PHYS 431: Analog Electronics (Winter 2015)

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

- **Jonathan Mackrory**  
  office: WIL 272  
  office hour: TBA  
  email: mackrory@uoregon.edu

- **Rudy Resch**  
  office: WIL 76  
  office hour: TBA  
  email: rresch@uoregon.edu

Course home page: [http://atomoptics.uoregon.edu/~dsteck/teaching/15winter/phys431](http://atomoptics.uoregon.edu/~dsteck/teaching/15winter/phys431)

Schedule: TTh 12:00-1:20, 318 Willamette, plus a 3-hour lab section (11 WIL)

Course reference number: 24991

Credits: 4

Prerequisites: PHYS 203 or equivalent; knowledge of complex numbers; MATH 256

Links: news, lab sections, 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 electronic components and
circuits at this basic level, and cover some of the more “realistic” features of 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 Ray Frey’s notes posted here.

I will also post course notes on this site as the term progresses.

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

- Barnaal, *Analog 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 rumored to be 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.

---

**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, January 29.

**Mid-term exam 2:** in class, Thursday, February 26.

**Final exam:** The final exam will be held Monday, March 16, 12:30-2:30 pm, 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 the next lab session (or the final exam, in the case of the last lab).

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

---

### Computer access

Some of the homework will require access to a computer for basic calculations (in low-level languages such as C or Fortran, or any of several higher-level packages such as Mathematica, Maple, Matlab, Octave, Mathcad, etc.) and basic plotting (e.g., GNUplot, Excel, etc.). I will use Mathematica for examples because of its availability at UO, but it is not necessarily the best choice for any particular problem. Contact the instructor as soon as possible if you do not already have access to such resources.

### Syllabus

<table>
<thead>
<tr>
<th>Tuesday</th>
<th>Thursday</th>
<th>Lab</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 January Resistors and Networks</td>
<td>8 January Capacitors and Inductors</td>
<td></td>
</tr>
<tr>
<td>Date</td>
<td>Topic</td>
<td>Lab</td>
</tr>
<tr>
<td>------------</td>
<td>---------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>13 January</td>
<td>Complex Impedance</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Resonant Circuits</td>
<td><strong>Lab 1</strong> Linear Components</td>
</tr>
<tr>
<td>20 January</td>
<td>Diodes</td>
<td></td>
</tr>
<tr>
<td>22 January</td>
<td>Bipolar Transistors</td>
<td><strong>Lab 2</strong> Diodes</td>
</tr>
<tr>
<td>27 January</td>
<td>More Transistors</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Midterm Exam 1</strong></td>
<td></td>
</tr>
<tr>
<td>3 February</td>
<td>Differential Amplifiers</td>
<td><strong>Lab 3</strong> Transistor Basics</td>
</tr>
<tr>
<td>5 February</td>
<td>Transistor Details</td>
<td></td>
</tr>
<tr>
<td>10 February</td>
<td>FETs</td>
<td></td>
</tr>
<tr>
<td>12 February</td>
<td>Op-Amp Basics</td>
<td><strong>Lab 4</strong> Transistor Circuits</td>
</tr>
<tr>
<td>17 February</td>
<td>Integrators, Differentiators</td>
<td></td>
</tr>
<tr>
<td>19 February</td>
<td>Instrumentation Amps</td>
<td><strong>Lab 5</strong> JFET Circuits</td>
</tr>
<tr>
<td>24 February</td>
<td>Op-Amp Bias and Power</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Midterm Exam 2</strong></td>
<td></td>
</tr>
<tr>
<td>3 March</td>
<td>Op-Amp Gain</td>
<td></td>
</tr>
<tr>
<td>5 March</td>
<td>Bandwidth, Slew, Stability</td>
<td><strong>Lab 6</strong> Introduction to Op-Amps</td>
</tr>
<tr>
<td>10 March</td>
<td>Comparators, Oscillators</td>
<td></td>
</tr>
<tr>
<td>12 March</td>
<td>PID Control</td>
<td><strong>Lab 7</strong> Op-Amp Circuits</td>
</tr>
</tbody>
</table>

**Other important dates:**
- Last day to drop without a W: 12 January
- Last day to register: 14 January
- Last day to withdraw: 22 February