Master Course Syllabus for EE 497/498 (ABET sheet)

Title: Industrial Design Capstone I, II

Credits: 4, 4

UW Course Catalog Description

Coordinator: John Sahr, Professor, Electrical Engineering, and Payman Arabshahi, Associate Professor, Electrical Engineering

Goals: This course is a two course sequence supporting a deep industrial design experience for electrical engineering seniors.

The course has one hour of regularly schedule contact hour, consisting of a meeting with the course instructor/coordinator, and otherwise is dominated by 12-16 hours of homework, laboratory, and project development each week. In addition, the students will receive project-specific advice and mentoring from dedicated industrial mentors (arranged by the instructor/coordinator).

The students will work in teams of three to six on their projects. It is possible that non-Electrical Engineering students whose expertise may be relevant and valuable to the project.

Objectives: At the end of this course, students will be able to

1. design an engineering artifact of significant complexity utility and sophistication
2. provide detailed and useful written documentation about the artifact
3. make an oral and poster presentation of the project
4. work in a small team to bring the project to completion
5. describe the organization and leadership required to bring the project to fruition

Textbook: Class notes, technical papers and reports.

Prerequisites by Topic:

1. Completion of a senior-level EE elective course or equivalent in another engineering department;
2. *(Desired, not required)* completion of the writing component of the degree.

Topics: A few lectures are given in supplemental topics including:

1. State space systems
2. Digital control
3. Linear quadratic regulators
4. Simple Optimization
5. Intellectual Property Protection

6. Project Management

Course Structure: The class has a reserved time slot of three times per week, each consisting of 50-minute sessions. Students form teams (of 3-4), and prepare a project proposal. This is done in consultation with the Professor and TA. The proposal follows a structure provided, and includes a budget, proposed milestones, and timeline.

After project approval, students work in teams. Most weeks there are project review meetings with each team, and seminars on relevant topics during scheduled class meeting times. Approximately every third week, a progress report is presented the entire class (either with powerpoint slides, videos or in-lab demonstrations). Throughout the project, each group maintains a website with all designs, reports and other documentation. This includes exercises related to project safety (during development, and safety for the user after completion). It also includes exercises related to standards and, when relevant, ethical concerns.

At the end of the two quarter course, each group will submit a paper in standard IEEE conference paper format (with hyperlinks to supporting software, data, videos, simulations and other resources). Each group will give a one hour final presentation. There is also a poster session, where each group can present to non-class members.

Computer Resources: Most projects involve embedded computers (eg., Arduino, Raspberry Pi), as well as simulation and/or programming on PCs, laptops or tablets. Some projects involve app programming on smart phones.

Grading: For EE 497, System Requirements Analysis Document 20%, Functional Analysis and Allocation Document 20%, Midterm Design Review and Report 30%, Final Design Review and Report 30%; For EE 498, Midterm Design Review and Report 30%, Verification Report 30%, Final Design Review and Report 40%

Laboratory Resources: A dedicated lab space is provided for all project teams that require it (some use researcher labs, if they are sponsored by such labs).

Outcome Coverage: This course provides the ABET major design experience and addresses all of the basic ABET outcomes.

Outcomes:

A. (M) *an ability to apply knowledge of mathematics, science, and engineering.* The design of devices incorporating robotics, control, and other systems hardware by its very nature demands constant use of knowledge of mathematics, science and engineering. The various components of the design interact in ways based on science, and described mathematically. The design of a system to a given set of objectives is a fundamental application of engineering knowledge. This, a successful design shows the student's achievement of this outcome.

B. (M) *an ability to design and conduct experiments, as well as to analyze and interpret data.* The design process has an analysis step in which the students must design and conduct experiments, and interpret the results to determine whether their design meets specifications. This process occurs many times in the course of the design process, and is documented in the project report.

C. (H) *an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.* The students are guided to develop specifications imposing realistic constraints on the operation of their devices. Much of this is driven by considerations of cost, safety and reliability. Students must choose among design alternatives on the basis of these considerations. Specific consideration of safety issues is required.

D. (H) *an ability to function on multi-disciplinary teams.* Students operate in teams of three to solve the design problem and prepare a final report. Team members naturally tend to specialize in one aspect of the design problem, such as security analysis versus economics, creating something of a multi-disciplinary environment within the team.

E. (M) *an ability to identify, formulate, and solve engineering problems.* The design problem presents itself as a series of interconnected engineering problems. In the open-ended design environment, the engineering problems are not explicitly stated, but must be identified by the design team before they can be solved. Evidence of this should appear in the project report and progress reports (including the individual team web pages).

F. (L) *an understanding of professional and ethical responsibility.* After project work starts, a one hour seminar on professional ethics covers the IEEE ethics guidelines and some discipline-relevant case studies. Student teams will provide a written analysis of a case study.

G. (H) *an ability to communicate effectively.* Teams must prepare web documentation of their project, progress reports, a final report as well as oral presentations and a poster

H. (M) *the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context*. During team presentations, the course instructor and TA ask specific questions regarding these issues, which are incorporated in student team progress reports.

I. (M) *a recognition of the need for, and an ability to engage in life-long learning.* The course material distributed does not contain all of the information necessary to solve the design problem. Students must consult reference sources and inform themselves concerning certain aspects of the design problem. This helps students realize that they need to be able to learn material on their own, and gives them some of the necessary skills.

J. (H) *a knowledge of contemporary issues.* The projects use currently available technological components, and are directed toward innovative designs. In team interaction with the Professor and TA, these issues are discussed.

K. (M) *an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.* Students are expected to use software and hardware tools in their project design, testing and analysis. This is reflected in student reports.

Preparer: John Sahr and Payman Arabshahi

Last revised: October 21, 2015