ECE 3155 Design Project

**Spring 2025**

The goal of the project is to design and build one of the circuits described at the end of this handout, or another **approved** project of your own design. The project is your choice, but the maximum grade that can be earned varies among the projects. Each submitted proposal for an original project will be reviewed, and assigned a maximum possible grade. In all cases, the indicated grades will be awarded for *satisfactorily completing all aspects* of the project. Deductions may be made if all requirements are not met.

Note that each of the suggested projects includes a set of ***quantitative specifications***, that is, a list of specific detailed criteria to be met by the project. Specifications include, for example, the maximum operating frequency of a function generator, or the accuracy and precision of an ac voltmeter. Proposals for original projects must include detailed quantitative specifications before they will be approved. The quantitative specifications will play an important role in determining the maximum project grade. Projects that do not meet these quantitative specifications will not earn the maximum possible grade.

Most components, including the breadboard, will be provided for you. (For example, one exception is the display for Project #1.) You are encouraged to use semiconductor components that are in your laboratory kit, but other components may be used if approved in writing by the instructor. Any resistor or capacitor value is acceptable, and does not need to be requested. You are not limited to the number of any component that you use, but you are limited as to the type. For example, you may use 20 op-amps, as long as they are all 741s. If you wish to use components that that are not in the lab kit, you must submit a request to your instructor asking to use that component. Your completed project may, at the discretion of the instructor, become the property of the Department of Electrical and Computer Engineering. Examples of projects from previous years are displayed in a glass case outside of the main ECE department office.

You must work in a team. Teams must have four or five members. Exceptions to this rule will be rare, and requests for such exceptions must be separately approved. You may pick the members of your team, but must do so by **February 4th**. One member of your team must submit the names of your team members to your instructor by e-mail to [shattuck@uh.edu](mailto:shattuck@uh.edu) . If you do not join a team on your own, the instructor will assign you to a team. Students not on a team will be assigned to one by Friday, February 7th.

Your team is required to submit a proposal for your project no later than **February 20th**, by email to [shattuck@uh.edu](mailto:shattuck@uh.edu). Include the name of your group in the subject line of the email. In this file you must include the names of the members of your team, quantitative specifications for your project, and between 3 and 5 reasonable milestones that your group will attempt to meet, with a date for each milestone. An example of a milestone might be that your group will have a major sub‑circuit in the project, such a variable frequency square wave generator, built and tested by March 5th. This proposal can be modified after February 20th, but a version must be submitted, with reasonable milestones, by February 20th. Modifications must be submitted and approved by the instructor no later than April 8th.

During the dates from April 14 through April 25, your team will demonstrate to an instructor that your circuit works according to specifications. A schedule of available time slots will be posted, allowing you to sign up for a time slot. Bonus points will be given for signing up for slots from April 14 through April 18. Your group should give a presentation no more than 20 minutes in length, with every member of the team presenting some aspect of the project. A team grade will be assigned based on the demonstration and on how well the project satisfies the specifications listed for it. All team members **must** be present at the demonstration. You should expect the instructor to ask questions of all team members. **Everyone on the team will be expected to understand to a reasonable extent all aspects of the project.** The instructor will lower the team grade if any person on the team is not able to answer reasonable questions about the project.

***Project Documentation***

* The **names** of all the members of the team must be prominently displayed on the circuit board(s), and on all the accompanying documentation.
* A neat **circuit schematic** showing all the values of the components in your circuit must be included. Show the actual components that you used in this schematic, not your design values. If you planned to use a 2.2[kW] resistor, but then ended up using a 2.7[kW] resistor because it worked better, show 2.7[kW] on your schematic. You do not need to measure the resistance to show the true value. Show the nominal value of the component that was actually used. As with all schematics, units should be shown clearly. A hard copy version of this schematic is required at the time of the demonstration.
* A **circuit map** must be included. This is a picture of your circuit, showing the location of all the components, drawn approximately to scale. Typically, components are represented by the approximate shape of the actual device you use, viewed from the top. An actual photograph with labels can be used if you wish. You may also wish to label your physical circuit to make it clear where each component is located, but this is optional. It must be clear to the instructor from your circuit map how your schematic relates to your physical circuit. It is typical to name every component, such as R1 and C7. If you do this, then the R1 label should be present on the schematic and on the circuit map. A hard copy version of this circuit map is required at the time of the demonstration.
* The **measurements** taken to demonstrate that your circuit worked must be shown clearly. The procedures that you used to measure them are also necessary, and must be shown clearly. This is not optional. If these items are not present, your grade will be reduced. As with all measurements, the appropriate number of significant figures should be shown. Measurements with an inappropriate number of significant figures will be considered to be unclear, and can be penalized accordingly. A hard copy version of these measurements and procedures is required at the time of the demonstration.
* The team will submit one copy of each of the above documents in hard copy form at the time of the Project Demonstration. In addition, each individual team member must submit a **Team Contribution Report** (see the form later in this handout) indicating the contributions of each team member. This form must be signed. **Team Contribution Report** must be submitted by email to [shattuck@uh.edu](mailto:shattuck@uh.edu), by April 25th. At the discretion of the instructor, the assessments made in the **Team Contribution Report** may be used to assign grades to each team member.

***Project Descriptions***

Project #1 AC VOLTMETER CIRCUIT

Design and build a circuit that takes an input sinusoid and produces a dc output that is proportional to the peak-to-peak amplitude of that sinusoid. The input sinusoid may be anywhere in the frequency range 10 [Hz] to 20 [kHz]. The rms ac component of the output must be less than 5% of the dc component of the output. The dc output must be used to drive an analog or a digital display, which should be calibrated to within 5%. The team must provide this display. The maximum grade on this project will be a "B".

Project #2 DIFFERENCE CIRCUIT WITH NEGATIVE OUTPUT

Design and build a circuit that takes a square wave and a triangle wave and subtracts one from the other. This difference must then be converted to an output that is always negative, regardless of the input. In other words, the DC component of the difference must be changed so that the output is entirely positive. The circuit needs to work for a wide range of dc components of the input. The output must not be seriously distorted in any other way. Small amounts of positive voltage at the output will be tolerated (up to 500[mV]). Your circuit should work for input waveforms anywhere in the frequency range from 100[Hz] to 10[kHz]. The maximum grade on this project will be a "C+".

You will need to figure out a way to come up with a square wave and a triangle wave using the equipment at one station. It can be done with the equipment available at one station.

Project #3 SWITCHED SINUSOID CIRCUIT

Design and build a circuit that produces an output sinusoid only when an input signal exceeds 8[V]. If this is not the case, the output should be zero. A separate sinusoidal input at 5[MHz] will be provided for your circuit. Thus, your circuit has two inputs and one output. One input is the sinusoid, and the other is the switching signal. Your output sinusoid must be five times as large as this input sinusoid, to within 0.5[dB]. Your output when switched off must be at least 30[dB] below the input. The maximum grade on this project will be a "B".

Project #4 BASIC SIGNAL GENERATOR

Design and build a circuit that provides a square wave and a triangle wave output. No inputs other than dc power supplies should be used. The output waveforms must be adjustable so that repetition rates anywhere in the range from 100[Hz] to 10[kHz] can be selected by the user. The maximum grade on this project will be a "C".

Project #5 ADVANCED SIGNAL GENERATOR

Design and build a circuit that provides a square wave and a triangle wave output. No inputs other than dc power supplies should be used. In this project the repetition rates must be variable, anywhere in the range from 20[Hz] to 20[kHz], and must be controllable by the user. The triangle wave output should have a distortion that is less than 5%. Your documentation must include a reasonable definition for this distortion, and how you measure it. Also, the amplitude of each of the outputs must be variable, and range from 1 to 10[Vpp]. Finally, the dc offset of each of the outputs must be variable over a range from -3[V] to +3[V]. The maximum grade on this project will be a "B".

# Project #6 NOTCH FILTER

Design and build a filter that has a gain of 30[dB] for dc, attenuates by 30[dB] at 60[Hz], and gives a gain of 30[dB] at 1[kHz]. Each of these gains and attenuations must be accurate to within 1[dB]. For frequencies above 1[kHz], the gain needs to be 30[dB], to within 3[dB], up to 20[kHz]. The maximum grade on this project will be a "B".

Project #7 ELECTRIC KEYBOARD

Design and build a circuit that produces the tones of a full octave scale, including sharps and flats. The output of the circuit must be audible for all gain settings, and the frequencies produced must be accurate to within 3% of the pitch required for that note. The output amplitude (volume) must be variable, and range over at least a 30[dB] dynamic range. In other words, the ratio of the largest amplitude at the output, to the lowest amplitude at the output, should be at least 30[dB] for all of the notes produced. The maximum grade on this project will be a "B".

Project #8 ANALOG TO DIGITAL CONVERTER

Design and build a circuit that compares an input voltage with 7 different levels, and produces a 3 bit digital output that corresponds to the amplitude of the input. The output should be held at this digital value for at least 1[ms], and then it can change again. The accuracy of your converter should be within 2%. The maximum grade on this project will be a "B-".

Project #9 YOUR CHOICE

Design and build a circuit that meets specifications that you have chosen. Submit your proposals, in writing, to the instructor. This proposal must include the **quantitative specifications** that your project is going to meet. Many students in the past have submitted proposals without quantitative specifications. No grade maximum can be set without quantitative specifications. If approved, a maximum grade as high as an "A" will be assigned for your project.

TEAM CONTRIBUTION REPORT

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Indicate in the table below your estimate of the contributions of each member of your team, including yourself. These assessments, along with those of your teammates, may be used to determine the final project grade assigned to each team member.

Your assessment is considered confidential, and will not be revealed to the other team members. Email your signed report to [shattuck@uh.edu](mailto:shattuck@uh.edu) by April 25, 2025.

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| --- | --- | --- |
|  | NAME | % CONTRIBUTION |
| YOUR NAME |  |  |
| PARTNER #1 |  |  |
| PARTNER #2 |  |  |
| PARTNER #3 |  |  |
| PARTNER #4 |  |  |
| PARTNER #5 |  |  |

The contributions must total 100%.

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Signature Date