Final Design Project: Choose Your Own Adventure
Engn/Phys 207—Fall 2022
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Welcome to the Final Circuits design project, meant to be an practical and integrative experience of everything you have learned in Circuits this term! This project is meant to be a fun, challenging, and rewarding experience.
For this design project you are asked to design, build, and test, and demonstrate proof of concept of your chosen circuit system. The final output will be written report describing and illustrating the operation of your system. Each team will put their final product on public display in the Science Center Great Hall near the end of the term and/or during finals week. The grading criteria and report requirements are the same regardless of which you select. Please see the section titled Report Guidelines and Grading Rubric below.
The design project will proceed in two stages:

1. ***Conceptual Design***. Draw your circuit up on paper. Describe what each functional block does. Write down transfer functions/quantify theoretical behavior. Make a bill of materials (BoM). Conceptual Design Guidelines are posted to the course website (linked here).

2. ***Practical Implementation***: Build the circuit, test it, refine/modify as necessary, demonstrate proof of concept

Important Dates

- Conceptual Design and Bill of Materials **due no later than 5pm on 29 Nov 2022**. The earlier, the better as we may need lead time to order parts.

- Proof of Concept **be prepared to show your fully functioning circuit/system during your lab section on 08 Dec 2022**.

- Final report **due no later than 11.59pm on 13 Dec 2022**. This is a firm deadline.

Rules of Engagement

- Because this assignment will be used to assess both practical skills and conceptual and quantitative understanding of circuit behavior, all students must satisfactorily complete this assignment in order to receive a passing grade for the course.

- You may collaborate with up to 2 classmates, and are encouraged to do so (in part, to avoid the lab equipment bottleneck). **All members must be fully engaged in all aspects of the project**. The final report must include an explicit statement explicitly stating who did what.

- Each team will submit a single design project report.

- Develop your own design. ou may consult with your class notes and other material you deem useful. You should avoid consulting other published designs, though doing so is not strictly prohibited. The idea is for you to exercise your creativity and synthesize various bits and pieces we've covered in this class. If you do consult outside resources, the expectation is that you master the content and fully understand how the circuit system actually works, not

simply merely replicate or regurgitate them. The instructor strongly encourages you to verify whether any resource you found is legitimate (there are some good ones out there, and many bad ones). Be sure to cite resources used in your final report!

- Google data sheets as needed—you are going to need them for op-amps, instrumention amps and optical sensors, etc.
- Google Arduino resources as needed! Remember: good coding means you are copying and pasting 90%. That said, go line by line to be sure you understand what's happening under the hood. That is, don't simply download, compile, and walk away (any 10 year old can do that, you all are way more sophisticated in your knowledge and skill level!)
- There is no time limit. You may spend as much time in the lab working on the project as you wish. I estimate that the time required to complete this project and the write-up to be about 25-30 hrs total. Please *optionally* note the amount of time you spent working on this project. This information will be used for feedback purposes only and will in no way effect your grade.
- There are many possible "good" designs. They all have tradeoffs. You should consider them and be able to justify your final design choices. Creative and elegant designs are encouraged!
- The instructor will be purposefully less helpful than usual with regard to circuitry with which you should be very comfortable by now (filters, amplifiers, etc.) If you become truly stuck to the point you are not able to proceed, of course come get help and/or advice from the instructor.
- The instructor will be available to help work through questions related to new concepts—but you should ask questions after making a valiant attempt first.
- Have fun with your project. It will hopefully be appropriately challenging, possibly at times frustrating, but ultimately an overall enjoyable very rewarding experience!

Report Guidelines and Grading Rubric

Think of the write-up as being a conversational piece and/or user's manual to communicate your design, experiment, and findings to a classmate (or anyone who familiar with various types of circuitry). It should be beautifully illustrated throughout, a visual feast for our circuits eyes. A good report should include most (all) of the following. 7 pages maximum for the main content! Appendices and citations do not count toward the 7 pages.

- Statement of what your circuit does. What problem does this solve, what is its real world usage and context?
- Overall design rationale for your circuit, broken down into functional blocks
- Intuitive explanation for how it works
- All relevant circuit diagrams with clearly labeled component values
- Calculations and justification supporting component and parameter values selected
- Photograph of of the actual circuit you built, carefully annotated so someone can connect what you drew for on paper to what you actually built
- Quantitative analysis: Show all relevant equations, transfer functions, calculations, computed generated plots of expected $G(f)$ vs $\log_{10} f$ etc, deriving where necessary.
- Results vs theory: how did your circuit actually behave? How was it supposed to behave as drawn up on paper? You know the drill. Use MATLAB to plot $G(f)$ dB theory curve with overlaid data points.
- Analysis and discussion of how well your circuit performs relative to what you designed it to do.
- Suggestions of how to improve your design or additional features that could be added.
- The write-up could be very nicely augmented by a video demonstrating proof of concept Best video wins a prize!

This being an open-ended project, your grade will be assigned based on the following rubric:

1. Writing style is clear and concise
2. Report is beautifully illustrated throughout
3. Relevance/real-world application is clearly stated
4. Circuit design is conceptually sound
5. Circuit was properly constructed and tested
6. Results are clearly illustrated in beautiful graphics and in text
7. Quantitative comparison of design in theory vs. the actual performance measured in lab.
8. Analysis of experiment is accurate and complete
9. Discussion includes relevant commentary on how well the objectives were met
10. Suggestions for modifications might be made to improve the design in the future