Student Project Guidelines

Introduction

The final two class days are reserved for the 123as/223a Final Student Project. You will work as a team of two or three to apply your circuit design skills to a real-world problem of your choice. The goal is to demonstrate a competent circuit design using the circuits, devices and concepts we have covered in the course. This means that I don't really care what your project does, just that it is well designed.[1] You will want to make sure that your idea is both reasonably challenging and feasible in the timeframe available. That means it must be possible to design it, build it and debug it in two class sessions. Your project does not need to be innovative or groundbreaking, but it is critical that it contains **significant analog circuit design**.[2] A project can include other aspects (software, mechanical hardware, etc.) but given the short time available and the fact that you will only be assessed on the circuit design portion of the project, you should try to avoid extraneous features that do not contribute to this evaluation. Both team members will be expected to contribute to the project's design and testing. Both team members will receive the same grade unless there is evidence that one or more individuals did not participate significantly in the project.

Potential Project Ideas

Here are some ideas for what I think might be appropriate project ideas (in no particular order):[3] See also Chapters 28N and 28O.

- a Lunar Lander game simulating thrust and gravity to land on the moon
- a Theremin based on optical or distance sensing (or RF if you are adventurous)
- a distance sensing bicycle taillight
- a hall effect bicycle speedometer and odometer
- something interesting using an analog accelerometer – perhaps a pedometer or level
- an optical heart rate monitor (photo-plethysmograph)
- a guitar tuner for one or more frequencies
- an electric flickering candle
- a go/no go or analog readout capacitor tester
- a picoamp meter
- a sweep generator
- an altimeter or rate of climb indicator
- an electronic scale with audio output
- a guitar fuzz box (or other sound altering circuit)
- an automatic gain/volume-controlled amplifier (but different from the JFET lab)

[1] Indeed, I don't really care if it works in the sense that it does what you wanted it to do, just that the circuits operate properly as you designed them to operate and you followed good design practices.

[2] That means "more than just rebuilding a circuit you already built in lab." However, combining several circuits you have tested in class to accomplish a larger objective is fine.

[3] I cannot guarantee that these are all possible in the time available, but I am happy to discuss any of them you are interested in.

- a beam balancer (we have some mechanics already available but this is probably too difficult in the time available)
- an analog voice encryption/decryption system
- a line-following cart (some mechanics available)
- a robot voice changer
- a sound following camera (use a hobby servo)
- a car parking warning system (audio and/or light warning)
- an IR remote control switch
- analog thermometer with refrigerator failure warning
- an electronic compass using a color sensor, magnets and color wheel
- a clapper (turn on and off a device by clapping)
- FM music transmitter and receiver (if no final exam)

Plan of Action

You should be thinking about projects before coming to the penultimate class. Think about what the circuits have built do and what problem you would like to solve. Unfortunately, you will need to spend a bit of time outside of class deciding what you want to do and putting together a rough block diagram of how you will build it. I will review your plan at the beginning for the class to make sure it is both complicated enough and not so complicated as to not be feasible.[4]

Bill of Materials

Given the compressed schedule, you will need to use parts we already have in the lab. In addition to the components used in the lab exercises, we have a good selection of other items including sensors (temperature, accelerometer, magnetic, etc.) and mechanical components. See the list at the end of this document. Figuring out and using a new part that you have not used previously in class counts for some of the complexity of your project.

Building and Testing

You will have all class period (beginning at 1:30pm) on the last two days of the term to work on your project. We will try to schedule some additional open lab hours on the following weekend. If it seems like your idea is too complex for the time available, we will work with you to try to whittle it down to something feasible. Your group will be expected to explain and demonstrate your project when done. Each team member should explain the parts of the circuit they designed, describing how it works and why it was designed the way it was. This should be a technical discussion showing a good command of the circuit's operation.

Deliverables

Before the final exam, you must provide a final, legible schematic of your design as built, with all component values labeled. The standard of review is that I should be able to hand the final schematic to an electronic technician to build a working duplicate of your project. An electronics technician can build a circuit from a schematic but cannot make design decisions. Everything must be fully specified on the schematic.

[4] Of course, you do not have to wait until then. You can post your idea on piazza if you want my feedback before then.

Google

The project circuit design is expected to be your own. Just building a project you found in a book or on the Internet without modification is not acceptable. I expect most projects to consist of a combination of familiar circuits we have discussed in class and/or build in lab, modified and interfaced together to meet the project specifications. If you use a circuit from a source other than class discussion or LAoE, you must disclose the source. You should also be warned that many of the circuits you will find in an Internet search are not well designed. In any case, I plan to ask you questions about the operation of the circuits in your design and the values used so just using a circuit you found without understanding it is not a winning strategy.

Grading

Your grade will be based on the quality of your circuit design and of the final schematic. Attention to Thevenin issues, reasonable choice of component value, tolerances, proper understanding and use of components are considerations in good design. Clear and understandable schematic with all component values/part numbers labeled are important in your documentation. A three-person project should be more complex than a two-person project. While a *correct* complex design will receive a higher grade than a simpler one, a poorly designed complex design will do worse than a simpler correct one. I expect your circuit to work – you may want to build and test in stages so you have something to show if you run out of time.

Partial List of sensors available in the lab

Note: quantities may be limited on some components. Let me know if there is a sensor you are interested in using.

- TCRT1000/1010 – IR emitter and phototransistor in a combined package. Could be used to build a photo-plethysmograph
- AD592 – precision temperature sensor (–25°C to +105°C)
- KMZ10B – hall effect sensor (senses magnetic fields) in a bridge configuration
- GP2D120 – distance sensor (4 to 30cm)
- GP2Y0A21YK0F – distance sensor (10 to 80cm)
- Adafruit 1031 – distance sensor (20 – 150cm)
- Parallax 28015 – distance sensor (3cm – 300cm)
- Parallax 28017 – dual-axis accelerometer (duty cycle output)
- Sparkfun ADXL335 – three axis accelerometer (+/-3g)
- Pololu MMA7361LC – three axis accelerometer (+/-1.5g to +/-6g)
- TSL230R – light to frequency converter
- Parallax QTI – light sensor
- Many different *Light Dependent Resistors* (LDRs)
- FlexiForce A101 – force sensor
- Parallax 30054 – Color Sensor using TCS230 sensor
- NE565 Phase Locked Loop
- AD633 – 4-quadrant analog multiplier
- UAF42A – universal active filter
- MF4CN-50 – 4th order switch capacitor low pass filter
- Meas-Spec.com – force sensors
- Analog meters for output (like the ones used in lab 1)

- Various geared and un-geared motors
- Hobby servos (controlled by pulse width)

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