Course Syllabus

ME 193B / ME 292B: *Feedback Control of Legged Robots*

Fall 2019

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Office Hours: TBD

Course Description

This course introduces students to the control of legged robots. The course will cover modeling and dynamics of legged robots, trajectory planning for designing walking and running gaits, and common control strategies to achieve the planned motions. Projects will involve students applying knowledge on a simulated / real system.

Course Prerequisite

Required: ME 132 (or equivalent), ME 104 (or equivalent)
Recommended: background in linear algebra and linear differential equations (ME C232 or EECS 221A or equivalent.)

Course Format

The class consists of classroom lectures, bi-weekly homework assignments, one mini Project, and one final project.

I. CLASS/LABORATORY SCHEDULE

Three hours of lectures per week.

Lectures: Tue/Thu, 12:30PM-2:00PM, 241 Cory Hall

II. ASSIGNMENTS

Homework will be posted on bCourses and due at 11:59 pm on Thursdays. No late homework will be accepted. For undergraduate students, One lowest HW set score will be dropped.

Homework will be due as a pdf to be submitted on bCourses. Homework solutions will be posted on bCourses after the due date. Graded homework will be returned in the next week.

III. MIDTERMS AND FINAL EXAM

None.

IV. PROJECTS

The class will have two projects - A mini project and a final project.

Mini Project: The mini project will be an individual project and will be at the technical level of 2 Homeworks.

Final Project: The final project will be a group project with groups varying between 1-3 students. For graduate students, the final project is expected to be at the level of work done for a conference paper. The final project will have an in-class presentations. More details (on potential projects, project proposals, final project reports, etc.) will be released soon.

V. PIAZZA

The course discussion forum Piazza is integrated into bCourses (see the left sidebar). The instruction team will monitor and contribute to this forum, and you are encouraged to use it to seek help from the instructors and your peers. You are also encouraged to contribute not only questions, but also answers to questions that you are comfortable with. Everyone should be automatically signed up.

Textbook(s) or Other Required Material

No Textbook. Relevant reading material will be made available online.

Academic Honesty

It is acceptable to discuss with your classmates the material contained in the homework assignments, online-quizzes and laboratory assignments. *However, we require that your submissions represent your own work.* Copying someone else's work or allowing your work to be copied constitutes cheating, and will result in zero credit for the entire assignment. In addition, Berkeley students who are found to cheat in assignments or exams will be referred to Student Judicial Affairs. For details, see the website of the Berkeley Center for Student Conduct.

Honor Code
The student community at UC Berkeley has adopted the following Honor Code**:** "**As a member of the UC Berkeley community, I act with honesty, integrity, and respect for others.**"

Grades and Grading

The course grade will be assigned based on the following percentages:

- 35% Homework
- 5% In-Class Participation
- 20% Mini Project
- 40% Final Project

Tentative Course Schedule

Date	Day	Topic	Due
August			
29	Thu.	Introduction and Course Overview	
September			
3	Tue.	Lagrangian Dynamics	
5	Thu.	Constrained Lagrangian Dynamics	
10	Tue.	Impact Modelling and Hybrid Systems	
12	Thu.	Passive Dynamic Systems and Limit Cycles	HW 1
17	Tue.	Poincare Maps and Stability Analysis	
19	Thu.	Reduced-Order Models (IP / SLIP)	
24	Tue.	Raibert Control	
26	Thu.	Virtual Constraints based Control	HW 2
October			
1	Tue.	3D Reduced-Order Models	
3	Thu.	Humanoid Robot Modelling	
8	Tue.	Zero Moment Point (ZMP)-based Control	
10	Thu.	Templates and Anchors	HW 3
15	Tue.	Whole-body Operational Space Control	
17	Thu.	Contact Force Control	
22	Tue.	Model Predictive Control	
24	Thu.	Model Predictive Control	HW 4
29	Tue.	Gait Optimization: Shooting and Collocation	
31	Thu.	Footstep Planning	
November			
5	Tue.	Hybrid Zero Dynamics (HZD)-based Control	
7	Thu.	Hybrid Zero Dynamics (HZD)-based Control	HW 5
12	Tue.	Case Study: Robot A	
14	Thu.	Case Study: Robot B	
19	Tue.	Case Study: Robot C	
21	Thu.	Special Topics: Metastable Walking	Mini Proj.
26	Tue.	Special Topics: CLF and CBF Control	
28	Thu.	NO CLASS (Thanksgiving)	
December			
3	Tue.	Special Topics: Mechanical Design for Legged Robots	
5	Thu.	Special Topics: Actuators for Legged Robots	Final Proj.

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