Electronics for Scientists - Spring 2020 - Syllabus
Prof. Haas, NYU Physics - andy.haas@nyu.edu
Class / lab: Mondays 12:30-4:30pm, Meyer 221
Office hours: Thursdays 9am-11am, 726 Broadway, Room 858

Introduction to basic analog and digital electronics used in physics experiments. Topics include DC and AC circuits, filters, power supplies, transistors, operational amplifiers, analog to digital converters, and digital logic.

This is primarily a lab class, but lectures will also be given at the start of each lab to introduce the relevant material. One hands-on exercise will be done each week. You'll also have access to your setup throughout the week should you need more time to work on it.

The course is suitable for an intermediate or advanced undergraduate, or graduate student, with a science focus. No prior knowledge of electronics beyond introductory physics concepts is assumed. Mostly just high-school level math is needed, but some complex notation will be used.

Work / grading:

A written report will be handed in each week explaining the circuit developed, showing how it operates in real life (with attached plots, oscilloscope screenshots, etc.), and answering the questions asked in the book. It is due *one week after the start of the lab*, by the start of class, by emailing a pdf of your report to me. Students work in pairs (with a partner) on each lab experiment, but *write their own individual reports*. It is graded from 0-10 points. 1 point is deducted each week it's late. The lowest grade is dropped. These are in total worth 65% of the final grade. A final project of the students' choosing, with its own written report, is worth 25% of the final grade. A final in-class presentation, about either the final project or one of the weekly experiments, is worth 10% of the final grade.

Books:

- Learning the Art of Electronics: A Hands-On Lab Course, by Hayes and Horowitz
We mainly follow this book, but it references the one below (Readings in AoE) in nearly every chapter, for additional material.
- The Art of Electronics, 3rd edition, by Horowitz and Hill
- Bonus (new!): The Art of Electronics: The X Chapters, by Horowitz and Hill
- Exploring Arduino, 1st Edition, by Jeremy Blum
- Programming FPGAs: Getting Started with Verilog, 1st Edition, by Simon Monk
- Make Your Own PCBs with EAGLE, by Simon Monk

Notes: https://www.evernote.com/l/ADHfo88KC5xF9JiggM2Ghw6hmoFjp1DHhKc/

Website: https://physics.nyu.edu/~physlab/Electronics/electronics.html

Schedule:

Date	Topics / reading / lab
Jan 27	DC circuits, resistors, schematics, power, breadboards, electrical tools and measurements Reading / Lab: **1N AoE:Appendix B, O / 1L and simulations** [1]

Feb 3	AC and other time-dependent circuits, capacitors, inductors, impedance, decoupling, complex frequency analysis Reading / Lab: **2N / 2L**
Feb 10	Diodes, transformers, inductors, unregulated DC power Reading / Lab: **3N / 3L**
Feb 24	Transistors Reading / Lab: **4N 5N / 4L (and 5L if time)**
Mar 2	Op amps Reading / Lab: **6N 7N 9N / 6L.1-6 7L.3-4 (and 9L.1 if time)**
Mar 9	Voltage regulation, digital signals, transmission lines / scope use Reading / Lab: **11N Appendix C, AoE:12.1-3,10 / 11L and Digital Signals Lab** [2]
Mar 23	Arduinos, ADCs, serial interfaces, LEDS, DACs, sensors, motors Reading / Lab: **AoE:14.7,15.8-10, E.A.:1-4,6,8,9 / Arduino Lab** [3]
Mar 30	Digital logic and FPGAs Reading / Lab: **14N, P.FPGAs: 1-4,9 / FPGA Lab** [4]
Apr 6	Project work / **Design, breadboarding, schematics, component selection and ordering** [5]
Apr 13	Project work / **PCB layout, GND plane, routing, and ordering** [6]
Apr 20	Project work / **Get components, more breadboarding**
Apr 27	Project work / **Get PCBs, soldering, testing**
May 4	Project work / **Documentation**
May 11	Presentations

1) Use an online circuit simulator, such as https://www.falstad.com/circuit/.

2) Digital Signals Lab: Input an analog signal to a comparator and output driver, use a scope to accurately probe the fast digital signal (at the near end), send the signal down a long cable, and probe the signal at the far end and recover the signal.

3) Arduino Lab: Use an Arduino Uno to read an analog voltage, react by moving a motor, and interact using a serial connection with a computer.

4) FPGA Lab: Use an Elbert V2 FPGA development board to read digital signals, perform simple logic, and output results via output pins, 7-segment display, and VGA.

5) For final project schematics, PCB layout, and routing, we'll use Eagle software.

6) PCBs ordered from JLCPCB. Components bought from Mouser, or LCSC.