A Note from the EE Department

Dear Student:

We are very excited to see you start the senior project sequence here at Cal Poly’s Electrical Engineering department. The senior project is one of our classic “learn by doing” events and the department wants you to obtain maximum benefit for your future career. Please start your project definition and planning early as these three quarters of design, build, test, and documentation will go by very quickly. As you embark on your senior project, it will be useful for you to ponder the following points.

1) The EE senior design project comprises of 3 classes taken sequentially: EE460, EE461, EE462 or alternatively EE460, EE463, and EE464.

2) You should have a project topic and a commitment from an EE faculty to serve as your EE 461 / EE 462 advisor at the latest, by the end of the first week of EE 460 (preferably during the summer). This means that you should start talking to potential Faculty advisors for your senior project many weeks prior to the start of EE460.

3) While individual senior designs are possible, we encourage team-based senior projects. You should start exploring potential partners and projects before the start of the EE460 quarter.

4) The EE department has limited funds to help financially support your senior project. More information about this aspect will be provided by your EE 460 instructor and in this handbook under “funding support for senior project”.

5) Consider participating in the CENG senior project expo that occurs Week 9 of the spring quarter. Participants typically provide a poster and display project “show and tell” items for fellow students, faculty, and the public.
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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 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 success or failure of the project rests primarily with the student.

Senior Project consists of three 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 three consecutive quarters begin in either the Fall or Winter quarter; currently the Department does not offer starts in the Spring or the Summer quarters.

The grading policy for Senior Project 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 EE460, EE 461, EE462, EE463 or EE464. The grade of “RP” may be assigned in EE 461 (and EE 463) but not in EE 462 (and EE464); the RP will later be replaced with a letter grade.

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. 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 of 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 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 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 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.

**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 design 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 substantial proportion of the life cycle of a product.

The Senior Project experience will go through, in varying degrees, all 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**  Students must complete all 300-level required classes to be eligible for EE 460. EE 409 and EE 449 are co-requisites to EE460; for more details about the pre-requisites please consult the [EE course catalog](#).

**Registration** - If you have satisfied the pre-requisites, you will be able to register for EE 460. Registration in EE 461 and EE462 (EE 463 and EE464), however, requires a permission number issued by the EE Department. More details about the requirements will be provided by your EE 460 instructor.

**Funding Support for Senior Project**

In order to purchase materials for your senior project, you must work with your senior project advisor to obtain the materials. Please note that total purchases for any one senior project are limited to the following amounts, according to the project group size:

- 1 Student: $200
- 2 Students: $400
- 3 or More Students: $500

Your advisor must approve purchases regardless of method, to ensure that you are making appropriate decisions by following Cal Poly purchasing requirements. Students should not be buying the items themselves and requesting reimbursement from the department. Purchases should follow the procedure below:

1. You as the student work with your advisor to determine what materials need to be purchased. If the materials you request are not readily available at the department and the advisor deems them necessary for the project, proceed to Step 2.

2. Once the purchase is approved by your advisor, **your advisor emails** Yvonne Lynch ([ylynch@calpoly.edu](mailto:ylynch@calpoly.edu)) to request that the department purchase the materials. This will indicate that these materials have been approved to be purchased. In the email, advisor must include all relevant information about the senior project group and the materials for the department to make the purchase. Such information should include Project Group information and standard BOM information (the following share a cart link is a convenient way to share the BOM [https://share-a-cart.com/](https://share-a-cart.com/)):
   a. Senior Project Title
   b. Names of all students in Senior Project Group
   c. Product Name
   d. Model Number
   e. Vendor - **All vendors must be from credible organizations, otherwise purchase requests will be denied.**
   f. Price
g. Quantity required
h. Link to vendor website where product can be bought

3. The department will purchases the requested materials. Once the item(s) are delivered, the pertinent student(s) and advisor will be emailed by Yvonne Lynch (ylynch@calpoly.edu) and informed that their package(s) have arrived.

Please note that **items purchased with department/state funds become department/state property.** So, if a student wishes to keep a project or items, they would need to pay for that personally.

**Senior Project Guidelines**

*Guidelines*

The following are guidelines.

1. The **year-long senior project sequence** EE460/461/462 or EE460/463/464 are taken in successive quarters. EE 461(EE463) cannot be taken as concurrent to EE 460 and neither can EE 462 (EE 464) be concurrent to EE461 (EE463). Exceptions are granted rarely.
2. Select a project that will be a stepping-stone for your career after graduation. The project selected should be an open-ended problem requiring a literature search, engineering design, laboratory or shop work and creative thinking. The project should be of such magnitude and scope that it requires a minimum of 180 hours per student from inception to completion of the final report.
3. The final senior project report should be uploaded to the Digital Commons unless there is a Non-Disclosure Agreement (NDA) that would prevent general distribution to the public.
4. Students are encouraged to display their project results at the college of engineering and/or department senior project expo events.
5. **Progress Reports:** The purpose of progress reports is to keep the Senior Project Advisor, the project sponsor (if any) and student project partners aware of the status of the project. It is important that written reports are given on a regular basis so that all parties can monitor progress and make suggestions on improvements or solving problems.

**Senior Project Report Format and Contents:**

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
Statement of Disclaimer
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
X. Suggested Appendices. The Analysis of Senior Project Appendix is Required
   A. Analysis of Senior Project Document fille out with all its categories
   B. Specifications (requirements - do not include product specs sheets)
   C. Parts List and Costs
   D. Schedule - Time Estimates
   E. Wire List
   F. IC Location Diagram
   G. PC Board Layout
   H. Program Listing (for software)
   I. Memory Map (for software)
   J. 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 depending on the nature of the project.

2. If the Senior Project system fails to meet the agreed upon requirements, 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.

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. The document should 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 word-processing difficulties). Small Roman numerals - II, III, IV, etc., are used in numbering pages preceding the body of the report, with the 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 two 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 the 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 for additional information on standards.

o) Product specification sheets or application notes should not be included in the appendices but should be referenced in the text if necessary.
SAMPLE: TITLE PAGE

TITLE

by

Your Name Here plus contact information

Senior Project

ELECTRICAL ENGINEERING DEPARTMENT

California Polytechnic State University

San Luis Obispo

Date
SAMPLE: Disclaimer

Statement of Disclaimer

Since this project is a result of a class assignment, it has been graded and accepted as fulfillment of the course requirements. Acceptance does not imply technical accuracy or reliability. Any use of information in this report is at the risk of the user. These risks may include catastrophic failure of the device or infringement of patent or copyright laws. California Polytechnic State University at San Luis Obispo and its staff cannot be held liable for any use or misuse of the project.
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Senior Project Report Submission

Please contact the EE front desk for the current process of submitting your senior project. It is expected that all senior project documents will be submitted to Cal Poly’s digital commons.

Here is a link to the Cal Poly Digital Commons web site.

https://digitalcommons.calpoly.edu/

The Digital Commons upload exception might be for those projects that have a non-disclosure agreement. It is imperative that you include the Appendix on the “Analysis of Senior Project” with your digital commons upload. The department may also ask that you submit an electronic copy of your “Analysis of Senior Project” to the EE front desk.

The Senior Project submission process is now done electronically through the library. No hard copies of the project will be accepted by the library.

The steps for submission of your Senior Project are as follows:

1. Download the Senior Project Requirement Form from the following website: http://lib.calpoly.edu/seniorprojects/.
2. Upload your finalized, advisor-approved Senior Project to the DigitalCommons@CalPoly.

For more information on the submission process, please visit the Kennedy Library’s website at http://lib.calpoly.edu/seniorprojects/.
ANALYSIS OF SENIOR PROJECT APPENDIX:

Here is the “Analysis of Senior Project Template that must be included as an appendix in your senior project report submission to the digital commons. It should also be sent electronically to the EE front desk. This document is particularly important for the ABET accreditation process, so all senior project submissions need to include it. **This appendix is a required part of your senior project document submission.**

APPENDIX A

ANALYSIS OF SENIOR PROJECT DESIGN

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

Project Title:

Student’s Name: Student’s Signature:

Advisor’s Name: Advisor’s Initials: Date:

• **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.

• Engineering Standards
  • Describe engineering standards that were applied during your project development:
    • Example standards might include:
      a. American National Standards Institute (ANSI) ansi.org
      b. International Standards Organization (ISO) iso.org
      e. IEEE Standards: https://standards.ieee.org/develop/develop-standards/overview/
i. Shock and Vibration Test Standards: An example is the automotive standard USCAR 5.4.6

j. Product Temperature Range Standards: An example would be MIL-STD-810 for the department of defense.

k. Electrostatic Discharge Standards for products: [https://www.esda.org/assets/Documents/d1f4810d6e/Fundamentals-Part-6-ESD-Standards-090120-final.pdf](https://www.esda.org/assets/Documents/d1f4810d6e/Fundamentals-Part-6-ESD-Standards-090120-final.pdf)

l. Humidity Testing for Electronic Systems: An example would be MIL-STD-810