CE 186: Design of Cyber Physical Systems

Syllabus

Lectures: MW, 2-4pm; 210 Jacobs Hall

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

Instructors

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Catalog Description

Design and prototype of large-scale technology intensive systems. Design project incorporating infrastructure systems and areas such as transportation and hydrology; for example, watershed sensor networks, robot networks for environmental management, mobile Internet monitoring, open societal scale systems, crowd-sources applications, traffic management. Design of sensing and control systems, prototyping systems, and measures of system performance. Modeling, software and hardware implementation. **Prerequisites:** Math 53, 54; E7 (programming); Physics 7A, 7B or equivalents; Upper division standing in engineering or physical science.

Objectives

1. To provide students hands-on experience in prototyping cyber-physical systems. The five axioms of CE 186 are: (i) infrastructure; (ii) hardware sensing/actuation; (iii) data analysis; (iv) connectivity; and (v) visualization.
2. To provide students with a "systems" perspective for designing, monitoring, and managing large-scale civil infrastructure.
3. To strengthen students' programming, prototyping, and mathematical analysis skills.

Contents

This course is centered around three projects: (i) an indoor environmental sensing node; (ii) a "smart" refrigerator; (iii) an electric scooter. Laboratory assignments facilitate the essential skills for completing the aforementioned projects.

Lab	Cyber Physical System Tool
1	Arduino Microcontroller & Communication
2	Analog, Digital I/O & Sensors
3	Python for Computing & Communication
4	Internet-based Services
5	Web Design & Visualization

Recommended Textbook Material:

No textbooks are required. Required and supplemental reading materials have been collected specifically for CE 186, and will be distributed throughout the semester via bCourses.

Assessment & Grading:

Laboratories	40pts	Five lab assignments (8pts each)
Training	2 pts	Jacobs Hall General Workshop Safety (2 pts)
Project	58pts	Declaration (1pt); Proposal (8pts); Four In-class oral updates (4pts each); In-class Presentations & Critique (10pts); Jacobs Showcase (2pts); Final Report (20pt); Self/Team Evaluation (1pt)

A total of 100pts are possible. Lab assignments, the project declaration, proposal, final report, and self/team eval will be submitted via bCourses, with Friday 5pm PT deadlines.

Projects

Students will engage in four member, semester-long course projects. The philosophy is to stimulate students' individual creativity and interests in cyber physical systems, grounded in the five CE 186 axioms. Teams may select amongst three projects, use Arduino, and construct a cyber-physical system:

- **Smart Energy & Environment:** Students will monitor and/or control an environment, e.g. Tiny House (THIMBY), a refrigerator, desk space, or snake terrarium! You are provided a wireless radio (ZigBee), and various environmental sensors, e.g. temperature, humidity, CO_2, photodetector.
- **Smart Mobility:** Students will have access to a 1000W electric scooter, e-bike computer, Arduino microcontroller, and a power supply relay. They should use a mapping service.
- **Smart Water:** Students will be provided with Arduino microcontrollers, soil moisture sensors, temperature sensors, water flow meters, and pumps.

Each team is required to complete:

- a declaration statement, indicating the team members and project topic (1 sentence on bCourses)
- a project proposal (2 pgs max on bCourses)
- four in-class oral updates to the course instructors (see schedule)
- a poster/demo presentation in the Jacobs Winter Showcase
- a final report (8 pgs max, double column IEEE format on bCourses)
- a self and team evaluation (on bCourses)

Software

This course will use a variety of software and programming languages. All software is FREE and previous experience is NOT required. We teach the essentials, and all software is EASY to learn.

Arduino: The Integrated Development Environmental (IDE) Software and documentation is available at https://www.arduino.cc/en/Main/Software

Python: This course utilizes the Python programming language. Matlab users will find Python easy to learn. The following specific packages are utilized

- Python 2.7 | https://www.python.org/downloads/
- Anaconda scientific computing package w/ Spyder IDE | https://store.continuum.io/cshop/anaconda/

Web Design: This course involves some web design, including HTML/CSS. Depending on the project, students may also use WAMP, PHP, Javascript, MySQL. There are literally thousands of decent, free HTML editors. Recommended editors include Atom, Brackets, Notepad++, Netbeans, CoffeeCup.

Computer Access: Students must bring a personal laptop with USB & WIFI access to class.

Hardware

All necessary hardware will be made available to students in Jacobs Hall. This includes Arduino Uno microcontrollers, various sensors, actuators, wires, tools, cables, power supplies, etc. Nominally, no hardware may leave Jacobs Hall with two exceptions. (i) Arduino "inventor kits" will be checked-out to students to take home for laboratory assignments. (ii) Expensive equipment (e.g. eScooters & CO_2 sensors) will be checked-out to students for their projects. For each checked-out item that is NOT returned/replaced, students will be penalized 5 pts from their lab assignment category. Students are welcome and encouraged to purchase their own hardware (e.g. Arduino Unos) and tools (e.g. wire strippers, screwdrivers, cutters), for the course. This is not required, however.

Jacobs Hall Facilities and Safety Training

To access the equipment in Jacobs Hall, you must complete the following training:

- General Workshop Safety (GWS) on bCourses. Upon completion you automatically receive a "Maker Pass". This provides keycard access to Jacobs Hall, and is a requisite for equipment training.
- For specialized equipment, e.g. Type A 3D printer, Laser Cutter, Electronics Lab, Woodshop, Metalshop, Vynil Cutter, you must pass BOTH the online training (bCourses) and hands-on training.

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 lab of your choice. Late submissions are not accepted after 5pm PT on the Tuesday following a Friday due date.

Regrade Policy: If you feel a problem was graded incorrectly, you may submit a regrade request to the professor. 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: 1pt extra credit is awarded for completing the course questionnaire (see schedule).

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.

Auditing or Satisfactory/Not-Satisfactory: Due to the nature of a group project-based class, auditing or enrolling with a satisfactory/not-satisfactory credit option is NOT permitted in CE 186.

E-mail Correspondence

Use [CE 186] 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`.