Digital Electronics

PHYS 432 - Spring 2008

http://physics.uoregon.edu/~torrence/432/

Updated Monday March 31, 2008

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Lab Assistant  Sequoia Alba
Lecture  TuTh 2:00-3:20 Willamette 318

Overview

This course will introduce the basic concepts of digital electronics. The emphasis will be on a basic working knowledge of electronics, suitable for experimental research in science. The following topics will be covered:

- binary arithmetic and logic gates
- combinational logic: multiplexers, decoders
- sequential logic: flip-flops, counters
- analog-to-digital (A/D) and D/A conversions
- finite state machines
- programmable logic, microprocessors

Grading

Course grades will be based on six weekly homework assignments (30%), six lab assignments (30%), two exams (10% each), and a final project (20%).

In order to pass the course, you must complete the labs, including the final project!

Syllabus

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This syllabus is tentative, and is subject to change as the quarter progresses.

Lecture Notes

A very nice series of lecture notes for digital electronics was originally written by Prof. Frey. These will also be made available (with some modifications) as a supplemental reference. These may or may not follow exactly the material covered this quarter, but they are a very useful source of information any way.

- **Basic Digital Concepts**
- **Logic Gates and Combinational Logic**
- **Flip-Flops and Introductory Sequential Logic**
- **Counters, Registers, and State Machines**
- **Microprocessors**
- **Analog/Digital Conversion**
- **Counters, Registers, and State Machines II**
- **Memories and Processors**

There is also a detailed article on Memory technologies from ArsTechnica [here](#).

Labs

Lab 'reports' are due on the Monday after labs are assigned. I really want to see proof that you did the lab and understood the material. Neatly organized notes taken during the lab itself, answers to the questions posed in the lab writeup, plus a short summary afterwards in your notebook is perfectly adequate. If you are very sloppy in your notes, you may also turn in a longer printed write up, but please get into the habit of taking neat legible lab notes. Either way, please turn in your lab notebook (legible or not) on Monday by noon. These can be turned in directly to me in my office, or to my mailbox in the physics office.

- **Binary Numbers and Logic**
- **Multiplexers**
- **Flip-Flops**
- **Counters**
- **Programmable Logic**
- **ADCs**
Most of the spec sheets needed for our labs can be found in the directory here. Typically, you only need the pin diagram on the first page, plus perhaps the truth table. Please don’t print out 18 pages unless you really need them. Some of the original TI data sheets can be found here. Search by part number (ie: 7402) Many web sites have online pin diagrams, like here, here, or here (in Korean!). A Google search will turn up many more.

Homework

Homework will typically be assigned Tuesday and due on the following Tuesday at the start of class. I will hand out solutions and potentially discuss the problems on the Tuesday when they are due, so late homework will not be accepted. Many of the homework problems are simply to force you to work through a particular concept ‘by hand’ at least once. The exams will closely follow the homework assignments, so it is worth making sure that you can do all of the homework problems. I reserve the right to not grade every single problem in detail.

- Homework #1
- Homework #2
- Homework #3
- Homework #4
- Homework #5
- Homework #6

Projects

A key part of this class is the opportunity for each student to pursue a term project of their own design. This project should contain some digital component, although you can also be some analog components if desired. Possible project ideas include:

- light-following sensor
- reaction timers/stopwatch
- persistence-of-vision devices
- LED matrix displays
- LCD display interfacing
- phase-locked loops
- mastermind game
- arbitrary function generator
- amplifier with programmable gain
- bus connections
- gated ADC
- stepper motor encoder/driver
- bar code reader
- credit card reader

The web is a great resource for project ideas, please start thinking about your projects early!

Project Proposals

Project proposals are due Monday May 19th at noon. The proposal should include:

- Description of circuit function
- Block diagram of circuit layout
- Part list highlighting non-standard parts
- References
- Fallback solution

You must get your proposal approved by me before you start. If you turn your proposal in early, you will get to start on your project sooner. It is fine to get a project idea from some external source. Please reference this, however, so I can read the original to get a better idea of the project scope. Your proposals will be graded, but essentially just that you turned the proposal in

Project Grading
The final project grade will be based upon the checkout and the write up. You need to schedule an appointment with me to see your project in action before Monday June 9th at 5PM. The write up, which should consist of your lab book development notes, your amended proposal, and a summary of the problems you had and what you would do differently next time, is due by 3FM on Wednesday June 11th in lieu of a final exam. No late reports will be accepted!

The idea, execution, and write up will all be considered in the final project grade. You may feel free to work with another person, but please factorize the problem into identifiable pieces. You need to get this arrangement approved by me in advance.

Project Tools

The following lists some basic items which may make your project more interesting and useful. A somewhat complete list of available parts can be found in the IC List. Additional parts can be found in the electronics shop on campus. Your TA can help you with this. There is the possibility of ordering specific parts for projects, but this must be arranged in advance. Come talk to me if you think you may need something special. Norvac Electronics (on West 11th) or web-based suppliers like All Electronics are good sources if you need to buy something yourself (or even to just get some ideas).

- Clocks - 555 timer chips or 10 MHz crystal oscillators are available.
- ADCs - we have some integrated ADC chips available. You do not have to build your own.
- Memory - we have an assortment of SRAM, EPROM, and EEPROM available. You will have to figure out on your own how to use the EPROM burner (although I can help).
- Programmable Logic - We have lots of 16v8 PLAs available.
- PIC Microcontrollers - We have 8-pin 12F676 and 14-pin 16F676 or 16F684 PICs. The 16-series work fine for 8-bit applications and have a bit more memory. We also have a few older 16F84A devices. These have more IO pins, but don't have many of the built-in features, like ADCs or oscillators.
- Microprocessors - we have several Rabbit 2000 microprocessors. For any relatively complex problem, using a microprocessor is probably the best solution. Information is available downstairs or at Rabbit Semiconductor. This is probably only suitable for somebody with previous programming experience, as you don't really have time to learn C as well as how to use the Rabbits.