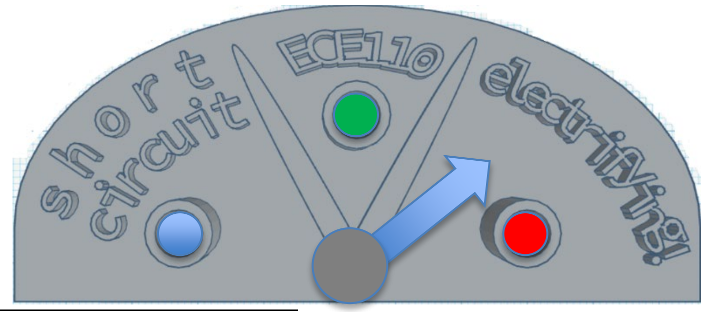
A Nice Round of Applause for ECE110!

End of Term Design, Demo, and Report



Overview

Your final project will provide that opportunity to highlight your ability to communicate technical ideas through both written and verbal (demonstration) formats. The final project should focus on making design decisions based on theory, validating those decisions with data, and communicating the aspects of your project through a report and a video.

The final project requests you and your team to collaboratively design and build an applause meter. Each design will need a microphone input and an LED array output plus the necessary electronics from your ECE 110 Electronics Kit to make it work well. You will also be welcome to modify this project, but these are the minimum requirements.

Figure 1: A generic block diagram depicting the minimal final project.

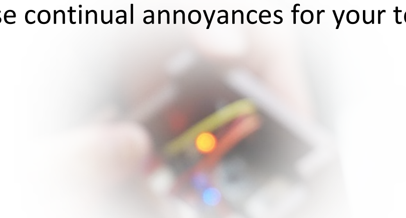
An Important Note About Teamwork…

The distribution of primary duties on any project is never 100% equitable, but this is a team activity where all students stand to benefit from a functional solution. As a teammate finishes their individual activities, they need to pivot assistance to another teammate to keep the project moving towards a successful completion. Please do not feel content to exit lab early and leave a teammate struggling.

Design Considerations

Microphone

While a single microphone would be technically sufficient for an applause meter, multiple microphones would provide enhanced behavior, being able to pickup sounds from a large physical space more reliably. Additionally, as the microphone person, you will not want to continually generate sounds while testing the remainder of your circuit. To eliminate this, you will want to create a waveform on your breadboard that “simulates” the output of the microphone (electronically, not audibly!) so that testing can continue without those continual annoyances for your team or the other teams in the lab!

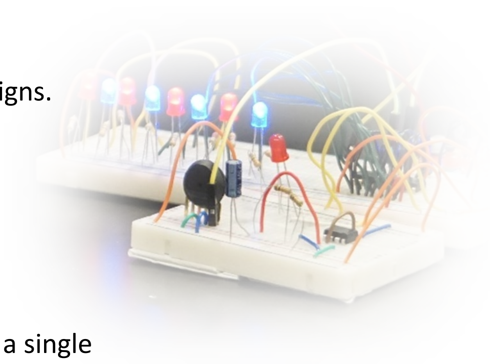


LED Array

Your LED array must have a minimum of three LEDs and three different colors. While simple in concept, you will want to consider “human factors” in your design. For example, some LEDs may have a naturally-brighter appearance that may need the current to be tempered to create the right “effect.” Also, you will want the colors and brightness of the LED to become more impressive with increased sound level. You will also want it to respond with the appropriate time constants (how fast the array responds to sounds and fades away, the “upper” light fading back to the lower lights before all going out). While not required, access to a 3D printer can provide an opportunity to really make your array a fun focal point of the working design.

Electronics

The electronics block in Figure 1 is a bit ambiguous. Of course the microphone and the LED are also both electronic designs. However, we can take the time now to address some overall needs of this project.



Gain

The microphone signal will be weak, a voltage signal on the order of mV. It needs a boost! This is often done using an operational amplifier.

Persistence

Creating persistence of the LEDs in the array will also be an interesting aspect of this design challenge. If you intend for a single hand clap to register on the LED array, you should consider that the hand clap will be very short in time duration. There-and-gone-again on the order of ms. If this were amplified and applied to a single LED, the quick “blip” of light might be almost imperceptible. If a clap near the microphone is intended to light multiple LEDs rising up higher on your LED display before gently descending again, the design will require even more thought. Luckily we have some training in RC time constants and we will provide additional materials to help you brainstorm solutions.

Impedance Matching

Impedance is not a term we use much in ECE 110, but that's okay. You can just think of impedance as being similar to resistance. But what is it we are trying to match? Well, remember how we learned about equivalent circuits? How we could predict the behavior at the intersection of two circuits joined together by reducing each to simpler Thevenin equivalent? When designing an electronic circuit, we need to think about how the loading of each prior circuit will affect its behavior. For example, when you first get a voltage signal out of your microphone, you will likely be monitoring the open-circuit voltage! Since that voltage is small, you will design another circuit designed to amplify the voltage of an ideal voltage source. Is the microphone circuit an ideal voltage source? You should strongly doubt that. A better model might be a Thevenin model that includes some Thevenin resistance as you look backwards from the amplifier into the microphone circuit. Determining Thevenin-equivalences of our sub-circuits and making modifications to accommodate mismatches will be critical to our success.

General Circuit Design Issues

In addition to impedance matching, circuit designers often run into many other challenges and design decisions. For example,

- voltage signals from one area of your breadboard can find their way to the power rail and show up superimposed on voltages at other nodes throughout your circuit. What can you do to isolate these voltages to avoid such "crosstalk?"
- Operational amplifiers can run on a single power supply or two power supplies. What are the pros and cons of each?
- Variations in your voltages as your battery weakens could alter the performance of one or more of your subcircuits. What can you do to make circuit behavior more robust?

As a team divide the exercises provided to you by the TAs. You will often work in pairs on different modular exercises but regularly consult as a team throughout the final project so everyone knows what is being learned in each task.

Grading Guidelines

The final project will provide an opportunity to communicate technical ideas through both written and verbal form. The final project should be more about making design decisions, validating those decisions with analysis and data, and communicating the aspects of your project through a report and a video. Your audience now should be your cohort of students, all educated with a full semester of ECE 110!

Your audience for this exercise is more technical than your previous audience. While they do not want a boring presentation, their interests are more technical and ECE 110 terms will not be foreign. The terminology used in the report and video should resonate with the terms used in class. There should be use of engineering analysis, discussion of engineering tradeoffs, and definitely images and video from the oscilloscope.

Each student is required to submit the report (4-8 pages in length, done as a team) and a video (three-to-five minutes in length, also completed as a team with each individual taking a presentation role within the video). Every student must take a lead role in at least one significant component (sub-circuit) of the design build. Grading will be based on several aspects of the project as judged by the combination of the report and the video.

Video Requirements: (Link to the Rubric)

Introduction: Names and section

Verification: Demonstration using the oscilloscope that verifies *each* sub-circuit functions correctly.

Operation: Demonstration of proper operation of the completed design circuit.

Written Report Requirements: (Link to the Rubric)

Design: Did you utilize the datasheet(s) and course material to make one or more important design decisions? Were your decisions based on analytical understanding?

Analysis, Troubleshooting, and Validation: Did you confirm one or more predictions regarding your design plan? Did you confirm those predictions using engineering tools, like the voltage readings from the oscilloscope? Did you use the oscilloscope to "peek" into your circuit when having any difficulties?

Communication: Were you able to communicate your technical expertise in design and validation well in both written and verbal manners through the report and video? Did you use technical terms and perform technical analysis as appropriate?

Conclusions and Future: Conclude your report and video with one or more of the following: thoughts on what went wrong and how engineering tools might have allowed you to fix it given more time, discussion on how the material ties into topics of ECE 110, brainstorming on what could be a future project in electronics that might excite you.

Table 1: Total Final Project Points

Assignment:	**Points Possible**
Weekly Reports (Update plus Next Actions), must be present	3x300
Written Report	600
Video Report	300
Question and Answer Session (last meeting of semester)	200
Extra Credit ("elegant solution" or going above-and-beyond)	Up to 50
Total:	2000

Final Design Report

Prerequisites

- Completed ECE final design project.

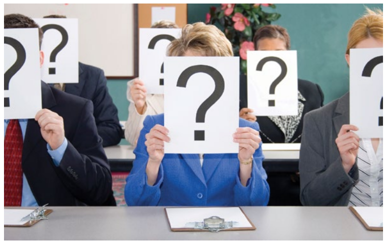
Learning Objectives

- Write a technical report suitable for the final report of an engineering design course.
- Follow a **rubric** specifically designed for the final report.

Procedure

The final written report is your opportunity to piece together different aspects of your training from this semester while working on a project with multiple sub-circuits. Specifically, the tools, skills, and knowledge gained from lab, lecture, homework and other resources in ECE 110 should shine forth as you complete your design. In fact, it is more important that you highlight the use of tools, the applications of skills, and the revelations of knowledge than it is to merely attain a working demonstration with little insight into the function and limitations of each part and the successful integration of those parts.

Each member of your team is expected to contribute in a non-trivial way to this final written report. To do so, your team should subcontract the responsibility of one separate section of the body of the paper to each teammate and plan a meeting ahead of the deadline to work as a team to complete the abstract, introduction, and conclusion while ensuring that the paper reads through smoothly as if written by a single individual. **Each section should be augmented with the netID** of the teammate who is ultimately responsible for its creation and content and the netIDs of contributing authors to that section may follow as appropriate. Not every section needs to cover every element of the rubric, but every team member must show competence in their application of ECE 110 material.



Your audience is your instructor, your TAs, and your fellow students who know about as much about electronics as you do!

References

Be prepared to dig deeper on concepts you don't fully understand by revisiting course materials, office hours, your lab TAs, recommended texts, or online resources. These review/background materials can be greatly helpful in producing a strong report. Keep a record of your resources and include them in the report to avoid the mistake of plagiarism (also see the section called *Avoid Plagiarism* later in this document). Be explicit about material that has come from other resources and differentiate from the material you and your team has developed.

Consider the Audience

Your audience is your instructor, your TAs, and your fellow students who know about as much about electronics as you do! This report should be technical, but careful not to assume too much. Make any mathematical solutions clear in method much as you would have done to earn full credit in GradeScope homework. Use the engineering tools (M2k, schematics, simulation, etc.) and skills as expected in a technical report. This will affect your score on many of the rubric items. Keep this in mind throughout.

Report Format

Final Design Report Title (Team)

Abstract (Team)

Body of paper…

Introduction (Team)

Section 1 Title (primary netID#1, contributing team members)

Include theory, data, figures, calculations, design, analysis, references as appropriate

Section 2 Title (primary netID#2, contributing team members)

Include theory, data, figures, calculations, design, analysis, references as appropriate

Section 3 Title (primary netID#3, contributing team members)

Include theory, data, figures, calculations, design, analysis, references as appropriate

Section 4 Title (primary netID#4, contributing team members)

Include theory, data, figures, calculations, design, analysis, references as appropriate

Conclusions (and Future Directions, Team)

Title

This is a *final design report*.

Final Design Report: My Report Title Here

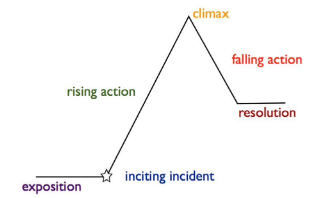
Abstract

The goal in technical writing is to generate a report that

- conveys your experiments and results at a level appropriate for the intended audience,
- follows a structure consistent with other sources of technical reports of similar nature and purpose,
- highlights key findings that are anticipated to be valuable to others.

Technical report writing has both similarities and differences to the *Art of Storytelling* which we used for developing our Storytelling report. Build excitement around your selected key aspect of the design. Why should others want to read your report? What will the report give them that they did not have before? Yours should leverage tools like the oscilloscope or multimeter, circuit schematics, block diagrams, data in tables or plots, equations, and derivations.

The abstract may contain similarities to Freytag's pyramid. In the abstract below, the exposition, inciting incident, and rising action is replaced by a "pain point" followed by a description that elevates the severity of the problem and stoking interest in a solution. The solution to the problem is then proposed and the abstract ends happily. In the abstract, the main ideas are presented, but the details are best left to the body of the paper.



The abstract may contain similarities to Freytag's pyramid.

> **(Example) Abstract**: Instructors often identify significant weaknesses in the ability of a team of undergraduate students in engineering to generate a written report. Too often, the student team relies on distribution of responsibilities between teammates to accumulate disjoint pieces of information, often with incomplete sentences, poor formatting, and random pieces of data. The broader message of the document is lost to the reader and overarching conclusions are missing entirely. It is our finding that students will perform much better on written technical reports after considering the purpose of all portions of the report. Students in ECE 110 produce better reports after being properly trained.

Take careful consideration of what you learned throughout the semester. Your report will break down the project into specific goals. Your task as an engineering team is not only to build a working system for your client, but also provide documentation that provides confidence that the design was done properly. The documentation must be complete such that other engineers could quickly understand the work done as well as the limitations.

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You can write your abstract first but there is no firm and fast rule. It is important to draw the interest of the reader in quickly using a limited number of words. This is the purpose of the abstract. Keep it short, but let the casual observer know if they will find information of interest in the document that they may feel compelled to read further.

Introduction

This is where you will explore the problem and other solutions explored prior. Often it includes a number of references indicating that the background and state-of-the-art in solutions is well-known and that the proposed solution follows a natural progression. Many of your references for this report may come from the lab procedures and other materials made available to you, but others may come from, say, your own research online.

Body

The body of the paper will often consist of several sections, each outlining one aspect of your solution. The presentation should be clear and written with appropriate attention to the intended audience. Outcomes supporting your claims will be presented. The body will be the bulk of your report and we'll assist you in this document to determine what you may want to include.

Before writing the body or introduction, first produce an outline of what your team wants to emphasize. Glance through the rubric again, then determine as a team a direction for the report. Decide which schematics, data/plots/table, equations/derivations, and discussions are important to each section of the paper.

Individual: **For this report**, a division of labor was suggested. Not all sections will take the same amount of effort or time. When a teammate finishes their individual section, they need to transition into an assistant role to aid teammates who need additional help. The team is ultimately responsible for the overall success of their project.

Optional: If your team would like to construct a report worthy of extra credit, you could consider additional areas where you could do analysis of your solution (IV measurements that lead to a Thevenin model, perhaps) or create a particularly strong report of the design criteria that went into selection of components, frequencies, and time constants.

Team: While each teammate would take responsibility of a portion of the paper (approximately one page plus-or-minus per teammate), the entire team ensures the completion of the project and the report including editing, abstract, conclusions, and continuity such that it flows as from one voice. There is no minimum length to the paper, but it should not exceed 8 pages.

Conclusions (and Future Directions)

Having presented the research, this is an opportunity to provide an "executive summary," pulling the main points from each section while providing a concise argument for how they support your claims. Many readers might find your abstract interesting enough to jump to the conclusions of your paper. Here, they hope to find further support that your work will enhance their own knowledge and skillset and decide if a careful reading of the paper is in order. Rest assured that your TA will read the entire paper. 😊 Include future directions if you feel more work could have been done to support the current report or if you see interesting avenues for new projects related to the work already finished.

Look at each section of your paper and determine what it contributes to the work. How does each portion assist in understanding the overall solution? Provide a quick summary that ties the ideas together in one or more general conclusions *without* going back into the details already presented in the body of the paper. It should not be a duplication of the abstract but references to specific sections of your report's body to validate the strength of the study.

Avoid Plagiarism

Unfortunately, plagiarism cases occasionally appear and are dealt with severely. Here is some of what you should know.

- It is never okay to use code or language in your report from another source ***without*** documenting the source. Nor is it allowed to start with someone else's documentation and make editing changes in an attempt to "make it your own." It is *not* your own despite your paraphrasing and that is still plagiarism.
- ECE 110 allows the use of properly-documented resources (code and language) from outside resources, but only with proper reference and a ***clear distinction*** between the work you have personally accomplished and that which was done by a third party. Any report that blurs the distinction between what the team has accomplished and what the team has "borrowed" is plagiarism.
- Use of documentation from another student of ECE 110 (past or present) is not acceptable. We have a database of old reports and students who do this will be caught and charged through the university's FAIR system.
- Some courses outside of ECE 110 do not allow any code from outside sources whether you document it or not. Always ask if you are unsure of the course's policy.

You do not want this embarrassment, the associated penalties, nor this blemish on your record. The report is your personal responsibility even with teamwork. Ask questions of them and make sure your teammates don't "cut corners."

The penalty for plagiarism is high. All courses will issue a 0 on the assignment, but you can also expect a reduction in your letter grade or an automatic failure. No one wants this embarrassment!

Other Thoughts

When generating a report, it is not uncommon for the author to recognize holes in their understanding or in their data. Sometimes an additional experiment or two can be conducted to help. Perhaps additional knowledge gained throughout the semester will provide deeper understanding of an earlier exercise. Don't hesitate to find ways to improve your report.

Rubric

A rubric for grading is a set of guidelines by which the TA will critique your work. For this final design report, the TA will be using the following rubric. Reflect on the rubric often as your report takes form.

Table 2: Final Design Report Rubric

Criteria	Rating Scale			weight	Score
	3	2	1 or 0		
Formatting	Report has correct structure, complete sentences, tables, figures, captions, labels as appropriate.	Report has some structure, but some details are lacking.	Structure is very poor. Minimal effort in appearance and form.	× 20=	/60
Communication of Concepts	The paper communicates the goals, methods, and solutions well. Report makes significant use of course topics with explicit analysis. Circuit schematics, plots, and tables provide important details to the reader and are properly labeled.	Report provides calculations without significant relevance to the goals of the paper or makes errors in theory or calculations. Visuals are poorly labeled or explained; provide little benefit to the reader.	Only numbers and text are present without evidence that the concepts are understood. Schematics or other visuals are weak or missing entirely.	× 20=	/60
Tools	The oscilloscope and other data were used to gain insight into the operation of the circuit. One or more plots support the information relayed in the report.	An oscilloscope plot or data from the multimeter was included but provides minimal support to the goals of the report.	Little relevant data was included from the measurement devices.	× 20=	/60
Design	The report clearly outlines the requirements, science, and equations behind the choice of values used for circuit components and their arrangement in the solution.	The report attempts to follow guidelines provided by the course documents, but there are errors that show the design constraints were poorly understood and applied.	Circuits were constructed, but the report gives little or no consideration to the choices made.	× 40=	/120
Analysis	One or more circuit is analyzed after its construction to validate expectations. Deviations from expectations might lead towards a possible redesign.	Analysis is attempted, but sloppy.	No true analysis of a constructed circuit.	× 40=	/120
Teamwork	There is strong evidence of equal contribution and responsibility from the teammates expressed in the	Multiple or all team members show contributions, but document does not reflect	Collaboration between teammates appears weak	× 40=	/120

	paper. Furthermore, the paper has been edited to provide a consistent voice throughout the sections.	improved quality from that collaboration; sections are disjointed.	and/or individual contributions are not clear.		
Conclusions (and Future Directions)	Conclusions are stated and supported by the body of the paper. Future directions (if included) consider any shortcomings or an interesting expansion of the current work.	Conclusions are presented but not well supported by the paper.	Missing or vague.	× 20=	/60
				Total:	/600

Table 3: Final Design Video Rubric

Criteria	Rating Scale			Weight	Score
	3	2	1 or 0		
Design	Video communicates all design choices made in your design (i.e. How does the design go from the sensor to the output). Include the use of a clear and complete circuit schematic of your making.	Video includes use of a complete circuit schematic. However, it is not clear from the video how the design implements the required functionality of the device.	Video does not include a complete circuit schematic. It is not clear from the video how the design implements the required functionality of the device.	3x25	/75

Function	Video demonstrates functionality of all required sub-systems, as well as completed device function.	Video demonstrates functionality of some (not all) of the required sub-systems. Or only demonstrates the completed device functionality.	Video does not demonstrate functionality of any of the required sub-systems nor the completed device functionality.	3x25	/75
Tools	Video uses the oscilloscope to demonstrate individual sub-circuit behavior in a controlled-input environment. Furthermore, measurement devices are used to verify the required functionality of sub-systems.	Video does not use the oscilloscope or multimeter correctly; however, some attempt was made to empirically verify behavior of the subsystems.	Video does not use the oscilloscope or multimeter to verify behavior of the vehicle.	3x25	/75
Teamwork	There is strong evidence of equal contribution and responsibility from the teammates expressed in the video. Each student should be highlighted in a small portion of the video regarding their contribution.	Multiple or all team members show contributions, but the video does not reflect individual contributions from each student.	Collaboration between teammates appears weak and/or individual contributions are not clear.	3x25	/75
				Total:	/300