ECE 4899-4999
ECE 4951

ECE SENIOR DESIGN PROJECT HANDBOOK

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

Updated Summer 2009

TABLE OF CONTENTS

I. INTRODUCTION

This handbook contains information on senior design project activities: registering for the senior design project, manuscript guidelines, the standard form of the senior project report, and the oral presentation.

I.1 Overview

ECE 4899 and 4999, Senior Design Project I and II, together comprise a two-semester course that allows electrical and computer engineering students to work as a team in developing and executing a group design experience. ECE 4951, Senior Design Workshop, offers an alternative, one-semester design experience. Students, working closely with their team members and senior project advisors and using all of the skills and knowledge they have gained in course work---create, build and implement a design of their choice. A written summary and oral report are due at the end of the semester in which ECE 4999 or ECE 4951 is taken.

I.2 To Register for Senior Design Projects I-II (ECE 4899 and ECE 4999)

1. Choose a minimum of one, preferably two or three, team members to work on the project with you. The senior design project team must be inter- or multi-disciplinary in composition. This inter- or multi-disciplinary team composition can be satisfied in one or more of the following ways:

   (a) Inclusion of students from one or more of the following departments: Chemical Engineering; Civil Engineering; Industrial Engineering; Mechanical Engineering.

   (b) Participation as an ECE student on a senior design team in either Chemical Engineering; Civil Engineering; Industrial Engineering; Mechanical Engineering.

   (c) Having at least one team member be a dual major; i.e. In addition to ECE; Mathematics, Physics, Computer Science, Civil Engineering, Industrial Engineering; Mechanical Engineering; Chemical Engineering is a non-exclusive list of second majors.

   (d) If all team members are ECE majors, there must be a mix of technical electives for the team members. The disciplinary expertise mix must be appropriate to the project content and scope. Requires approval on the Senior Project Override form.

   (e) If all team members are ECE majors, there is faculty input from non-ECE faculty or input from engineers or engineering managers in the private or public sector. Requires approval on the Senior Project Override form.

   (f) Team participation in a National-level project competition.

2. Decide with which ECE faculty member(s) your team is going to work. Non-ECE student team members must obtain permission from a faculty member in their home department.

3. Each team member must complete the Senior Design Project Override form which is available in the ECE Office (271 MWAH).

4. Each team member should complete the form and bring to the faculty member with whom they wish to do their project and obtain his/her signature. Bring to the ECE Office for department approval and override

number.

5. Overrides will not be approved until all team members are listed on the approval form, and form has been signed by both faculty and department head.

I.3 To Register for Senior Design Workshop (ECE 4951)

1. Discuss workshop topic with faculty teaching the course.

2. Obtain override permission from course instructor.

3. Course instructor(s) will determine team groupings and responsibilities.

4. Course instructor(s) will serve as senior project advisor.

II. SENIOR DESIGN PROJECT/WORKSHOP ACTIVITIES

II.1 Project Proposal

Producing a good design proposal consists of: 1) making a preliminary study, 2) discussing procedures with your faculty senior design project advisor, 3) developing a plan, and 4) making an outline. Submit the proposal to your senior project advisor in memo form:

DATE: Today's Date
TO: Your Faculty Senior Design Project Advisor
FROM: Your Name
SUBJECT: Senior Design Project Topic

In the body of the memo, discuss your proposed design, its purpose and uses, major features, advantages, and (possibly) what you intend to gain by studying this particular design project.

II.2 Professional Component

The professional component of your senior design experience requires you to acknowledge that any engineering project, including your senior design project, impacts a wide spectrum of human experience, not just your partners on your design team or your colleagues in the department. Your project report must address most of the following considerations:

1. Economic Concerns
   * Does your design fit within economic constraints of your budget?
   * Is your design affordable for the target customer for your project?

2. Environmental Concerns
   * Does your design produce waste that threatens the environment?
   * Is your design compatible with existing environmental codes?

3. Sustainability Concerns
   * Does your design waste raw materials?
   * Does your design use renewable energy resources?

4. Manufacturability Concerns
   * Is your design mass producible or must it be hand-crafted individually?
   * Is your design a one-of-a-kind device, or can it be replicated easily?

5. Ethical Concerns
   * Does your design address the ethical issues delineated in the "IEEE Code of Ethics" and the IEEE Computer Society "Soft Engineering Code of Ethics and Professional Practice"? (See pages 13-14).
   * Does your design address key items in #6 below?

6. Health and Safety Concerns

* Does your design meet applicable ANSI and/or IEEE standards?
* Do you provide adequate instruction for safe use of your design?

7. Social Concerns
   * Is your design compatible with existing social concerns or standards?
   * Does your design interfere with the lives of others?

8. Political Concerns
   * Does your design work within the laws of your community?
   * Does your design require any special licensing or permission for operation?

II.3 Project Time Line

With your senior project advisor and team members, set deadlines for your project. Your outline, written reports, notebook reviews, prototype demonstration, acceptance test, rough draft of the final report, and the final report should all be placed on a project time line. Setting a time line is an important part of the design process; you and your advisor will gain more from the project if work proceeds in an orderly fashion. Your advisor will be in tune to your progress if you meet at regularly scheduled times, and you will be more likely to make some progress each week of the class. A project time line will assist you in learning how to meet deadlines - a prerequisite skill for professional engineers.

II.4 Outline

The project outline provides the backbone for your project activities. It should cover the aspects of your design, design procedures, equipment and costs, suppliers, and also a breakdown of the estimated number of hours you will spend on research, construction, testing, debugging, and documentation. Such an outline will provide an accurate picture of the economic feasibility of your design, and will help you in developing a project time line.

Laboratory Notebook

Maintain a day-to-day project notebook following standard engineering practice guidelines.

Progress Reports

Schedule three or four times when you and your team members will sit down with your senior project advisor to discuss your work to date. Prepare a written report of your activities including observations, percent of work done, revised time schedule, costs, and any other pertinent information.

Prototype Demonstration

This aspect of the project is equivalent to the Critical Design Review. All elements of the project should satisfy the requirements at this point.

Rough Draft

Begin the rough draft of your report by the end of the fifth week of ECE 4999/ECE 4951. Prepare according to these guidelines. Submit the draft to your advisor by the middle of the seventh week to allow plenty of time for comments, and to provide sufficient time for you to revise carefully.

Senior Design Project Report and Demonstration

Following the Manuscript Guidelines in Part II of this handbook, submit one hardbound copy to your senior project advisor, and one electronic copy to the ECE Department. A seminar in which you and your team members present the results of your project to a group of engineering students and faculty is required.

Oral Presentation

Information on your senior design project presentation must be e-mailed to the department office at least two days in advance so that notices can be posted and e-mails sent to ECE student and faculty aliases. E-mail the following information to ece@d.umn.edu with a copy to msaarela@d.umn.edu: name, location, time, title, and a brief abstract. Try to arrange for a time when most faculty can attend; 4:00 PM in the late afternoon (except Friday) often works best. Invite external sponsors if practical.

Room scheduling for the senior design project presentations must be arranged through the ECE Office. Usually 191 MWAH and 102 MWAH are available after 4:00 PM. Because of the location of equipment, the department recognizes some presentations may need to be held in one of the teaching laboratories. We will do our best to accommodate this (however, due to space limitations, the room could be crowded).

In addition to providing a copy of the written report, students should provide a copy on disk or CD ROM of any Power Point presentations or copies of overheads.

Grading

Grades for the senior design project/workshop courses will be determined in a method designed by the project advisor or workshop instructor. The grade should reflect how well the project addresses each of the underlined items in this section of this handbook, "II. SENIOR DESIGN PROJECT/WORKSHOP ACTIVITIES", including the "Professional Component". In particular, the grade must reflect more than just whether the project "works" or "does not work". Each component of the project, as itemized in this section, should be completed to the satisfaction of the project advisor or workshop instructor, and the grade should reflect the degree to which the project addressed each of these components.

III. MANUSCRIPT GUIDELINES

Overview

Senior Design Project I and II (ECE 4899 and ECE 4999) and Senior Design Workshop (ECE 4951) culminate in a final report due by the end of the semester in which ECE 4999/ECE 4951 is taken. Your report will follow naturally from a well thought out proposal, a logical outline, and accurate and complete lab notebook, and detailed progress reports. The report is as important as the design and execution of the project; there is concern in industry today that engineers may be trained to present their research work in a standard written form that is easily understood and logically ordered. Your senior project report will demonstrate that you possess these skills.

The following manuscript guidelines are widely accepted in engineering practice. However, these are not intended to be unaltered rules for report preparation. Not every senior design project can be effectively presented in this format; therefore, discuss with your team members and advisor deviations from these guidelines. Also useful will be an on-going review of IEEE journal articles. Through a steady reading diet of engineering journals you will become accustomed to the crisp language of the engineer and the accepted ways of presenting technical data and research.

Schedule your work so that your advisor will receive a rough draft of your report two or three weeks before the end of the semester. This will provide sufficient lead time for your advisor to thoroughly review and constructively criticize the report, and adequate time for you to revise the paper so that points are not lost due to missing or inappropriately presented formulas and equations, faulty procedures, or for a failure to follow report guidelines.

For a more detailed discussion of report preparation, please refer to *Professional and Technical Writing Strategies,* your text from Comp 3130 Advanced Writing: Engineering.

Word Processing Standards

1. **Paper -** Use a high quality 8 1/2 x 11 inch white paper; select the high quality mode on your printer.

2. **Margins -** To allow for binding, establish at least a 1-1/2 inch (3.8cm) left margin for all pages of the report. Maintain 1 inch (2.5 cm) top, right, and bottom margins. Each major heading (Introduction, Discussion, Conclusion, etc.) should begin a new page. The top margin for a page on which a heading appears should be 2 inches (5.0 cm).

3. **Pagination**

   a. Use Arabic numbers placed in the upper right corner, about 3/4 inch (1.9cm) down from top edge. Do not number the first page of the text. The page number appears centered on the bottom margin on pages beginning with major headings.

   b. Prefatory pages of the report - table of contents/figures, and abstract - are numbered in lower case Roman numerals centered 3/4 inch (1.9cm) from bottom edge. The title page should be counted

but not numbered; thus, the table of contents page becomes ii.

c. No punctuation follows the page number.

Illustrative Material

1. **Graphs -** Used to present numerical data in a visual form, graphs are ideal for showing the significance of data not otherwise immediately apparent. However, since graphs cannot usually provide exact figures, they are often accompanied by tables. The following standards apply to presenting graphs in your report:

   a. Title - Provide a title that describes the data clearly and concisely. If your report includes two or more illustrations assign a figure number, as: *Fig.2. Sallen key filter with open capacitor* (No period after title.) Center the title below the graph or align it with the left edge of the graph. If the title will take two or more lines, break it into lines of roughly equal length.

   b. Spacing - If the graph appears on the same page as text, triple space after the last line of the best preceding the graph and before the line of text immediately following the illustration.

   c. Margins - Be certain the graph and title fall within the margins of the text. Maintain the standard margins on all edges of the paper.

   d. Source lines - If the information in your graph comes from another source, include a source line several spaces below the figure title; align it with the left margin of your paper. Textual reference-- Be sure the significance of the graph is clear in the text, and that the graph is positioned as close as possible to (but not before) the text that refers to it.

2. **Tables -** Used to show large numbers of related facts or statistics in a brief space, a table presents data in a more concise form than text, and more accurately than graphs. A table makes comparisons easy because of the arrangement of the figures into rows and columns; however, overall trends about the information are more easily seen in graphs or charts. Thus tables and graphs are usually used together in the technical report. Many of the same rules apply to the presentation of graphs also apply to tables**.**

   Exceptions:

   a. Title - As for a graph, the title should describe concisely what the table represents, but it is placed <u>above</u> the table. Table numbers are usually Roman, i.e., I., II., etc.

   b. Footnotes - Used for explanations of individual items in the table, symbols (*, #) or lower-case letters, rather than numbers are usually used to key table footnotes.

   c. Continued lines - When a table must be divided and run to the next page, repeat the boxhead (which carries the column headings) and give a table number at the head of each new page with a "continued" label (Table II, continued).

3. **Illustrations** - Used sparingly, illustrations such as photos, drawings, diagrams, and charts contribute to your reader's understanding of the subject. The same rules apply to illustrations as are listed under **Graphs**, above. In addition:

a. Spacing - Allow sufficient white space around and within the illustration.

b. Proportions - Specify the proportions used or include a scale of relative distances when appropriate.

Table of Contents

Center title. Basically the table of contents is the outline of your project. Entries appear as headings in the text and are generally numbered II, III, and so on, with subsections labeled II.1, II.2. In this way, readers may easily find sections and subsections. Each major section (i.e., Introduction, Background, Apparatus) begins on a new page.

Lists

Center title(s). Lists of figures appear on a separate page following the table of contents if your report contains five or more figures (graphs, photos, charts, diagrams). If your report contains fewer than five figures, number as a separate section of the table of contents. This same rule applies to lists of tables.

Abstract

Center *Abstract*. Allow triple or quadruple space after title. Double-space the text. The abstract briefly and succinctly tells the why, the what, the scope, the findings, and the conclusions of your entire report. It may be two or three short paragraphs, but usually the abstract is one paragraph. (Do not assign a section number.)

Introduction

The introduction begins the body of your report and should be numbered as *I. Introduction,* and centered on the page. (Subsequent sections shall be similarly numbered and titled.) The introduction explains what the report is about and why it was written. It should put the design project into perspective and lead the reader smoothly into the subject of the paper.

Historical Review

Dependent on the subject of the report and the nature of the design, this section may be titled *Present State of Knowledge, Overview, Theory and/or Analysis,* etc. This section presents work done to date in the field particular to your project. In this section you have an opportunity to refer your readers to items in the Reference/Bibliography sections that you found helpful in your research.

Apparatus

This section also may be titled *Materials, Equipment, Specifications, Design Overview, Description of Experiment,* dependent on the nature of your project. This section may include lists of equipment, software, hardware. It may include diagrams, formulas, and so on, but must include a written discussion with references to figures or tables. Every figure or table must be labeled and must follow the textual reference.

Test Procedures

Or *Methods,* etc., this section tells you what you did and how you did it. Use the past tense of the verb in describing experiments, and avoid *I, we, you*. Do not use imperatives, e.g., "Analyze the circuit by

breaking it up into its component parts". Provide as much detail as your readers, all of whom are engineering students and instructors, will need to understand what occurred. Include equations, tables, formulas, theorems or whatever is necessary to adequately explain the experiment or design.

Professional Component

In this section, address how your design impacts most or all of the eight concerns itemized in the Professional Component paragraph of Section II earlier in this handbook.

Results

This section describes what happened when the design was implemented. Don't be vague.

Discussion

This section provides an opportunity for you to analyze your data, conjecture (based on the results), objectively "wonder aloud" on aspects of the experiment, design, etc.

Conclusions

Every conclusion presented must be based on information provided in the report. Conjectures and floating conclusions are out of place. Check to be certain your conclusions are consistent with the results mentioned in the introduction. Do not say "Even though the design didn't perform as I wanted it to, if I could have spent more money for a more sophisticated circuit, I feel the results would have been successful". Also out of place in the conclusion are statements like the following: "I learned a lot from this project about designing an artificial ear and I thought it was time well spent and that the laboratory support in the department was excellent".

Appendices

Center title, as *Appendix A:* Schematics and so on. Each appendix appears on a new page, and pages are numbered consecutively with the text.

Formulas and Equations

To indicate the route whereby a conclusion or course of exploration was formulated, or to demonstrate the theory on which the idea or design is based, engineers include formulas and equations within the text of the technical report. Most word processing programs (e.g., MS Word) include equation editors; these should be used.

References

Within the text of the report, credit is given to the works of other, e.g., articles, books, and publications which provided background to your ideas and design. Follow these rules in referencing your sources.

1. Numbering - References are numbered sequentially throughout the report, but each source retains its

original number if it is referred to later in the report. Use Arabic numbers enclosed in brackets and place in the text immediately following the reference. Example: "An intermediate step has been suggested [1] in which derived data are used to exercise a coarse model of the proposed product before deciding upon specific design details".

2. Listing - All of the references appear at the end of your report on a separate page entitled *References.* Examples:

   [1] D. L. Schilling and C. Belove, *Electronic Circuits, (Book) Discrete and Integrated.* New York:McGraw-Hill, ch.3, 1979.

   [2] E. R. Laithwaite, AElectromagnetic Levitation,@ *Proc. (Article) of IEEE,* vol. 112, no. 12, pp. 2361-2375, 1965.

   [3] L. J. Giacoletto, Ed., *Electronics Designers= (Manual) Handbook,* 2nd ed. New York:McGraw-Hill, 1977.

   Note that references are <u>not</u> alphabetized.

<u>Bibliography</u>

Usually a reference list will serve as a combination footnote and bibliography. However, if you wish to include a list of works and URLs you consulted but did not directly refer to in your report, or that you wish to recommend to your readers for further reading, include a bibliography page after the reference page and following any appendices. The following rules apply.

1. Order - Entries are alphabetized by authors or editors; last names or by the first significant word or works without authors. Examples:

   Penguins World Atlas, The. Harmondsworth, England: Penguin, 1984.

   Schilling, D. L., and C. Belove. *Electronic Circuits, Discrete and Integrated.* NewYork:McGraw-Hill, 1979.

2. Spacing - Indent second and subsequent lines five spaces. Single space individual entries. Double space between entries.

3. Do not number entries.

Sample Title Page

TITLE OF PROJECT

Jane S. Smith

May __, 20_

Department of Electrical and Computer Engineering
University of Minnesota Duluth
Duluth, MN 55812

Approved_____Date_____
Advisor's Signature

Sample Table of Contents

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CODE of ETHICS

IEEE Code of Ethics

http://www.ieee.org/web/membership/ethics/code_ethics.html

As per IEEE Bylaw I-104.14, membership in IEEE in any grade shall carry the obligation to abide by the IEEE Code of Ethics (IEEE Policy 7.8) as stated below.

We, the members of the IEEE, in recognition of the importance of our technologies in affecting the quality of life throughout the world, and in accepting a personal obligation to our profession, its members and the communities we serve, do hereby commit ourselves to the highest ethical and professional conduct and agree:

1. to accept responsibility in making decisions consistent with the safety, health and welfare of the public, and to disclose promptly factors that might endanger the public or the environment;

2. to avoid real or perceived conflicts of interest whenever possible, and to disclose them to affected parties when they do exist;

3. to be honest and realistic in stating claims or estimates based on available data;

4. to reject bribery in all its forms;

5. to improve the understanding of technology, its appropriate application, and potential consequences;

6. to maintain and improve our technical competence and to undertake technological tasks for others only if qualified by training or experience, or after full disclosure of pertinent limitations;

7. to seek, accept, and offer honest criticism of technical work, to acknowledge and correct errors, and to credit properly the contributions of others;

8. to treat fairly all persons regardless of such factors as race, religion, gender, disability, age, or national origin;

9. to avoid injuring others, their property, reputation, or employment by false or malicious action;

10. to assist colleagues and co-workers in their professional development and to support them in following this code of ethics.

Approved by the IEEE Board of Directors
February 2006

CSDP: Software Engineering Code of Ethics and Professional Practice

"The time is right to get serious about this. As software becomes increasingly dominant in the IT industry, and, indeed, in everything else, there is an obvious need for a professional-level recognition. Far too much is placed on particular credentials for specific products or applications without regard to the bigger picture. The result is poorly engineered software projects."

(Version 5.2) as recommended by the IEEE-CS/ACM Joint Task Force on Software Engineering Ethics and Professional Practices and Jointly approved by the ACM and the IEEE-CS as the standard for teaching and practicing software engineering.

Short Version

PREAMBLE

The short version of the code summarizes aspirations at a high level of the abstraction; the clauses that are included in the full version give examples and details of how these aspirations change the way we act as software engineering professionals. Without the aspirations, the details can become legalistic and tedious; without the details, the aspirations can become high sounding but empty; together, the aspirations and the details form a cohesive code.

Software engineers shall commit themselves to making the analysis, specification, design, development, testing and maintenance of software a beneficial and respected profession. In accordance with their commitment to the health, safety and welfare of the public, software engineers shall adhere to the following Eight Principles:

1. PUBLIC - Software engineers shall act consistently with the public interest.

2. CLIENT AND EMPLOYER - Software engineers shall act in a manner that is in the best interests of their client and employer consistent with the public interest.

3. PRODUCT - Software engineers shall ensure that their products and related modifications meet the highest professional standards possible.

4. JUDGMENT - Software engineers shall maintain integrity and independence in their professional judgment.

5. MANAGEMENT - Software engineering managers and leaders shall subscribe to and promote an ethical approach to the management of software development and maintenance.

6. PROFESSION - Software engineers shall advance the integrity and reputation of the profession consistent with the public interest.

7. COLLEAGUES - Software engineers shall be fair to and supportive of their colleagues.

8. SELF - Software engineers shall participate in lifelong learning regarding the practice of their profession and shall promote an ethical approach to the practice of the profession.

SOFTWARE ENGINEERING CODE OF ETHICS AND PROFESSIONAL PRACTICE

IEEE-CS/ACM Joint Task Force on Software Engineering Ethics and Professional Practices