PHYS 483/683 Practical Electronics for Physicists
T,TH 1:00-2:15pm, BPB 123

Prerequisite: PHYS 181 or BS in Science or Engineering

This course will cover concepts in electronics and their practical implementation. Approximately half the time will be spent in the electronics shop conducting hands on exercises.

The course will start with the proper use of electronic test equipment (current limited power supply, Volt/Ohm/Amp meter, function generator, oscilloscope, etc). There will be a brief overview of the different kinds of resistors, capacitors, and inductors available (temperature stability, frequency response, etc).

You'll learn how transformers, rectifiers, and voltage regulators work and to read component datasheets. You'll learn to calculate power dissipation, estimate the temperature rise of components, and add heat sinks when needed. You'll then design and build a power supply (120VAC to 12VDC). We'll also discuss the benefits and drawbacks of using switching supplies and DC/DC converters (newer and usually more efficient power supplies).

You'll learn to design circuits with op-amps and understand many common amplifier configurations (difference amp, summing amp, current to voltage converter, integrator, and differentiator). You'll learn how to set the gain and frequency response of the amplifier. You'll learn how comparators and LED's work. You'll learn to use FET's & BJT's as switches to control large currents and to turn on relays. You'll use this knowledge to design and build a temperature controller (i.e. a circuit to turn on & off a heater such that the temperature stays near the set-point).

We'll cover the basics of digital logic and look at some commonly used digital IC's. You'll build an oscillator and pulse generator and learn how to control the frequency and pulse width. You'll learn what a Flip-Flop is and how counters work. Throughout the semester we'll have discussions and demonstrations covering shielding, EMI reduction, impedance matching, photodiodes, photomultiplier tubes (PMT's), thermal noise, etc. At the end of the semester you'll learn to solder. You'll practice by soldering the components from one or more of your circuits (hopefully your own design) onto perfboard or a printed circuit board.

For more information contact:
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Please see this link for select, useful information for students (from UNLV administration):
https://www.unlv.edu/sites/default/files/page_files/27/SyllabiContent-MinimumCriteria-2018-2019.pdf

Rough timeline:

3 days: Learn to use the power supply, DVM, function generator, and Oscilloscope
Overview of the different kind of resistors, capacitors & inductors available
(Quick review of voltage, current, voltmeter, & ammeter)
3 days: Build a relay driver circuit on a breadboard (control lamp or motor)
(Build driver circuit on right side of breadboard (leave room for comparator etc).
Learn about power transistors, SCR's, FET's, heatsinks & power dissipation, flyback diode
Learn to read a datasheets (use SSR or relay for AC, BJT or FET for DC)
2 days: Build comparator circuit to trigger relay if voltage below some value (hysteresis)
4 days: Build 12V power supply with linear voltage regulators
Learn about linear and switching supplies, rectification, filtering, & capacitor placement
(transformers, rectifiers, capacitors, ripple vs. load)
Floating vs. Grounding, Floating limits before arcing
1 day: Midterm exam
4 days: Build amplifiers using op-amps (adjustable gain, current to voltage – photodiode input)
Learn to read an op-amp and photodiode data sheet (overview of PMT's)
(light sensitivity, speed, wavelength dependency, darknoise, temperature dependence etc)
2 days: Add filtering and inputs (frequency selection, microphone & photodiode inputs)
4 days: Build a few digital circuits (oscillator, counter, and pulse generator)
Learn low-noise techniques (shielding, decoupling, board layout, etc.)
3 days: Learn high-speed techniques (impedance matching, termination, ground loops, etc.)
Learn to read a digital IC data sheet
2 days: Solder circuit (point to point on perfboard or a PCB)
1 day: Final exam (comprehensive, about 2/3 new & 1/3 old)

Grading:

10% Homework
10% Quizzes
20% Designing, building, and demonstrating working circuits in the lab
30% Midterm
30% Final

27 days + 2 tests

Normally about an hour is spent after the scheduled end of class building & testing circuits in the lab. If you can't stay after class you'll need to schedule time to build and debug circuits and demonstrate it works.

Please review and bring relevant material from the PHYS483 web site to class (circuit explanations, schematics, pin configuration for IC's, etc). This will help when breadboarding and debugging circuits.

A good reference is "**Practical Electronics for Inventors, Fourth Edition, by Paul Scherz and Simon Monk**". It covers some subject mater covered in class. It also covers topics in more detail and has more examples. Note: The book is **not required** but may help when working on your own.