Senior Design Project Course Sequence
Electrical and Computer Engineering

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Abstract

This paper describes the senior design project course sequence at the University of Evansville. The two-semester sequence of courses (along with a non-credit seminar) serves as the capstone design course for electrical and computer engineering students. It combines a senior design project, practice in oral and written presentation of a design proposal and final report, and a discussion of professional ethics.

The non-credit seminar is usually taken in the spring of the junior year. Students select projects involving areas of current interest in engineering and make presentations preparatory for the engineering design project series.

The first semester of the two-semester course sequence is devoted to a discussion of ethics in professional practice and the preparation and presentation of an engineering design proposal. Students work with the course coordinator and a faculty project advisor to develop the proposal and preliminary conceptual design. They also practice oral presentation of their proposals.

The second semester of the two-semester course sequence is devoted to completion of the technical design, validation of the final design, and final presentation of the project results in written and oral form. The students work with the faculty project advisor and the industrial advisor (or problem originator).

In addition to projects sponsored by local industry and by the university, other types of projects involve the invention and patent process and preparation of a paper for submission at an undergraduate research conference.

Introduction

The goals of the senior design project sequence are three:

1. To examine the concepts of professional responsibility and employer authority and to review the codes of ethics of several professional organizations
2. To study the various steps in the engineering design process and to complete a design project
3. To practice both oral and written communication skills by preparing an engineering design proposal and a final design report and by giving oral presentations of each.

The overall course sequence consists also of three parts:

1. EE 494 Senior Project Seminar (0 credits)
2. EE 495 Senior Project Phase I (3 credits)
3. EE 497 Senior Project Phase II (3 credits)

The first course, EE 494, provides an introduction to the sequence and to the last two of the three goals. The second course, EE 495, addresses all three goals, while the third course, EE 497, addresses the last two of the three goals. Details of the three courses are covered in the following sections.

EE 494 Senior Project Seminar

In the senior project seminar, which meets for one fifty-minute session each week, students are presented with a variety of project ideas, some proposed by local industry and some proposed by faculty members. Students are encouraged to suggest projects of their own invention, but such projects are allowed only subject to approval by the course coordinator. Two other types of "projects" that have been attempted in recent years are the development of an invention by a team of students who prepare the necessary papers for a patent application and the preparation of a paper for submission to an undergraduate research conference.

Once students have selected projects, they are asked to perform an initial assessment of the problem to identify the engineering problem or problems to be solved and to make a preliminary attempt to suggest alternate approaches to solving the problems.

Near the end of the semester, students are asked to prepare a "mini-proposal" and give a brief (2 - 5 minute) talk describing the project they have chosen and how they think they might approach the problem. The "mini-proposal" is a one or two-page essay that describes the problem, its origin, and the importance attached to its solution; identifies any previous work on the same problem; and gives a brief outline of the proposed work. At this stage most students are simply giving their interpretation of the project presented. Since many of the ideas presented to the students are descriptions of something that would be useful if it could be implemented, students must decide for themselves how the "thing" could be made or shown to be feasible. The instructor can give some guidance to the students at this point to insure that the preliminary problem description is a reasonable interpretation of the project originally presented to the class.

Some projects are attempted in teams, although most have in the past been individual projects. In recent years there has been more emphasis placed on team projects; the patentable invention projects were specifically formulated as team projects with three or four team members.

EE 495 Senior Project Phase I

Students in this course combine study of engineering ethics, preparation of an engineering design proposal, and practice in oral presentation skills. The text used is prepared specifically for this course through the McGraw-Hill Primis system. It combines selections from *Effective Technical Communications* by Eisenberg (McGraw-Hill 1993), *Ethics in Engineering* by Martin-

Schinzinger, the ACM Code of Ethics, and a proposal outline used at the University of Evansville.

The selections from the technical writing book include material on writing a proposal and on preparing and giving a technical talk. Also included is a section on grammar and style. The proposal outline used at the University of Evansville is included in the text as an alternate example to illustrate the fact that, although there is no unique format for a technical proposal, the information included is the same. At approximate two-week intervals, starting at the beginning of the semester, students turn in to the instructor and to the project advisor rough drafts of the problem statement and objectives, the procedure to be followed (including both the technical plan and the management plan), and the entire proposal. Each draft is graded by the instructor and returned with comments. By the time a student submits the final copy of the proposal at the end of the semester, most parts have been critiqued by the instructor and the project advisor twice.

There are typically fourteen weeks of classes in a semester. During the first four weeks the class periods are used for discussion of assigned reading from the ethics section of the text. Also during this time students give presentations of answers to questions in the text and of their version of a code of ethics for engineers. The material in this part of the text includes discussions of loyalty, professionalism, employers' authority, conflicts of interest, confidentiality, unionism, white collar crime, and the codes of ethics of ABET, AAES, NSPE, IEEE, and ACM. Several case studies are included. In answering questions related to the ethics case studies, students are asked to use the engineering ethics cases from the World Wide Web Ethics Center for Engineering & Science (http://web.mit.edu/ethics/www/engcases.html) as examples to support their answers when possible. Students are asked to work in groups of three or four when discussing the questions, and each group gives a presentation of their answers to the class. The class is encouraged to ask questions and comment. The final assignment for the topic of ethics is for each group to write its own code of ethics, using ideas from the various codes of ethics they have read and their own ideas on any additional topics that should be addressed. (Sexual harassment in the workplace is one frequent additional topic addressed in the student codes.)

Starting during the fifth week of the semester, students are asked to give oral presentations of the problem statement and objectives portion of their proposals. Students' presentations are video-taped on separate cassettes, and students are asked to review their own taped presentations. The audience is asked to fill out written evaluations of the presentations, which are given to each presenter along with the video tape.

By the end of the sixth week, a draft copy of the entire proposal is required. Individual conferences with the instructor are held during the class period for the next two weeks or so. It is during this time that the instructor can make detailed comments and suggestions on each proposal.

During the next three weeks students give practice oral presentations of their final proposal. These presentations are again video-taped and given to the students along with audience

evaluations. The final three weeks of the semester are used for the final oral presentations, which are once again taped and evaluated by the audience.

At the end of the semester, students submit the final copies of their written proposals and a written critique of their own presentations and response to the evaluations written by the audience. By this time the conceptual design for the project should be complete and included as part of the proposal.

The course grade is determined by averaging the grade from the instructor, which includes all class activities, and the grade from the project advisor, which is determined from the written work submitted to the project advisor.

The present structure of this course has evolved over the fifteen or so years that I have taught it. The practice presentations were added several years ago as a result of suggestions from students in the course.

EE 497 Senior Project Phase II

During the final semester of the senior project sequence the final design, construction, and testing of the project is completed. Validation by simulation or analysis using generally accepted theory is an appropriate alternative to construction and testing for some of the projects. Students are asked to submit a final written report as well as an oral presentation of their results.

Since most of the actual work on the project itself takes place in this phase, regular class sessions are not held. Several class periods at the beginning of the semester are used to distribute an outline of a typical final report. About the middle of the semester the schedule for the final presentations if developed. The final presentations are held on one day, usually a Saturday, near the end of the twelfth week of the semester. Volunteers from local industry serve as judges for the presentations and select candidates for awards.

Students are expected to consult regularly with the project advisor throughout the semester. By the end of the fifth week of the semester, each student is expected to schedule a concept technical design review with the faculty project advisor (and industrial sponsor as appropriate). Some project advisors require periodic written progress reports as well. By the end of the tenth week of the semester, each student is required to schedule a “dry run” presentation with the project advisor.
Final written reports are due at the end of the semester. The final presentation is held slightly before the end of the semester so that any student who may not be able to demonstrate satisfactory results has some time to remedy any deficiencies noted during the presentation.

The grade for the course is assigned by the project faculty advisor.

Summary

In the senior project course sequence students carry out an engineering design project from initial problem selection to final design and practice oral and written communication skills by giving presentations of the original proposal and the final report. In addition, they participate in discussion of the ethical issues important in engineering practice. By having the opportunity to give several practice presentations that are critiqued by the audience and to review video tapes of their own presentations, they receive guidance on ways to improve their presentation skills.

Examples of Projects

A device to measure the velocity of arrows released from a hunting bow.

A special purpose photographic timer.

A small animal respirator used in medical research.

An adjustable phase shifter used as a test instrument in communications electronics.

A helium leak check robot used to check for leaks in valves. The project was sponsored by local industry and the finished machine was shipped to a customer.

A radio link between computers. This project was completed before the time such a system was routinely available commercially.

The electronics used in conjunction with prototypes of hydrogen sensors for Sandia Labs.

A home temperature control system with a central computer monitoring the temperature in individual rooms and adjusting the heating or cooling registers to maintain room temperatures that could be individually programmed. The central control system communicated with the room control units over household wiring circuits.

A microprocessor-based interface between a PC and a monochromator that used the PC to control a scan over a desired range of wavelengths and display the resulting spectrum.

Several team projects to develop patentable inventions.

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