PHYS 235 — Final Projects
Spring 2019

Assignment

Your task is to design and construct an electronic circuit that incorporates both analog and digital elements to perform some "useful" function. You may use an Arduino, but the project should not be a programming project. In addition to demonstrating a working circuit you must also write a manual that describes how to use the circuit and how the circuit works. Your project should be bigger in scope than any individual lab exercise in this course, but a good final project can be based entirely on circuit components that you have already used in lab, and fit on one proto-board. (It's ok to incorporate a few new circuit elements, but I don't want you to be pushing very far beyond principles and components that we have already covered.) Projects are to be completed by teams composed of two students.

The best projects will:

- include some analog and some digital circuit elements;
- include some original design work (that goes beyond copying someone else's schematic diagram);
- be completely understandable by someone who has successfully finished this course.

Schedule

- **April 4: Selection of Teams, Project Title, Initial Proposal**
  This proposal will be discussed with an instructor.

- **April 10: More Formal Proposal**
  This proposal should:

  - State the goal of the project in a few sentences.
  - Give a preliminary circuit diagram (or block diagram with statement of principles).
  - Include a parts list (see spreadsheet template on course web page) that gives:
    * Manufacturer's part name/number, e.g., LM741 op-amp.
    * Vendor where part can be purchased, with vendor-specific part number and price. (For information, use links to vendors on course web pages.)
    * Quantity needed for each part.
    * Total cost of project. (Components in our stock room do not need to be included in total cost, but they should still be specified.)

    It is *essential* to include any speciality parts at this time.

  Part of the grade on your project will be based on your proposal, so put some thought and effort into it. (You will be allowed to deviate from your proposal if, after discussion with the instructors, it is deemed necessary.) The best proposals will be based on something that you are confident that you can achieve, with possibilities for more challenging extensions.

- **April 20/21: A complete circuit diagram**
  This should be a more developed design than that submitted with your initial proposal. It may have some "block" components for standard pieces that you have already constructed in a lab in this course.

- **Construction.**
  You will have the lab periods starting on April 18 to work on your projects. You can also use the lab room at any other time.

- **April 25-29: Circuit Demonstration**
  You will sign up for a time during the last three days of class to demonstrate to an instructor that your circuit works. Manuals must also be submitted by 5:00 p.m. on April 29.

Grading

- **Operation of the circuit.** (10 pts)
  - Does the circuit work?
  - Does the circuit work reliably?
- **Documentation/Manual.** (10 pts)
  - Is the goal of the project clear?
  - Can a user who is totally unfamiliar with the project make the circuit perform its intended function?
  - Does the manual include a functional block diagram?
  - Does the manual include a complete schematic diagram?
  - Does the manual include a diagram that makes the physical layout of components clear (so that it would be possible to debug or repair the circuit)?
  - Can another student in PHYS 235 who is totally unfamiliar with the project understand how the circuit works?
- **Circuit Design & Circuit Construction/Organization.** (10 pts)
  - Is the final circuit design appropriate for the intended function?
  - Was the initial proposal done carefully and developed into a final design in a timely manner?
  - Is the circuit laid out on the proto-board in a clear well thought out manner?
  - Is the wiring neat enough that the circuit could be debugged or modified for other purposes?
- **Degree of Difficulty.**
  This will be multiplicative weighting factor of $1.0 \rightarrow 1.5$ The weighting factor rewards challenging projects whose design, construction, and debugging is more difficult. Carefully consider the difficulty of the project you choose: although choosing a more difficult project will result in a higher weighting factor, such a choice presents the risk of project that doesn't work. The weighting factor will be determined by the project you complete, not the project you propose. A good strategy is to choose a project that has a simple basic core that can be embellished with more difficult additions.

Project Ideas (from previous years)

(This list is perhaps light on projects for which you can use an Arduino.)

- Electronic toy or game (e.g., a reaction time game, dice game, logic game, pong, snake, etc.)
- Transducer based project — device that detects some physical quantity and does something with the measurement. (Digital thermometer with a visible LED scale; differential thermometer which measures temperature differences; automatic plant waterer that detects moisture in soil; pH meter and automated buffer preparer, light-level detector . . .)
- Clock based project — digital alarm clock, sports scoreboard, stop watch or programmable timer.
- Electronic lock
- Sound activated or proximity-activated device
- Capacitance meter with digital readout
- Capacitance touch-dimmer switch for turning on/off an electric lamp or other device
- Stay-awake alarm for cars. Every 30 seconds, the thing beeps. The driver then has to press a button. If the driver fails to push button in 5 seconds or so, it beeps again, but louder. Keeps getting louder until button is pressed.
- A "remote control" composed of a transmitter (using an infrared LED) that sends different sequences of pulses (depending on the button pushed), and a receiver that does different things depending on which button was pressed.
- Quiz-show buzzer system (determines who "buzzed in" first and locks out other buzzers). Maybe include a score-board along with this.
- Traffic light controller. (Perhaps using sensors to detect metal cars, allow for pedestrian crossing, etc.)
- Flashing lights displays (perhaps displaying messages, etc.).
- Function generator (perhaps with a digital display)
- Music-related item: fuzz box, tone generator, cheesy organ, funky audio effects device, metronome.
- Electronic calculator with ability to enter two numbers and perform an operation displaying result.

- Electronic musical instrument.
- Simple optical spectrometer.
- Audio graphical equalizer display.
- Sonar range finder.
- Digital sound recorder.
- Automated tracking system.
- 2-bit Simple Simon Game
- Digital Alarm Clock
- "Quick Draw" Reaction Game
- Electronic Lock with Disabling Mechanism
- Random Number Generator (with bounds checker)
- Break-in Detector with Digitally Recorded Response
- Audio Sound System with Mixer
- LED Optical Writing Tablet
- Incoming Call Detector for Cellular Phones
- "Don't Forget Your Keys" (Ultrasound Proximity Detector)
- Automated Tracking System for Reflected Laser Spot
- Digital Pedometer
- pH Meter and Automated Buffer Preparer
- Electronic Dice