PHYS 432: Digital Electronics (Spring 2016)

Instructor: Daniel A. Steck
Office: 277 Willamette     Phone: 346-5313     email: dsteck@uoregon.edu
Office hours: walk-in and by appointment
Teaching Assistants:

| Erik Keever | office: WIL 441 | office hour: TBA | email: ekeever1@uoregon.edu |
| Sudarshan Karki | office: WIL 315 | office hour: TBA | email: skarki@uoregon.edu |

Course home page: [http://atomoptics-nas.uoregon.edu/~dsteck/teaching/16spring/phys432](http://atomoptics-nas.uoregon.edu/~dsteck/teaching/16spring/phys432)

Schedule: TTh 12:00-1:20, 318 Willamette, plus a 3-hour lab section (11 WIL)
Course reference number: 34963
Credits: 4
Prerequisites: PHYS 203 or equivalent; MATH 253; contact me if you have not taken PHYS 431

Links: news, lab sections, textbook, course notes, labs/homework sets and keys.

Course overview

As a scientist, your goals in studying electronics are somewhat different than, say, an electrical engineer studying the same subject. Without delving into too much of the details of how electronic components work, you need to have simple conceptual models that will allow you to understand schematics well enough to troubleshoot a misbehaving instrument, design a simple circuit to filter a signal, or track down and eliminate noise in a lab measurement. Basically, things that will help you do physics in the laboratory. We will study digital electronic components and circuits at this basic level, from basic logic gates to interfacing analog and digital circuits to basic microprocessor operation. We will also cover some of the more realistic features of
digital components that you need to understand to design and work with more precise circuits, as well as the tricks and techniques you need to make circuits work.

See the tentative syllabus below for a preliminary list of topics we will cover.

**Lab:** The whole point of electronics is to put theory to work and make (working!) electronic circuits. Thus, the lab component of the course is critical. The goal of the labs is to give you a functional knowledge of electronics and to get you comfortable working with electronic devices.

You will need to attend one 3-hour lab component most weeks (see syllabus below for schedule). There will be multiple lab sections, and we will arrange these during the first week of class.

You should also obtain a laboratory notebook (i.e., as you would use in a real laboratory), permanently bound with quad-ruled pages (like this). This is the primary record of your lab work, and you should record all your notes and measurements in this book.

**Texts:** There is no required textbook to purchase for this course. The main reference for this course will be online notes posted [here](#). Another good, free reference is a set of notes by Ray Frey, posted [here](#).

There are a few books that are good introductions to electronics, and you might consider picking up one or more of these:

- Barnaal, *Digital Electronics for Scientific Application* is good and readable, and appropriate for the level of this class. Cheap, used copies are widely available.
- Horowitz and Hill, *The Art of Electronics*, 2nd ed. This is the bible for scientific electronics, and any experimental physicist who works with electronics has a copy. It is a more difficult book, but excellent as a cookbook for designing circuits. The 3rd edition is coming out soon, so you may want to hold off on purchasing it unless you can find a cheap copy.
- Moore, Davis, Coplan, and Greer, *Building Scientific Apparatus* is not exclusively about electronics, but is also a bible for experimental physics, and covers everything from glassblowing to vacuum to electronics. This book covers a fair amount of electronics, but the coverage of digital electronics is more limited.

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**Grades**

Grades for the course will be based on homework, two mid-term exams, and a final exam. The relative weights will be as follows:

- Homework: 20%
- Mid-term exam 1: 10%
- Mid-term exam 2: 15%
Final exam: 20%
Labs: 35%

**Homework:** will be assigned weekly and each assignment will be due in class one week after it is assigned. Thereafter, late homework will be accepted, but at a 25% penalty for each 24 hour period it is turned in late. Partial assignments may be turned in, and only the late portion will be penalized.

**Mid-term exam 1:** in class, Thursday, April 21.

**Mid-term exam 2:** in class, Thursday, May 19.

**Final exam:** The final exam will be held Tuesday, June 7, 8:00-10:00 am, in 318 Willamette.

**Labs:** There are 7 total lab projects. For each lab, you should turn in a brief report on your work. This is not the same as what you record in your lab notebook. The report should summarize the work you did in the lab. Provide headings for your entries that correspond to the sections in the lab instructions. Clearly indicate the location of required material in your report. Note any unusual or unexpected results. You should turn in your reports in the box in room 11 at least 48 hours before your next lab meeting.

**Pass/fail grading option:** a passing grade requires the equivalent of a C- grade on all coursework (homework, labs, and exams).

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**Syllabus**

<table>
<thead>
<tr>
<th>Tuesday</th>
<th>Thursday</th>
<th>Lab</th>
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<tbody>
<tr>
<td>29 March Binary and Logic Gates</td>
<td>31 March Boolean Algebra</td>
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<tr>
<td>5 April Karnaugh Maps</td>
<td>7 April Implementing Logic Gates</td>
<td>Lab 1 Binary Numbers and Logic</td>
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<tr>
<td>12 April Multiplexers</td>
<td>14 April Flip-Flops</td>
<td>Lab 2 Decoding, Multiplexing, and Sequencing</td>
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<td>19 April Counters/Registers</td>
<td>21 April Midterm Exam 1</td>
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<td>26 April State Machines</td>
<td>28 April Comparators</td>
<td>Lab 3 Flip-Flops</td>
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<td>Date</td>
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<td>3 May</td>
<td>555 Oscillators</td>
<td>5 May</td>
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<td>10 May</td>
<td>Analog-to-Digital Conversion</td>
<td>12 May</td>
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<td>17 May</td>
<td>Phase-Locked Loop</td>
<td>19 May</td>
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<td>24 May</td>
<td><strong>No Class:</strong> Memorial Day</td>
<td>26 May</td>
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<tr>
<td>31 May</td>
<td>State Machines with Memory</td>
<td>2 June</td>
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**Other important dates:**
- Last day to drop without a W: 4 April
- Last day to register: 6 April
- Last day to withdraw: 15 May