

## ECE 4760: Laboratory 5

### Design project.

#### Introduction.

For this exercise, we want you to pick a project, then design and build it. During this period there will be no other assignments, so we expect you to spend all of your time for this course on the project. As a rough estimate, this means a minimum of 12 hours/week in lab. You will be expected to be in lab at the usual times every week and to show significant progress each week of the project. When choosing a project you will need to consider availability of hardware, time available, a monetary budget, and your programming skill. You may want to look at several of the links on the 4760 home page for project ideas.

#### Grading:

- Grades will be assigned by rank-ordering all projects in all sections, thus you will be competing against everyone in the class for this grade.
- 20% of your project grade depends upon being prepared each week and on the quality, quantity and character of the work done during each week. Each week in lab a one-page progress report may be due.
- 30% depends on the project demonstration at the end of classes.
- 50% will be based on your project writeup. the writeup will be a web page, previewed during the demo, and handed in on the specified university due date.
- The members of a group *may be graded differentially* if it becomes obvious to the staff that team members are not contributing equally.
- There will be a bonus for finishing early. The  $\text{bonus} = \text{round}(2.7 * (\text{floor}(\text{days}) . ^{0.5}))$ . (Table) Note that fractions of days early are eliminated by this function. This bonus is designed to reduce lab congestion during the last week and to reward good design in a real-world fashion. If you intend to finish early, you must demo you web page at the same time.

#### Web pages, social media, and contests

- **You must write a web page and demo the page when you demo your project.**  
This page will serve as a clean draft of the page you must hand in the day of the scheduled final project submission for this class.  
(This day is not specified by the University until the final exam schedule is announced)  
This web page must be **portable in html format** and not linked to a proprietary server (for example <http://www.wix.com/> is unacceptable).
- You must submit your web page for grading ([see below](#)). Failure to follow the submission procedure may result in a lower grade.  
You may optionally opt-in for inclusion of your project on the course page.  
If you will ever be asking me for a recommendation, I suggest that you opt-in your project.  
**In the final report, Appendix A**  
**One of two sentences!**  
**Either: "The group approves this report for inclusion on the course website."**  
**Or: "The group does not approve this report for inclusion on the course website."**

The project web pages help me remember the details of a project and person.

- I will submit student videos to YouTube for inclusion on the [ece4760 channel](#), if you opt-in.
- You might consider submitting your projects to [hackaday](#), [hackedgadgets](#), or other blog sites. I will also do this, *only if you approve the project for web inclusion*.
- I will help any group to try publishing their project in a print magazine.

About [40 student projects](#) have gotten into print, often in [Circuit Cellar Magazine](#).

A few have gotten into the peer-reviewed literature, usually with more work as an independent study.

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### Procedure:

Depends on what you will build. You should talk often to your lab instructor.

### Special project restrictions:

No projectile devices or weapons of any kind will be allowed as projects.

No drug or alcohol related projects will be allowed (except perhaps a breathalyzer or similar device, with appropriate restrictions).

All projects will use a PIC32 architecture.

### Budget considerations:

Your budget will include MCU(s), boards you build, power supplies, parts you order, and everything else you buy.

Hardware you already own *is included* in the budget.

Budget exceptions:

- Vendor samples are not included in the budget. Good places to find samples:
  - [Analog Devices](#)
  - [FreeScale](#)
  - [Maxim](#)
  - [National semiconductor](#)
  - [sensitronics.com](#) has a sample page of thin film force sensors
- Hardware you can scrounge is not included in the budget. Be prepared to explain where it came from.
- Projects which involve research groups or design projects *outside the course* will be considered on a one-by-one basis for budget exceptions.  
This is to encourage collaboration with ongoing projects at Cornell. You must get this exception approved by the instructor.

The instructor will order parts from the following vendors once/week, on Monday at 0800.

- To order a part, you need to email the instructor the EXACT part number as given at the vendor's site  
(the vendor's part number, not the manufacturer part number), the vendor name and the price.
- Parts with typos in the part number will not be ordered.
- Parts which are backordered will not be ordered.
- Parts with a **total** (for the whole project) value/group exceeding \$20 will not be ordered.
- Parts requests arriving after 0800 Monday will be delayed one week.

- [digkey.com](http://digkey.com) Very good inventory and parts search capability. Has linked data sheets.
- [allelectronics.com](http://allelectronics.com) Surplus displays, motors, switches, LEDs
- [adafruit.com](http://adafruit.com) display modules, connectors, breakout boards for SMD, [much more](#)
- [sparkfun.com](http://sparkfun.com) displays, prototyping, RF, sensors, and [more](#)

#### Budget Details:

- The total budget this year will be \$100 per group including the amount you spend, the amount I spend, and the following *rental fees* for the following lab hardware.
- **Penalty for being overbudget:**  $deduct\ points = ((cost - 100) * 0.316)^2$  If  $cost > \$100$
- Costs: *Please note that these costs are for budget calculations only.*  
*No money changes hands.*
  - MicroStickII \$10
  - white board \$6
    - solder board (6 inch) with the same layout as a white board \$2.50
    - small solder board (2 inch) \$1.00
  - each power supply \$5, each 9 volt battery \$2. *We do not stock batteries!*
  - [custom PC board](#) \$5
  - PIC32MX250F128B \$5 **Always use a socket for the MCU**
  - TFT LCD \$10 **Do not not solder this to your project!**
  - Keypad \$6 **Do not not solder this to your project!**
  - LCD TV \$5
  - jumper cables \$0.20 each
  - sip or header socket/plug \$0.05 PER PIN
  - SOIC/SOT23 carriers \$1.00

#### Student observations:

A [group in 2002](#) added the following thoughts.

Here are the top 10 things you can do to survive EE 476 Final Project Month:

1. If you use a chip other than the one you've been using in class all semester, read the documentation thoroughly, subtle differences are going to kill you. It's just a matter of for how long they kill you.
2. If you feel heat from your board, or smell burning: THERE IS A SHORT. Don't look for the short first. TURN OFF THE POWER!
3. If the voltages look right, and the wiring looks right, but nothing's happening, it is possible that your chip is fried, don't be afraid to ask for another chip. This would've saved me a week of pain, and a bad hit to morale.
4. If you're stuck on something, ask Bruce or the TA's. Make a reasonable attempt to solve it yourself, but don't sit there for three hours just because you cannot remember which port of the opamp is correct. Remember, we all look like we're working, so Bruce's spider sense won't kick in. You must call him, he can't call you.
5. Order parts early. Order duplicates if you can afford it.
6. If you're going to solder onto a perf board, you don't have to rip apart your breadboard. Just make another copy of the circuit.
7. You will not finish if you don't start early.
8. You probably won't finish if you don't take advantage of extended lab hours.
9. Do what you can do out of lab out of lab.

10. Seriously, pick a project you'll enjoy. These four weeks can be pain, or the most fulfilling of your Cornell Career.

A [group in 2003](#) added this:

Know your limits. As much as we'd all love to have a final project whose bells and whistles rival Las Vegas slot machines, realize that a month is a very short time, and that dealing with the disappointment of having to scale back your project as you progress along is much better than coming to the same realization on the day of your demonstration.

## Assignment

You will be graded on several aspects of the project:

1. Appropriate level of hardware/software complexity.
2. Appropriate use of microcontroller. At least 50% of work must be done on PIC32 series chips. Arduino libraries will not be allowed.
3. A project which works according to specification (which you will write).
4. Level of effort and organization shown in lab.
5. Ability to stay within budget.
6. A demonstration of the final project to Bruce during the **last regular scheduled lab period of the semester**.

The demonstration will include an explanation of your web page describing the project.

7. Completeness and understandability of the final report.
  1. The final report is a web page which **must be handed in** on the day and time specified for a final project in this course by the University.  
The report must be emailed as described ([see below](#)).
  2. The final report web page draft **must be demonstrated** when you do the project demo **during your last regular lab period**.  
The final report web page will consist of one folder with exactly one html file with the file name `index.html`.  
In the folder there may be c-source files, images, mpegs, or other supporting documents linked to the one html file.  
Style examples: [Pace Clock](#), [wireless EMG](#), [intellibot](#).
  3. **In the final report, Appendix A**  
***One of two sentences!***  
***Either: "The group approves this report for inclusion on the course website."***  
***Or: "The group does not approve this report for inclusion on the course website."***

Documentation must include all the major sections.

You may omit specific subsections not relevant to your project, **except in the conclusions section**, where all subsections must be addressed. All appendices must be included.

Final report outline:

- Near the top of the first page:
  - **project title**
  - **student names** (and optionally netids)
- Introduction
  - One sentence "sound bite" that describes your project.

- A summary of what you did and why.
- High level design:
  - rationale and sources of your project idea
  - background math
  - logical structure
  - hardware/software tradeoffs
  - Relationship of your design to available IEEE, ISO, ANSI, DIN, and other standards.
  - Discuss existing patents, copyrights, and trademarks which are relevant to your project.
- Program/hardware design:
  - program details. Could someone else build this based on what you have written?
  - hardware details. Could someone else build this based on what you have written?
  - Be sure to specifically reference any design or code you used from someone else.
  - Things you tried which did not work
- Results of the design:

This is the section which is most often lacking in student projects. Be specific!  
If you took calibration data, then show it!  
If you have images or video, include it.

  - speed of execution (hesitation, filcker, interactiveness, concurrency)  
Be quantitative. Show graphs!
  - accuracy (numeric, music frequencies, video signal timing, etc)  
Be quantitative. Show graphs!
  - how you enforced safety in the design.
  - interference with other people's designs (e.g. cpu noise, RF interference).
  - usability by you and other people (perhaps with special needs).
- Conclusions:
  - Analyse your design in terms of how the results met your expectations. What might you do differently next time?
  - How did your design conform to the applicable standards?
  - Intellectual property considerations.
    - Did you reuse code or someone else's design?
    - Did you use code in the public domain?
    - Are you reverse-engineering a design? How did you deal with patent/trademark issues.
    - Did you have to sign non-disclosure to get a sample part?
    - Are there patent opportunities for your project?
    - Are there publishing opportunities for your project?
  - Ethical considerations. Referring to the [IEEE Code of Ethics](#), specifically explain how decisions you made or actions you took in this project were consistent with this Code of Ethics. I expect at least 200 words on this topic. A bulleted list will not be acceptable.

- Legal considerations. For instance, if you use a transmitter, you must discuss the appropriate FCC legal restrictions.
- **Appendix A**  
*One of two sentences!*  
**Either: "The group approves this report for inclusion on the course website."  
Or: "The group does not approve this report for inclusion on the course website."**
- Appendix with *commented* program listing
- Appendix with schematics (you can download free software from [expresspcb.com](http://expresspcb.com) to draw schematics)  
A block diagram is *not* a schematic.
- Appendix with cost details with all part numbers, vendors, and their price. This cost will include components as described in the Budget Considerations section.
- Appendix with a list of the *specific tasks* in the project carried out by each team member.
- References you used:
  - Data sheets
  - Vendor sites
  - Code/designs borrowed from others
  - Background sites/paper

**The web page final report must be submitted as described here.**

**Failure to follow this submission procedure may result in a lower grade.**

**Unless you *optionally* opt-in for inclusion on the class web page, your report will not appear on the projects page.**

If you will ever be asking me for a recommendation, I suggest that you opt-in your project. The project web pages help me remember the details of a project.

**In the final report, Appendix A**

***One of two sentences!***

**Either: "The group approves this report for inclusion on the course website."**

**Or: "The group does not approve this report for inclusion on the course website."**

**To submit your report:**

1. Put all of your web page files in one directory.
2. Name this directory with the concatenated netids of **all the group members**, e.g., br14\_bfg88  
Since the pages will be on a UNIX server, you must:
  - Make sure the cases (upper/lower) of all filenames agree with their hyperlinks.  
For instance: `JPG != jpg` in a file name  
NOTE that some picture editors CHANGE the case of the extension when they store an image.
  - Separate folders in a path using foreslashes (/) not backslashes.
  - Use only alphanumeric characters and underscores in filenames (NO SPACES, no punctuation).
  - Check all your links to make sure they are relative to your main page.
  - Use a directory name consisting of the group's concatenated netids.
3. ZIP the directory.

4. email it to **BRL4@cornell.edu**.  
OR if it is too big use *dropbox.cornell.edu*
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