robot Dynamics and Control Spring 2014
Topics include: - Return maps - Impact dynamics - Hybrid (CT and DT) systems - Zero moment point - Locomotion models - Motion planning (A*, RRTs, …) - Gradient descent - Dynamic programming - Underactuation - Partial feedback linearization Lab? **No.** There is NO LAB, but each student will work (individually, or in a group) on a **Final Project**, involving a control problem relating to some course topic(s). This project may also overlap with a research project being pursued for thesis work.	Topics include: - Mechanical impedance - SISO control - Feedforward - Jacobians - Wheeled-vehicle control - (Non)-holonomic constraints - Lagrangian dynamics - State-space methods - Force/impedance control - Partial feedback linearization Lab? **Yes.** This course uses Lego Mindstorms to implement control for 3 systems: - a 2-link arm, - an omni-wheel car, and - a 2-wheeled inverted pendulum robot.

- For more info on the upcoming Spring 2014 course, see also:
  http://www.ece.ucsb.edu/courses/ECE179/179D_F12Byl/
  (click on "Lectures" tab...)

- For more info on THIS course (Fall 2013), see "website" on previous page.

- Neither course is prerequisite for the other.

- If you take ECE 594D THIS quarter, you may still register for and receive credit for "ECE 594D" in Spring, because they are NOT the same course. Again, the course number is generic, indicating a "Special Topic in Controls", only.