CE 295: Energy Systems and Control

Syllabus

Lectures: MWF, 3-4pm, 212 O'Brien Hall

Website: (`http://bcourses.berkeley.edu`) Used for course announcements, materials, grades

Instructors

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Catalog Description

Introduction to control system tools for students interested in energy system applications. Applications of interest include batteries, electric vehicles, renewable energy, power systems, and smart buildings/homes. Technical tools include system modeling, state-space representations, stability, parameter identification, state observers, feedback control, and optimization. **Prerequisites:** Grad student standing; multivariable calculus (Math 53); linear algebra (Math 54); probability and statistics (CE93); programming (E7/CS61); mechanics (Phys 7A); electricity/magnetism (Phys 7B); thermodynamics (E115/ME 40) or equivalents.

Objectives

1. To encourage the development of a "systems and control perspective" necessary for the design and management of energy systems.
2. To provide students with an introduction to energy systems across multiple infrastructures, including transportation, buildings, and power systems.
3. To strengthen students' programming and mathematical analysis skills.

Contents

This course provides control system tools for the analysis and management of energy systems. The homework assignments facilitate motivation and application of these tools.

HW	**System & Control Tool**	**Energy Application**
1	Dynamic system modeling	Batteries
2	Model Identification	Building heating
3	State Estimation	Offshore Oil Drilling
4	Optimization	Power Systems
5	Optimal Control	Hybrid vehicles

Recommended Textbook Material:

No textbooks are required. Course notes have been developed specifically for CE 295, and will be distributed throughout the semester via bCourses. Nevertheless, the following textbooks are officially recommended for additional background:

- G. M. Masters, Renewable and Efficient Electric Power Systems, John Wiley & Sons, 2013
- D. C. Karnopp, D. L. Margolis, and R. C. Rosenberg, System Dynamics: Modeling, Simulation, and Control of Mechatronic Systems, John Wiley & Sons, 2012
- S. Boyd and L. Vandenberghe, Convex optimization. Cambridge University Press, 2009.

These textbooks have been placed **on 2 hr. reserve** in Kresge Engineering Library.

Assessment & Grading:

Homework	50pts	5 two-week assignments (10pts each)
Midterm	20pts	In-class exam, Monday March 7, 2016
Project	30pts	Declaration (1pt), Proposal (5pts), Progress Report (5pts), Symposium (8pts), Final Report (10pts), Self/Team/Class Eval (1pt)

A total of 100pts are possible. The grading is a straight-scale. Graded HW assignments will be submitted and returned via bCourses, with Friday 5pm PT deadlines.

Projects

Students will engage in two-team member, student-defined, semester-long course projects. The philosophy is to stimulate students' individual creativity and interests to deliver a high quality investigation in energy systems and control. The project topics must apply one systems and control tool (modeling, param identification, state estimation, optimization, optimal control) to an energy system. Each team is required to submit:

1. a declaration statement, indicating the team members and project topic (one sentence)
2. a project proposal (2 pgs max)
3. a progress report (4 pgs max)
4. a poster/project board presentation
5. a final report (15 pgs max)
6. a self/team/class project evaluation

A "Project Guide" with detailed instructions will be distributed via bCourses.

Numerical Computing

Assignments require the use of numerical computing languages, such as MATLAB or Python. You may complete assignments in either language. Note, these languages are not taught in CE 295.

- **MATLAB:** MATLAB 2016 is FREE for download at <https://software.berkeley.edu/matlab>. MATLAB Academy <https://matlabacademy.mathworks.com/> is recommended to learn/refresh.
- **Python:** Python 2.7 (recommended) is FREE for download at <https://www.python.org/downloads/>. We recommend Anaconda distribution for SciPy packages <https://www.continuum.io/>, and IPython Notebook <http://ipython.org/notebook.html> for an interactive computational environment. Code Academy <https://www.codecademy.com/> is recommended to learn/refresh Python.

Computer Lab Access: A CEE Computer Lab Account is required to use the computers in 345 and 541 Davis. Use the link below to request an account. `http://www.ce.berkeley.edu/resources/computing/create_lab_account`

Policies

Late Submissions: One point is subtracted for each 24 hours submitted late (rounded up to nearest integer). Two free late days are allowed on any *HW* of your choice. Late submissions are not accepted after the Tuesday following a Friday due date (max 5 days late).

Regrade Policy: If you feel a problem was graded incorrectly, you may submit a regrade request to the head instructor. This request MUST be submitted within one week of receiving the graded assignment, with a short paragraph justifying the regrade. Any regrade request is subject to a full regrade, i.e. points may be lost. Our grading philosophy is to achieve *consistency* and *transparency*.

Extra Credit: Students who find errors and supply corrections to the notes will receive 0.1 pts extra credit. You receive 0.1 pts for each new error and correction that you supply, subject to instructor approval. First come-first reward. Students must report the corrections by e-mail, to leave a paper-trail. Each student can receive a maximum of two points, i.e. for twenty corrections. Keep in mind that the notes are continuously updated on bCourses, so make sure the correction is applicable to the most up-to-date version.

Planned Absences: You may request to submit assignments early or late. E-mail me your request two weeks prior to the assignment due date. Requests due to extended holidays will not be granted. Requests due to emergencies or personal reasons will be handled case-by-case.

Late Enrollment: Students require instructor permission to enroll after the first week of classes. Missed assignment deadlines will result in zero credit, unless otherwise arranged with the instructor.

E-mail Correspondence

Use [CE 295] in your message subject. We typically respond within one day, however our ability to help declines as e-mail volume increases. Please be considerate and concise. Do not wait until the due-date to ask questions, otherwise they may not be answered.

Code of Conduct

Students must abide the Code of Conduct. For further reference, see the Berkeley Campus Code of Student Conduct at `http://sa.berkeley.edu/code-of-conduct`.