Digital Electronics

PHYS 432/532

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

PHYS 432/532 Blackboard Web site

Updated: Tuesday, February 17, 2004

Syllabus | Notes | Labs | Homework | Projects

Labs due Wednesday 2/18 before 5 PM
No class Thursday 2/19
Project proposals due Monday 2/23
Homework due Tuesday 2/24

| Instructor | Prof. Eric Torrence | Willamette 418, 346-4618
|            |                    | torrente@physics.uoregon.edu
|            |                    | Office Hours: Mon. 10-12

| Teaching Assistants | Jeff Kolb | jkolb@darkwing.uoregon.edu
|                    | Jeffrey Early | jeearly@darkwing.uoregon.edu

| Class | UH 10:20-11:30 Willamette 318

| Labs | Lab schedule
|      | Note: An assigned lab time is not required. Students are encouraged to work the labs on their own.

| Textbook | Art of Electronics, 2nd Ed., Horowitz and Hill
|          | Student Manual for A of E, Hayes and Horowitz (optional)
|          | A copy is on reserve in the science library.

Overview

This course will introduce the basic concepts of digital electronics. 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
- state machines, processors, memory, bus connections

The undergrad (PHYS 432) and graduate (PHYS 532) will be taught together with the same assignments, but different grading and expectations. This course emphasizes a basic working knowledge of electronics, suitable for experimental research in science.

Grading

Course grades will be based on weekly homework assignments (20%), lab assignments (25%), one mid-term exam (15%), one final exam (15%), and a final project (25%).

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

Syllabus
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<th>Week</th>
<th>Lecture</th>
<th>Lab Assignment</th>
<th>Notes</th>
<th>Homework (Due Tues.)</th>
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<tr>
<td>1 (Jan 5)</td>
<td>Binary numbers, logic levels, gates</td>
<td>Text 8.01-8.11</td>
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<td>Hwk #1</td>
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<tr>
<td>2 (Jan 12)</td>
<td>Boolean algebra, Karnaugh Maps</td>
<td>Binary Numbers and Logic</td>
<td>Text 8.12-8.15</td>
<td>Hwk #2</td>
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<tr>
<td>3 (Jan 19)</td>
<td>Multiplexers and Decoders</td>
<td>Multiplexers</td>
<td>Text 8.14-8.15</td>
<td>Hwk #3</td>
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<tr>
<td>4 (Jan 26)</td>
<td>Sequential Logic, Flip-Flops, Counters</td>
<td>Flip-Flops</td>
<td>Text 8.16-8.17</td>
<td>Hwk #4</td>
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<tr>
<td>5 (Feb 2)</td>
<td>Midterm Review Midterm Feb 5th</td>
<td>Counters</td>
<td>Text 8.18-8.19</td>
<td>No Hwk!</td>
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<tr>
<td>6 (Feb 9)</td>
<td>Projects A/D conversion</td>
<td>ADCs</td>
<td>Text 9.15-9.26</td>
<td>No Hwk! Read Text...</td>
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<tr>
<td>7 (Feb 16)</td>
<td>Counters and State Machines II No class Feb 19</td>
<td>Finish ADCs (due Feb. 18th)</td>
<td>Text 8.24-8.32</td>
<td>Hwk #5</td>
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<tr>
<td>8 (Feb 23)</td>
<td>Memories</td>
<td>Project Proposals Due 2/23</td>
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<td>9 (Mar 1)</td>
<td>Applications</td>
<td>Project</td>
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<td>10 (Mar 8)</td>
<td>Review</td>
<td>Project Checkout Due 3/12 Report Due 3/15</td>
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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 written by Prof. Frey. These will also be made available (with minor 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 ways.

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

**Labs**

Lab 'reports' are due on the Friday of the week when 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 plus a short (one page written) summary afterwards 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 nct) on Friday by 5PM.

Undergrads should give their notebooks to Jeff Kolb, or put it in his mailbox on the second floor just inside the grad-student lounge. Grad students should drop their notebooks off at my office (preferred), or put them in my mailbox in the physics office.

- Binary Numbers and Logic
- Multiplexers
- Flip-Flops
- Counters
- ADCs
Homework

Homework will typically be due on Tuesday at the start of class. 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 not to grade every single problem in detail.

- Homework #1 (Solutions)
- Homework #2 (Solutions)
- Homework #3 (Solutions)
- Homework #4 (Solutions)
- Homework #5

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 for the 432 students there can be a stronger emphasis on analog electronics if desired. Possible project ideas include:

- self-leveling tilt-meter
- light-following sensor
- reaction timers/stopwatch
- phase-locked loops
- mastermind game
- arbitrary function generator
- amplifier with programmable gain
- bus connections
- stepper motor encoder/driver

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

Project Proposals

Project proposals are due Monday February 23rd at noon. The proposal should include:

- Description of circuit function
- Block diagram of circuit layout
- Part list if 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 Friday March 12th 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 Noon on Monday March 15th.

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.
- 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).
- 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 here [http://www.rabbitsemiconductor.com/]. This is probably only suitable for somebody with previous programming experience.
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Lab Schedule

Updated Tuesday, January 13, 2004

Note: You are encouraged to work on your labs independently whenever you have time. Since there are only a limited number of breadboards, the people who have signed up below have priority during these times.

Tuesday 12:00 - 15:00

TA:

- Anthony Case
- Chunbai Wu
- James Marr
- Sun Lan

Wednesday 9:00 - 12:00

TA:

- Mark Cater
- Daniel Cassell
- Rahmat
- Pengfei Nie

Thursday 12:00 - 15:00

TA:

- Jonathan Baumgardner
- Matthew Buck
- Sandra Penny
- Jason Proett
- Seth Taurininen
- YanLing Zhao

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