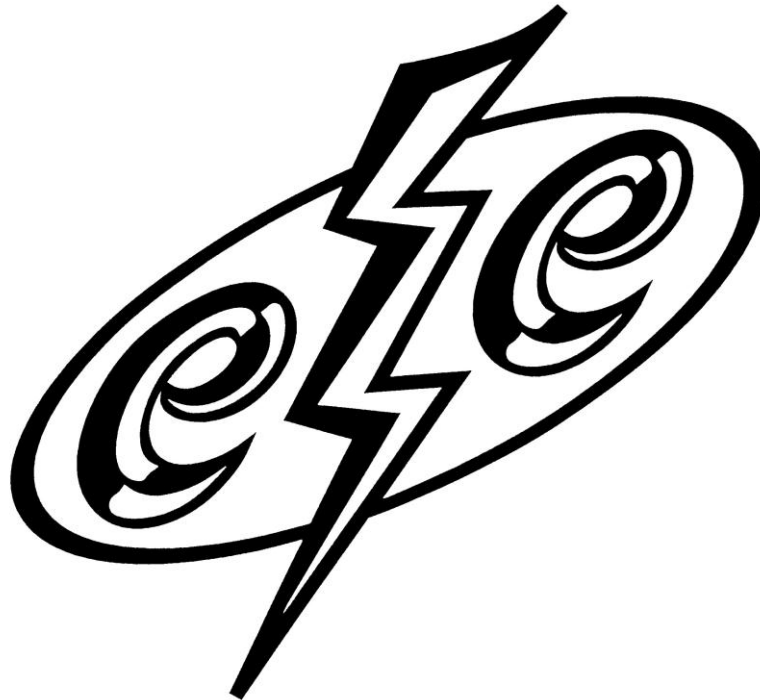


ELECTRICAL ENGINEERING DEPARTMENT
California Polytechnic State University
San Luis Obispo, California



EE 460/463/464

SENIOR PROJECT HANDBOOK
2011-2012

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A Note from the Department Chair

Dear Student:

I am 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. Each year I look forward to the senior project exhibition where I can witness all of the creativity and energy that are put into these projects. 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) You should plan on taking EE 460/EE 463/EE 464 in three successive quarters.
- 2) It is important that you choose and begin planning your senior project early in the EE460 quarter. This means that you should start talking to potential Faculty advisors for your senior project prior to the start of EE460. Students need to be well engaged in senior project activity by the time the EE460 has finished and the EE463 quarter has started.
- 3) Please consider doing a team senior project! Your team members can include other EE colleagues or from other engineering majors or outside the college. I would emphasize again that you should start exploring potential partners and projects even before the start of the EE460 quarter.
- 4) As department chair, I have been working on creating a "senior project fund". This fund can provide financial support for a limited number of senior projects that do not have their own funding source. Please contact me if you are interested in this "senior project fund" support.
- 5) Get ready for the senior project exhibition that occurs at the end of the EE464 quarter. You will need to provide a poster and display project "show and tell" items for your fellow students, faculty and the general public.
- 6) A well-executed senior project can be a great stepping stone to your next career phase. Please. View the senior project as a key activity for your career's success.
- 7) Please contact me if you have any questions.

Sincerely,

Dennis Derickson Ph.D.
EE Department Chair
ddericks@calpoly.edu
805-756-7584

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Objectives of Senior Project and Grading Guidelines

By the beginning of the senior year the student will have experienced a variety of laboratory situations reasonably similar to those encountered in industrial employment. Cal Poly requires that each student successfully complete a Senior Project as a requirement for graduation. Many students recognize Senior Project as the most beneficial course sequence they take because the students are minimally supervised, and the success or failure of the project rests primarily with the student himself or herself.

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

Senior Project (EE 463, 464) uses the following grading policy:

- *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 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 goal for these requirements is that the experience gained by the students should correspond to that of an engineer in industry developing a product. It should not represent an exclusively research or analysis task. A tangible product must form the Senior Project’s primary focus.

Project Lifecycle

A typical engineering project (that the Senior Project experience models) can divide up into seven generic phases: proposal, requirement, design, build, integration, test, operations and maintenance. These seven phases can occur sequentially, though they can overlap. The next sections describe each phase.

Proposal - The project begins with a proposal to address product feasibility 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 covers the amount, method of payment, the fees, incentives, and penalties. The schedule establishes milestones and give dependencies on other aspects of the project to those milestones. The contractual requirements identify the performance of the system with binding requirements, provide “boiler plate” stipulations, and include special considerations.

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

Requirements - The requirements define the project. 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 of test conditions. This phase contains a system-requirements review. The specifications form a critical element of the requirement review, 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 defined between the systems and internal interfaces defined between sub-systems. In addition, an operational interface document generally defines the user-machine interface.

Design - The design phase tends to offer engineers the most fun. It consists of primarily two sub-phases, culminating in at least 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 to implement those functions, defines the components and satisfies the interfaces. This design review contains additional documentation to describe the system. The CDR presents a detailed design. Generally, at this point in the product development, prototype components verify satisfaction of critical requirements. At this time, there exist 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 performed at this level ensures 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. Integration intrinsically becomes more difficult in proportion to the square of the number of sub-systems constituting the total system. Difficulty arises from the interaction of the interfaces and the attendant requirements associated with those interfaces.

Test - The test phase involves performing the acceptance test based upon the plan developed during the requirements and design phases. During the requirements phase, and further detailed during the designing phase, a detailed plan develops for showing satisfaction of all requirements. At this point, the product transfers to the customer after demonstrating that it satisfies all the requirements specified in the contract as well as those defined in the requirements phase.

Operations, Maintenance, and End-of-life - During this phase, the system incorporates into an operational environment, and personnel receive training in system use and maintenance. This phase can last quite a long time, and represents a rather large proportion of the product life cycle.

The Senior Project experience goes through, in varying degrees, all of these phases, except possibly for the last phase. Documentation materials prepared for the report should also support the product operation and the maintenance. Subsequent sections discuss typical Senior Project schedule and milestones. Interpret these milestones in the context of the above discussion of an engineering product development cycle.

Registration for Senior Project

Eligibility - 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 EE 460 plays in this process). Completing these courses ensures that the student has a good basic knowledge of electrical equipment, electronic devices, and basic logic design. These and other courses position the student to undertake a Senior Project, while applying experience gained in the engineering program up to this point.

Registration - Students ready for EE 463 can register by obtaining a permission 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 permission number can be given out. Students wishing to enroll in Senior Project should submit their permission form 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 may become full, therefore, 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 eliminate many registration problems. 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

Advisors can supplement the following guidelines as required.

1. Students normally take EE 460, 463, and 464 in three successive quarters. Exceptions may occur when students do not enroll for three successive quarters. EE 400 may normally not be used to extend senior project, so exceptions would require Department Chair approval.
2. A deliverable of EE 460 is a senior project plan, approved by the student's proposed senior project advisor. Note: this is a complete plan and not an abstract. The student also makes a class presentation of the proposed project during EE 460.
3. A written progress report is due no later than the last day of classes in EE 463. The advisor may require additional progress reports and/or demos.
4. The student must make a demonstration or acceptance test of the project no later than the last day of week nine for EE 464.
5. Submit reports to the library with the help of the department for archiving.

Student Duties

1. Select a project to work on. The project selected should require library/World Wide Web study, engineering design, laboratory or shop work and creative thinking. The project should have 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. Take care to avoid overly ambitious projects and to obtain your Senior Project Advisor's approval during EE 460.
2. Write a plan for the contemplated project and get approval from the instructor who has agreed to serve as your Senior Project Advisor.

Project Plan: The plan should contain specific details, because it constitutes an agreement between the Senior Project Advisor and the student, signifying an agreement by the student to follow the procedure herein, and an agreement by the Senior Project Advisor that such a procedure satisfies the course requirements. From the EE 460 ABET Syllabus:

- a. Define requirements.
 - b. Define approach, with block diagrams, functionality, and interfaces.
 - c. Define specifications of various blocks, or subsystem components.
 - d. Define project plan via Gantt chart, with milestones.
 - e. Estimate development time and costs, and product cost.
 - f. Determine additional resources, borrowed for the project, if any.
 - g. Identify key skills, methods or tools, needed in project.
 - h. Identify key knowledge or skills missing, which need to be learned.
 - i. Student submits a completed proposal, approved by a potential advisor.
3. Follow the planned project work. Any advisable deviation from the plan requires Senior Project Advisor approval and submission in writing as an addendum to the plan.
 4. Submit to the Senior Project Advisor brief written and oral progress reports as required.

Progress Reports: Progress reports keep the Senior Project Advisor advised of the status of the project and ensure the student continuously writes about progress. The written reports can provide helpful information for Senior Project Report drafts. Such reports also call to the Senior Project Advisor's attention those students who have encountered 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, with minor changes, will become the final report. The report should use the organization, 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 preparing the Senior Project final report, follow a professional format to make the report acceptable to the Department. The following list contains major headings the report should contain. The list is not necessarily all-inclusive, nor is its arrangement fixed. Individual preferences often vary as to these major headings titles. Examine archived senior projects in the library and on the digital commons for more formatting examples.

Example Senior Project Report Format:

- Title Page
- Table of Contents
- Lists of Tables and 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. Appendices
 - A. Senior Project Analysis—see Appendix D on p. 19
 - B. Specifications and requirements
 - 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

Employ the following specific and important manuscript details, including format, when composing the final manuscript.

1. When drafting the manuscript, emphasize expressing your ideas. Legibility is imperative. The document may vary from a rather lengthy report to a relatively short one. Maximum length will not typically 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. A Senior Project report must include test results, a bibliography or reference list and pertinent figures and photographs for a final grade higher than an “F.” Use the EE 241 Lab Manual advice, also copied in Appendix C on p. 16, about how to present figures, captions, equations, simulations, and references.
4. Include a title page, table of contents, list of tables and list of figures in the format of the

examples given on the following pages.

5. Find more information about submitting senior project reports electronically on the library website: <http://lib.calpoly.edu/seniorprojects/>.
6. Number each figure and table and provide a descriptive and concise caption. All graphs should have clearly labeled axes, along with numbered scales and appropriate units. Scale data plots to emphasize key information. Locate figures and tables logically with respect to the textual material.
7. Follow these conventions:
 - a) Include short quotations in the text, within quotation marks.
 - b) Double indent and single-space long quotations (over three lines) without quotation marks.
 - c) Number pages. Use small Roman numerals - ii, iii, iv, etc., to number pages preceding the body of the report, with exception of the title page. Use Arabic numerals - 1, 2, 3, 4, etc., to number all succeeding pages.
 - d) Start each major heading (Introduction, Background, Requirements, etc.) or new chapter on a new page. For these pages, increase the top margin.
 - e) Figures contain photographs, drawings, circuit diagrams and similar illustrative materials. Number figures consecutively throughout the report in Arabic numerals, i.e., Figure 1, Figure 2. The figure caption appears below the illustration. If narrative text follows the figure caption, allow space between the caption and following text.
 - f) Designate tables in Roman numerals, as Table I, Table II, etc., throughout the text. Table captions appear above the table. The title is all capitals. Allow space between the bottom of the table and following text.
 - g) Refer to **EVERY** table and figure by number **at least once** in the text narrative.
 - h) Use illustrative material (i.e., a figure or table) whenever appropriate to the text. Place the figure or table following as near as possible to the text material which just referenced it.
 - i) Place essential explanatory notes for illustrative material below the figure or table. Use footnotes and endnotes as illustrated in Appendix C.
 - j) Footnotes identify quotations and indebtedness to a source for specific information. Use standard footnote format and placement. The reference to which a footnote refers should appear at the bottom of the same page as a footnote or in a final bibliographic section as an endnote. 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 the IEEE Style, reference [1] on p. 18 or the MLA Style for more details.
 - k) Use standard Unit Symbols, SI Prefixes, and Abbreviations. Consult a reference, if necessary.
 - l) 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. Refer to the official IEEE website www.ieee.org for additional information on standards.
 - m) Photographs can convey important information to the final report.
 - n) Product specification sheets or application notes may not have to appear in report appendices, but cite them with complete bibliographic references in the report. **Obtain permissions to include any copyrighted materials.**

SAMPLE: TITLE PAGE

TITLE

by

John Doe

Senior Project

ELECTRICAL ENGINEERING DEPARTMENT

California Polytechnic State University

San Luis Obispo

2012

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Senior Project Report Submission (Directions for Students)

Please read the following information very carefully to ensure that your Senior Project will be processed. Failure to adhere to these steps may delay your completion of requirements. All information must be completed prior to submitting your Senior Project report to your Advisor.

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. Pay the \$12 Senior Project fee to the University Cashier and retain two copies of the receipt. While one copy is yours, the other copy will be used in step four below.
2. Download the Senior Project Requirement Form from the following website:
<http://lib.calpoly.edu/seniorprojects/>.
3. Fill out Sections I, II, and III of the downloaded Senior Project Requirement Form.
4. Print the completed form and attach the second copy of the Cashier's receipt.
5. Take the Senior Project Requirement Form, attached copy of the receipt, a final copy of your Senior Project Report, and the Analysis of Senior Project Design Form (found in Appendix D of the Senior Project Handbook) to your Senior Project Advisor.
6. Your Advisor will fill out Section IV of the Senior Project Requirement Form and sign the form.
7. When your Senior Project Advisor receives your Senior Project Requirement Form with attached copy of the receipt, a final copy of your Senior Project Report, and the Analysis of Senior Project Design Form, he/she will complete the Senior Project Requirement Form. You then must turn in to the EE department office the following:
 - a. An electronic copy of your completed Senior Project Report (email: ee-office-staff@calpoly.edu)
 - b. Completed Senior Project Requirement Form
 - c. The attached Cashier's receipt
 - d. **MANDATORY FOR ALL STUDENTS: An electronic copy of your addendum on "Analysis of Senior Project Design"** (found in Appendix D of the Senior Project Handbook.) This Material is collected by the EE Department for ABET (American Board for Engineering and Technology) and their review as part of the accreditation process.
8. Upload your final, Advisor-approved Senior Project Report to the DigitalCommons@CalPoly.
9. Your Advisor will assign a grade for your Senior Project.

For more information on the electronic Senior Project submission process, please visit the Kennedy Library's website at <http://lib.calpoly.edu/seniorprojects/>.

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 — THE LABORATORY REPORT¹

The laboratory report developed after completing a series of experiments is the main product of the team's work used for evaluation. Writing effective technical reports is a valuable skill that will enhance the engineer's professional career.

The purpose of the laboratory report is to describe the measurement procedure, lab results, and analysis procedure, and to interpret and compare experimental measurements against theoretical predictions. The discussion and conclusion sections indicate the knowledge gained by completing the experiments.

No single format accommodates all technical reports, but please follow the recommended structure:

1. Cover page
2. Introduction
3. Procedure
4. Experimental Data
5. Discussion
6. Conclusions

This Appendix C from the EE 241 Lab Manual explains how to format **figures, tables, captions, footnotes, references, and writing style**. Instead of the lab report structure, use the manuscript information on page 5.

1. The **Cover Page** identifies the course number and name, the experiment number and title, group number, author name(s), and the report delivery date, not the due date. Inquire if the instructor prefers this information on a separate page or at the top of page 1.
2. The **Introduction** briefly states experiment objectives or goals. This section guides the reader through the report by stating, for example, that experiments considered three different circuits, consisted of two parts, or that additional calculations or data sheets appear in an appendix.
3. The **Procedure** describes the experimental setup and how the measurements were acquired. Include circuit schematics with nominal and measured component values. Mention test instruments and settings, and describe any special measurement procedures.
4. The **Experimental Data** section includes tables, graphs, and data analysis. Number each figure and table and provide a descriptive and concise caption. Refer to instructor for caption length recommendations. All graphs should have clearly labeled axes, along with numbered scales and appropriate units. Scale data plots to emphasize key information. Multiple plot graphs should include a legend or clear labels on each curve; a graph containing one plot does not require a legend. Missing or improper figure identification and labeling degrades lab report quality. For images captured from test instrumentation or simulation software, reverse image black backgrounds, for example, by using the Paint application. Table columns should include descriptive headings that identify the data shown and any appropriate units. Unless a table is larger than one full page, do not allow the table to split across two pages. For tables that extend to a second page, repeat the column headings on each new page.
5. The **Discussion** section should include a comparison of the expected outcomes, derived from theory or computer simulation, to measured values. One way to compare multiple data sets is to plot the theoretical prediction and experimental data on one graph using different line styles or colors to distinguish each data set. Consider using a table to convey relatively few data points (approximately 5-10). Answer all questions posed in the lab manual, and include supporting analysis and calculations. Provide adequate and complete bibliographic references. For example, cite web page URLs for data sheets and cite other information obtained from books, including textbooks. Citations include the author's name, title, publication date (and

¹ Partially adopted and edited from "Laboratory Report Format" courtesy of New Jersey Institute of Technology, Electrical and computer engineering department. Last revised 3-June-11, EE dept., Cal Poly.

date accessed for electronic references). If necessary, indicate “author unknown.” Use the IEEE citation style [1, 2].

A critical part of the discussion is error analysis. Comparisons between theoretical and experimental outcomes seldom result in perfect agreement. Sometimes substantial discrepancies exist. This does not necessarily indicate experiment failure. The results are valid, provided the experimenter can justify the discrepancies. Perhaps, results require a new theory. For such discrepancies, include error values and possible (justifiable) causes. Often, differences between expected and measured values arise from experimental artifacts, or after omitting important analysis factors. For example, instrument precision and accuracy or the ability to read scales may contribute to errors. Actual circuit component values rarely correspond exactly to nominal values due to manufacturing tolerances. Loose connectors and broken cables are not acceptable causes for measurement errors.

The following section contains an error analysis example:

Low-Pass Filter Measurement Example: *This example illustrates how measurement technique can influence agreement between predicted and measured results.*

Fig. 1 shows the low-pass filter circuit diagram under test. An input voltage applied to resistor R_1 produces an output voltage V_{out} across C_1 . An Agilent 33120 Function Generator supplies 1 Vrms (V_{in}) at frequencies between 10 Hz and 50 kHz, and an Agilent 54622 Oscilloscope measures V_{out} . An Agilent 34401A DMM (Digital Multimeter) measures $R_1 = 1603.2 \Omega$, and a GenRad 1659 RLC Bridge measures $C_1 = 103.8 \text{ nF}$ at 1 kHz.

The low-pass filter forward gain characteristics shown in Fig. 2 obtained by measuring the ratio of V_{out} to V_{in} do not exactly agree with the theoretical prediction. According to theory and the simulation whose code appears in Table I, the low-pass filter should have a pole at the frequency

$$f_p = \frac{1}{2\pi R_1 C_1} = \frac{1}{2\pi (1602.3\Omega)(103.8\text{nF})} = 957 \text{ Hz.} \quad (1)$$

The directly measured RMS data lie within 3% of the theoretical response for frequencies below 50 kHz. RMS magnitudes derived from peak-to-peak Quick Measure values exceed theoretical predictions by 2.5-71% for frequencies below 50 kHz, incurring significant measurement error due to decreasing signal to noise ratios at higher frequencies.

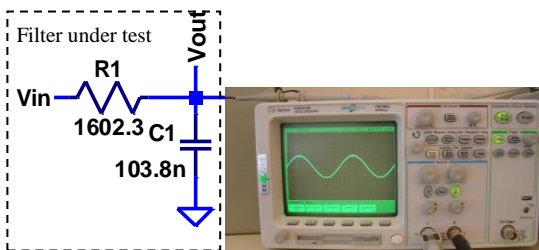


Fig. 1. Circuit 1. R_1 and C_1 form a low-pass filter.

TABLE I
PSpICE INPUT DECK (.CIR FILE) FOR A LOW-PASS FILTER

```
* EE Curriculum Committee, 2011
* Fig. 1 shows the circuit diagram for
* the Fig. 2 Low Pass Filter Example.
Vin Vin 0 AC 1V
R1 Vin Vout 1602.3 ; Filter Resistor
C1 Vout 0 103.8n ; Filter Capacitor
.ac dec 5 10 100k
.PROBE
.END
```

Place a comment in the first line of the .cir file.

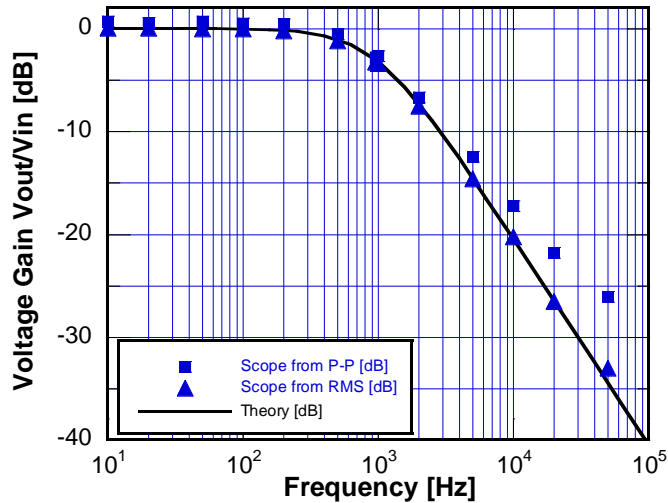


Fig. 2. Frequency response for a low-pass filter. The squares represent measured oscilloscope data using the Quick Measure peak-to-peak function. The triangles represent measured oscilloscope data using the quick measure RMS function. The solid curve shows the expected low-pass RC circuit response from PSpice simulation results based on Table I and Fig. 1.

The low-pass filter response illustrated in Fig. 2 indicates a pole corresponding to R_1 and C_1 at 957 Hz. Direct RMS oscilloscope readings substantially overlap theoretical predictions. Peak-to-peak oscilloscope readings translated into RMS values include more noise; hence, measured values lie above theoretical values for all tested frequencies.

6. The **Conclusions** section summarizes the experiment and describes how well experimental results agreed with theoretical predictions. Mention alternative procedures and experiment improvement suggestions. Instructors highly value constructive and original statements.
7. **Writing recommendations:** For professional reports, do not use first or second person singular (I, me, my, you, your) and avoid first person plural (we, our). Also, do not use vague phrases such as “the test results were good,” which contains no useful information. Instead, cite specific parameters, values, and test conditions as in the phrase, “the test results indicate output voltage regulation to within 1.5% at a load current of 0.5A.” Write the report concisely and completely using professional language appropriate for an engineer reporting to management or a customer organization. Edit using Richard Lanham’s Paramedic Method to make writing more clear and concise [3].

References

- [1] H. Bronleigh, “IEEE Style,” Home - IEEE Style - LibGuides at Murdoch University, September 2010. [Online]. Available: <http://libguides.murdoch.edu.au/content.php?pid=144623&sid=1229928>. [Accessed: December 31, 2010].
- [2] Institute of Electrical and Electronics Engineers, Inc., *IEEE Transactions, Journals and Letters: Information for Authors*. Piscataway NJ: IEEE, 2006. Available: http://www.ieee.org/portal/cms_docs/pubs/transactions/auinfo03.pdf. [Accessed February 23, 2007] pp. 4-5.
- [3] R. A. Lanham, *Revising Prose*. 5th ed. New York: Pearson, 2007. Available: <http://writing2.richmond.edu/writing/wweb/concise.html> [Accessed: December 20, 2010].

APPENDIX D — 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.

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**

• What economic impacts result? Consider:

Human Capital – What people do.

Financial Capital – Monetary instruments.

Manufactured or Real Capital – Made by people and their tools.

Natural Capital – The Earth's resources and bio-capacity.

• When and where do costs and benefits accrue throughout the project's lifecycle?

• What inputs does the experiment require? How much does the project cost? Who pays?

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?)

• How much does the project earn? Who profits?

• Timing

When do products emerge? How long do products exist? What maintenance or operation costs exist?

Original estimated development time (as of the start of your project), as Gantt or Pert chart

Actual development time (at the end of your project), as Gantt or Pert chart

What happens after the project ends?

• **If manufactured on a commercial basis:**

• Estimated number of devices 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 impacts associated with manufacturing or use, explain where they occur and quantify.

• Which natural resources and ecosystem services does the project use directly and indirectly?

• Which natural resources and ecosystem services does the project improve or harm?

• How does the project impact other species?

• **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 social and political issues associated with design, manufacture, and use.
- Who does the project impact? Who are the direct and indirect stakeholders?
- How does the project benefit or harm various stakeholders?
- To what extent do stakeholders benefit equally? Pay equally? Does the project create any inequities?
- Consider various stakeholders' locations, communities, access to resources, economic power, knowledge, skills, and political power.

- **Development**

- Describe any new tools or techniques, used for either development or analysis that you learned independently during the course of your project. Include a literature search.