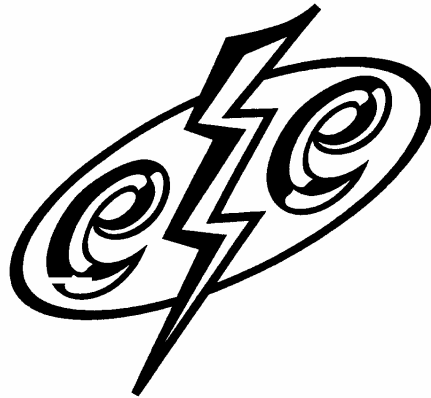


**ELECTRICAL ENGINEERING DEPARTMENT**  
**California Polytechnic State University**  
**San Luis Obispo, California**



**EE 460/463/464**

**SENIOR SEMINAR/  
SENIOR PROJECT HANDBOOK**

**2003-04**

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## A Note from the Department Chair

Dear Student:

As you embark on your senior project, it will be useful for you to keep the following points especially in mind:

- 1) You should plan on taking EE 460/EE 463/EE 464 in three successive quarters, if at all possible. This makes the senior project experience more cohesive. You should also not plan to use EE 400 to extend the length of your senior project, even though students have done this from time to time in the past. One of the challenges of the senior project experience is time management.
- 2) The senior project proposal abstract that you produce in EE 460 should be regarded as critical to your overall project success. A good project begins with a carefully thought-out project proposal. Note that the nature of senior project is such that what you have originally proposed may indeed evolve with time. This is normal, but does not minimize the importance of your original planning process.
- 3) Although “deadlines” are typically instructor-dependent, you should plan on finishing your full proposal by the first day of Week Two of EE 463, and should plan on submitting a written progress report by the last day of classes in the quarter you are taking EE 463.
- 4) You should plan on making a demonstration or acceptance test of your project no later than the last day of Week Nine of EE 464.
- 5) In general you should start the write up of your final report by the beginning of week (six) for 464 and complete the write up and hand it in with sufficient time for your advisor to read it.

Good luck. Feel free to make an appointment to see me if you have any questions or concerns about the senior project experience. You will find the information in this handbook to be of great value—so please read it carefully.

Sincerely,



Michael M. Cirovic, Chair  
EE Department

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## **Objectives of Senior Project and Grading Guidelines**

By the beginning of the senior year the student will have been exposed to a variety of laboratory situations reasonably similar to those to be encountered in industrial employment. Cal Poly requires that each student successfully complete a Senior Project as a requirement for graduation. Senior Project is recognized by many students as the most beneficial course sequence they must take because the students are provided with a minimum of supervision and the success or failure of the project rests primarily with the student himself or herself.

Senior Project consists of two consecutive quarters of work during which the student will perform the functions normally required of an engineer in an industrial unit that is introducing a new product. The two consecutive quarters typically begin in either Fall or Winter quarter.

The grading policy for Senior Project (EE 463, 464) is as follows:

- *A letter grade (A, B, C, D, or F) shall be assigned at the end of the quarter in which a student is enrolled in EE 463 or EE 464. However, a grade of “RP” may be given in EE 463 **if** the student has made sufficient progress in EE 463 to warrant continuation into EE 464, but the advisor cannot reliably assign a letter grade. The grade of “RP” will later be replaced with a letter grade.*
- *A grade of “RP” will **never** be given in EE 464.*
- *A grade of “I” or “U” will **never** be given in EE 463 or EE 464.*
- *Because a grade of “I” will not be given in EE 464, students with incomplete projects will generally receive a grade of “F”. **It is Department policy that such students re-enroll in EE 464.***

All Senior Projects to be deemed acceptable must have a product at their completion. This product will normally consist of hardware. It is possible for students to have a software project, but the software project must represent a complete product that has passed an acceptance test. The intent for these requirements is that the experience gained by the students should be one that is commensurate with an engineer in industry developing a product. It should not represent a task that is exclusively one of research or one of analysis. A tangible product must be the primary focus of the Senior Project.

### **The Life of a Project**

A typical engineering project (that the Senior Project experience models) can be divided up into seven generic phases: proposal, requirement, design, build, integration, test, operations and maintenance. These seven phases are basically sequential, though there can be some overlap between them. Each of the phases is described below.

**Proposal** - The project begins with a proposal that addresses the feasibility of the product with respect to technical, cost, schedule and other criteria. The proposal generally culminates in a contract award. \*This contract addresses such items as cost, schedule and performance and contractual requirements. Cost information will cover the amount, method of payment, the fees, incentives and penalties. The schedule will establish milestones and give dependencies on other aspects of the project to those milestones. The contractual requirements will identify the performance of the system with binding requirements, provide “boiler plate” stipulations and include special considerations.

**Requirements** - The requirements define the project and the project to be produced. For engineers, this is generally the most difficult phase. Generally, there is a specification tree form of documentation, arrayed in a hierarchical fashion starting with system-level specs down to subsystem level specs, then unit specs. Also included are interface control documents and acceptance test conditions. This phase is generally completed with a system-requirements review. The critical element of the requirement review is the specifications, starting with the top level partitioning down to the sub-system level and following to the unit level. The interface documents follow the same hierarchy, with external interfaces being defined between the systems and internal interfaces being defined between sub-systems. In addition, there is generally an operational interface document that defines the user-machine interface.

**Design** - The design phase is generally the most fun for engineers. It consists of primarily two sub-phases, culminating in two reviews: a preliminary design review, called the PDR, and a critical design review, called the CDR. The PDR presents the functional design; it partitions the requirements into functions and specifies how those functions can be implemented, defines the components and satisfies the interfaces. Associated with this design review, is additional documentation that describes the system. The CDR presents a detailed design. Generally, at this point in the product development, prototype components have been produced to verify satisfaction of critical requirements. At this time, there should also be draft test plans associated with the product to show satisfaction of requirements.

**Build** - The build phase consists of actually constructing the units or components and packaging them. Testing is performed at this level to make sure that all the elements satisfy their individual requirements allocated with the specifications.

**Integration** - Integration represents the largest risk in the schedule for the development of a product. This means putting the components or units together into a product. In a large project, this would mean putting the sub-systems together into the system. There is an intrinsic difficulty that is proportional to the square of the number of sub-systems that constitute the total system. This is because of the interaction of the interfaces, and the attendant requirements associated with those interfaces.

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\* The contract award for a Senior Project is the advisor’s acceptance of the student’s proposal.

**Test** - The second to last phase is the test phase. The acceptance test is performed in this phase, and it is based upon the plan developed during the requirements and design phase. During the requirements phase, and further detailed during the designing phase, a detailed plan is given for showing satisfaction of all requirements. At this point, the product is sold to the customer by demonstrating that it has satisfied all the requirements specified in the contract as well as those defined in the requirements phase.

**Operations and Maintenance** - This is generally the last phase in the life of a project. In this phase, the system is generally incorporated into an operational environment in which personnel are trained in its use and maintenance. This phase can last quite a long time, and represents a rather large proportion of the life cycle of a product.

The Senior Project experience will go through, in varying degrees, all of these phases, except possibly for the last phase. Materials should be prepared as part of the documentation supporting the operation and the maintenance of the product produced. In subsequent sections, we will discuss the typical schedule and milestones for the Senior Project. It would be well to interpret these milestones in the context of the above discussion of the development cycle of an engineering product.

### **Registration for Senior Project**

**Eligibility** - To be eligible to register for EE 463: Senior Project, the student must have completed the prerequisites listed in the current Cal Poly catalog (note the key role that EE 460 plays in this process). Completion of these courses insures that the student has a good basic knowledge of electrical equipment, electronic devices and basic logic design. Having completed these courses, the student is in a good position to undertake a Senior Project and to apply experience gained in these and other courses taken in the engineering program up to this point.

**Registration** - Students who are ready for Senior Project can register by obtaining the schedule code number from the EE Department office. An EE Senior Project Permission to Enroll Form (available outside the Department office) must be on file in the Department office before the schedule code can be given out. Students wishing to enroll in Senior Project should submit their permission slip to the Department office as soon as possible. Waiting too long to obtain an advisor may result in delayed registration for Senior Project by one or more quarters because an instructor's workload is full, making him/her unavailable.

It is recommended that students treat obtaining a Senior Project Advisor as an engineer would treat trying to sell a potential product to a customer, with the customer being the Senior Project Advisor. With this thought in mind, it is in the student's best interest to prepare the proposal and project outline as soon as possible, and use these written documents to present to potential Senior Project Advisors. Through these preparations, they can sell their Senior Project to an Advisor. Early negotiations with faculty members to obtain a Senior Project Advisor will eliminate many problems with registration. Therefore, the Department recommends that the student get a faculty member to agree to be his/her Senior Project Advisor two quarters prior to signing up for EE 463. An added advantage is that students can minimize the risk associated with the Senior Project schedule by knowing what they are going to do before the actual start of the course.

## **Senior Project Guidelines and Student Duties**

### *Guidelines*

The following are considered to be guidelines - advisors can supplement as required.

1. EE 460, 463, and 464 should normally be taken in three successive quarters. Exceptions may occur when students will not be enrolled for three successive quarters. EE 400 may normally not be used to extend senior project (exceptions will require approval of the Department Chair).
2. A deliverable of EE 460 is an abstract of a senior project proposal, approved by the student's proposed senior project advisor. The student will also make a class presentation of the proposed project in EE 460.
3. A proposal is due no later than the first day of week two of classes for EE 463. (Note: this is a full proposal and not an abstract.)
4. A written progress report is due no later than the last day of classes in EE 463. (Other progress reports and/or demos may be required by the advisor.)
5. The student must make a demonstration or acceptance test of the project no later than the last day of week nine for EE 464.
6. All reports are to be turned in to the library through the department for archiving.

### *Duties of Students*

1. Select a project on which he/she wishes to work. The project selected should be such that it requires library/World Wide Web study, engineering design, laboratory or shop work and creative thinking. The project should be of such magnitude and scope that it requires a minimum of, but not much more than, 150 hours from inception to completion of the final report. Care must be taken to avoid overly ambitious projects and to submit the proposal to the Senior Project Advisor before the end of the second week of the quarter the student is enrolled in 463.
2. Write an outline of contemplated project and get approval from the instructor who has agreed to be your Senior Project Advisor.

**Project Outline:** The outline should be specific in details because it will constitute an agreement between the Senior Project Advisor and the student, signifying an agreement by the student that the procedure herein will be followed, and an agreement by the Senior Project Advisor that such procedure will satisfy the course requirements.

3. Follow the outline in project work. Any deviation from outline that seems advisable at a later date must be approved by the Senior Project Advisor and submitted in writing as an addendum to the outline.

4. Submit to the Senior Project Advisor brief written and oral progress reports as required.

**Progress Report:** The purpose of progress reports is to keep the Senior Project Advisor advised of the status of the project. Such reports are intended to call to the Senior Project Advisor's attention those students who have experienced difficulties with their Senior Project or who have not devoted sufficient time and energy to their work.

5. Prepare first draft of final report.

**First Draft of Final Report:** The student should actively seek help from the Senior Project Advisor in the organization and presentation of his or her subject matter. It implies a completed draft that can be revised, and with minor changes, will become the final report. The report should be organized in the format and style presented in this handbook.

6. Make changes in first draft recommended by the Senior Project Advisor and submit the final report, ready for submission to the library.

## **Manuscript Information**

In the preparation of the Senior Project final report, a specific format must be followed to make the report acceptable to the Department. The following is a list of the major headings that appear in the report. The list is not necessarily all-inclusive, nor is its arrangement fixed. Individual preferences are likely to vary as to titles of these major headings. Students are encouraged to examine archived senior projects in the library to see examples of these formats.

### *Format of the Senior Project Report*

Title Page

Table of Contents

List of Tables and/or Figures

Acknowledgements

Abstract

I. Introduction

II. Background

III. Requirements

IV. Design

V. Test Plans

VI. Development and Construction

VII. Integration and Test Results

VIII. Conclusion

IX. Bibliography

Appendices

A. Specifications (requirements - do not include product specs sheets)

B. Parts List and Costs

C. Schedule - Time Estimates

D. Wire List

E. IC Location Diagram

F. PC Board Layout

G. Program Listing (for software)

H. Memory Map (for software)

I. Hardware Configuration/Layout

The following are specific and important manuscript details, including format, to be followed in the final composition of the manuscript.

1. The emphasis in the preparation of the draft should be on expressing your ideas. Legibility is imperative. The document may vary from a rather lengthy report to a relatively short one. Maximum length will not ordinarily exceed 60 pages and few reports would have less than 25 pages; typical length is 40 pages for the complete report.
2. In the event that the Senior Project system fails to function, the student must explain why it is not possible to develop a functioning system and propose a "fix."
3. Test results, a bibliography or reference list and pertinent figures and photographs must be included in a Senior Project report for a final grade higher than an "F."
4. A title page, table of contents, list of tables and list of figures in the format of the examples given on the following pages shall be included.
5. The student is responsible for its conformity to certain conventional requirements as well as for its neatness and accuracy. A good quality printer paper is required. The paper must be regulation letterhead size, 8 1/2" x 11". Diagrams up to 11" x 17" can be processed, but diagrams over that size should be placed at the end of the report where they will be given special processing.
6. All graphs must be at least sketched with correct title and labels on axes. They must be placed in their correct location with respect to the textual material. Margin requirements must be observed. Graphs shall be considered as figures.
7. Certain conventions shall be followed:
  - a) Top, right, and bottom margins are 1 1/4"; left margin is 1 1/2".
  - b) All text material is double-spaced.
  - c) Short quotations are included in the text, in quotation marks.
  - d) Long quotations (over three or four lines) are double indented and single-spaced without quotation marks.
  - e) The pages are to be numbered normally 1/2" below the top of the page and 1 1/4" from the right-hand edge of the paper (exceptions for wordprocessing difficulties). Small Roman numerals - II, III, IV, etc., are used in numbering pages preceding the body of the report, with exception of the title page. Arabic numerals - 1, 2, 3, 4, etc., are used in numbering all succeeding pages.
  - f) Each major heading (Introduction, Background, Requirements, etc.) in the report shall start on a new page. For these pages the top margin shall be 2 inches.

- g) Photographs, drawing diagrams and similar illustrative materials are designated as Figures, which are numbered consecutively throughout the project in Arabic numerals, i.e., Figure 1, Figure 2. The figure designation and title are centered two line spaces below the illustration. Main words in the title are capitalized. If the text follows the title, two or three-line spaces are allowed between the title and following text.
- h) Tables are designated in Roman numerals, as Table I, Table II, etc., throughout the text. The Table designation and title is centered immediately two line-spaces above the table. The title is all capitals. Three spaces should be allowed between the bottom of the table and following text.
- i) EVERY table and figure must be referred to by number at least once in the text material.
- j) Illustrative material (i.e., a figure or table) is used whenever it is appropriate to the text and should be placed following as near as possible to the text material which just referenced it.
- k) Essential explanatory notes for illustrative material are placed below the figure or table. If a footnote is necessary, it is used according to standard footnote form, but it should not be separated from the figure or table by a dividing line.
- l) Footnotes should be used to identify quotations or indebtedness to a source for specific information. Standard footnote format and placement should be used. The reference to which a footnote refers should appear at the bottom of the same page. However, if the student desires, he or she may number the references throughout the text and place a list of references at the conclusion of the paper. The references run in numerical order throughout the text, but this order may be interrupted when necessary to incite again an earlier reference. Consult a reference such as MLA 1984 Edition for placement and augmentation of footnotes.
- m) Correct usage of abbreviations is mandatory. Please consult the Reference Room in the Cal Poly Library for standard electrical abbreviations.
- n) All diagrams must be indicated. Size and orientation with respect to the related text material must be shown. The title must be specified and located in its proper position. Diagrams shall appear in black and white. Refer to the official IEEE website [www.ieee.org](http://www.ieee.org) for additional information on standards.
- o) Photographs need not be included in the finished draft, although in general they can be an important part of the final report. When photographs that are to appear in the final report are not included in the finished draft report, indicate on a sheet what the photograph will show. Photographs will be considered figures for the purposes of designation and titling. Margin requirements must be satisfied on pages containing photographs and any photographs should be made small enough so that the title may be placed within the margins. Page numbers on pages containing photographs must be properly located.

- p) Product specification sheets or application notes should not be included in the appendices, but should be referenced in the text if necessary. Permission for reproduction of copyrighted materials must be obtained.

**SAMPLE: TITLE PAGE**

TITLE

by

John Doe

Senior Project

ELECTRICAL ENGINEERING DEPARTMENT

California Polytechnic State University

San Luis Obispo

1998

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Please read the following information very carefully to insure that your Senior Project will be processed. Failure to do so may detain your completion of requirements. All information must be completed prior to submitting your Senior Project report to your advisor.

1. ***SUBMIT ONLY ONE COPY*** of your Senior Project to your advisor unless he/she requests an additional personal one. These reports are put on microfiche and the typed copy will be returned to the student if a self-addressed stamped envelope is enclosed; otherwise, the copy will be discarded after one year.
2. Your Senior Project report must be accompanied by the following items:
  - a) **Senior Project Requirement Form** - A Senior Project Requirement form must be filled out and signed by your advisor; include this form with your original Senior Project report. (This form is available online at [www.lib.calpoly.edu/srproj/forms/senior.pdf](http://www.lib.calpoly.edu/srproj/forms/senior.pdf)). In 1996, students were also given the option of submitting their manuscript on computer disk or CD to be saved in the Learning Resource Center and to be made available on a check-out basis.
  - b) **University Cashier's Receipt** (\$6 microfiche fee).
  - c) **1 manila envelope** (size to fit Senior Project report ***UNBOUND AND UNPUNCHED***).
  - d) **1 manila envelope** stamped, self-addressed (if report is to be mailed to you).
  - e) **1 Title Page.**
  - f) **An addendum on "Analysis of Senior Project Design"** (as discussed in Appendix C) handed in along with senior project. This Material is collected by the department for ABET (American Board for Engineering and Technology) and their review as part of the accreditation process. **"Consider this item important."**

### **Honors Recognition and Special Awards**

Recognition is given to those students who have done an outstanding job on their Senior Projects. A certificate for Honors recognition is given to selected students at the EE Department Awards Banquet in May of each year. Faculty will nominate Senior Projects for consideration by the middle of April. A committee will be formed by those faculty nominating Senior Projects. The committee will review all nominated Senior Projects and select several for Honors recognition.

## **APPENDIX A**

### **Areas of Faculty Interest**

A list of faculty members' technical interests is available on the Web and is also posted outside the Department office.

## **APPENDIX B**

### **Procedure for Obtaining Free Parts**

These parts are made available through generous grants from various companies and may be used for Senior Projects or any other faculty approved project.

Follow the steps outlined below to insure prompt and accurate processing.

1. Use the PC in the Senior Project Labs, Rooms 111 and 118, to select the parts you wish to order. The program is menu-driven and fairly easy to use.
2. Print out a list of the parts you wish to order.
3. Have your Senior Project Advisor sign the printout.
4. Return the signed printout to the checkout window in Room 20-111.
5. Check the status board to find out when your parts are available to be picked up.

APPENDIX C

ANALYSIS OF SENIOR PROJECT DESIGN

Please provide the following information regarding your Senior Project and submit to your advisor along with your final report. Attach additional sheets, for your response to the questions below.

<b>Project Title:</b>
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<b>Student's Name:</b>	<b>Student's Signature:</b>
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<b>Advisor's Name:</b>	<b>Advisor's Initials:</b>	<b>Date:</b>
------------------------	----------------------------	--------------

- **Summary of Functional Requirements**  
Describe the overall capabilities or functions of your project or design. Describe what your project does. (Do *not* describe how you designed it).
- **Primary Constraints**  
Describe significant challenges or difficulties associated with your project or implementation. For example, what were limiting factors, or other issues that impacted your approach? What made your project difficult? What parameters or specifications limited your options or directed your approach?
- **Economic**
  - Original estimated cost of component parts (as of the start of your project).
  - Actual final cost of component parts (at the end of your project)
  - Attach a final bill of materials for all components.
  - Additional equipment costs (any equipment needed for development?)
  - Original estimated development time (as of the start of your project)
  - Actual development time (at the end of your project)
- **If manufactured on a commercial basis:**
  - Estimated number of devices to be sold per year
  - Estimated manufacturing cost for each device
  - Estimated purchase price for each device
  - Estimated profit per year
  - Estimated cost for user to operate device, per unit time (specify time interval)
- **Environmental**
  - Describe any environmental impact associated with manufacturing or use.
- **Manufacturability**
  - Describe any issues or challenges associated with manufacturing.
- **Sustainability**
  - Describe any issues or challenges associated with maintaining the completed device, or system.
  - Describe how the project impacts the sustainable use of resources.
  - Describe any upgrades that would improve the design of the project.
  - Describe any issues or challenges associated with upgrading the design.
- **Ethical**
  - Describe ethical implications relating to the design, manufacture, use, or misuse of the project.
- **Health and Safety**
  - Describe any health and safety concerns associated with design, manufacture or use of the project.
- **Social and Political**
  - Describe any social and political concerns associated with design, manufacture or use.
- **Development**
  - Describe any new tools or techniques, used for either development or analysis that you learned independently during the course of your project.

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