Phys 475: Electronics for Physicists

Fall semester 2024

Instructor: Prof. Peter Lewis (peter.mandeville.lewis@hawaii.edu)

Classroom/lab: WAT 415A

Class hours: Tuesdays 1:30-4:50pm [lecture+lab]
Thursdays 1:30-3:20pm [lecture]

Office hours: The Tuesday labs will provide ample opportunity for informal discussion. Additional office hours available by appointment (typically MWF mornings).

Prerequisites: PHYS 272L and at least junior standing, or permission of instructor.

Textbook: Schultz: *Grob's basic electronics*
(optional electronics Bible) Horowitz and Hill: *The Art of Electronics*
(scientific writing guide) Mack: *How to Write a Good Scientific Paper*
(general writing guide) Pinker: *The Sense of Style*

Homework: Assigned Tuesday, due the following Tuesday at 1:30pm. *No late homework will be accepted*.

Grading: Grades will be based on a curve derived from a total score composed of:

1. [20%] Homework
2. [20%] Midterm
3. [30%] Formal lab reports (for 5 labs of your choice)
4. [30%] Final project (individual electronics project; 20% for formal written report and 10% for oral presentation)

Writing intensive: This is a writing-intensive course. We will have two workshop sessions during lecture hours on scientific writing, and a major portion of your grade will come from formal written reports. You must adequately **complete all writing assignments** to pass the course with a D grade or better. Students who do not complete all writing assignments will receive a D– or an F grade, and will not earn W Focus credit.

You will write five formal lab reports (minimum 500 words each) covering weekly labs of your choice. These reports are expected to be in the format of scientific publications. Your lab report grade will partially reflect the quality of the writing, including structure, grammar, clarity, and coherence. You may submit **single drafts of the first two reports** for feedback on the writing prior to submitting the reports for grading.

You will select a final project to be completed during the last weeks of the course. You will present your project in a 10-minute talk in the format of a scientific conference talk and submit a formal report (minimum 2000 words). You can submit a **single draft** of the final report **by Dec 12** for ungraded feedback on the writing.

Course goals: Investigation of Kirchoff's Laws, electromagnetic circuit theory, Fourier analysis and stability theory with circuits. Applications to physical measurements are stressed.

Learning outcomes:

1. Be able to use basic physical principles, such as conservation of charge and energy, to analyze basic electronic circuits.

2. Be able to estimate power, frequency, gain, and noise limits under various conditions relevant to experimental scientific measurements.

3. Be able to analyze new electronic circuits and develop a systematic approach to reducing complex circuitry to its simple and comprehensible constituents.

4. Be able to design simple circuits to perform useful laboratory functions, such as signal amplification, frequency-of-interest filtering, and automatic data logging.

5. Be able to demonstrate mastery of fundamental course information through construction and presentation of a final student project.

6. Be able to write accurate, precise, clear, and concise reports in the scientific style, in accordance with the writing-intensive focus of the course.

Wk	Date	Lecture	Lab	Reading
1	Aug 27 Aug 29	Overview. V, I, R. **Writing workshop I**	**LAB1**: Intro/DC circuits	Intro, Chap 1-12
2	Sept 3 Sept 5	AC Circuits. Time/frequency domains.	**LAB2**: Capacitors	Ch. 13-26
3	Sept 10 Sept 12	Diodes	**LAB3**: Diode circuits	Ch. 27
4	Sept 17 Sept 19	Transistors	**LAB4**: Transistors	Ch. 28-29
5	Sept 24 Sept 26	Field Effect Transistors	**LAB5**: FETs	Ch. 30-31
6	Oct 1 Oct 3	Operational Amplifiers I	**LAB6**: OpAmps I	Ch. 33
7	Oct 8 Oct 10	Operational Amplifiers II	**LAB7**: OpAmps II	Ch. 33
8	Oct 15 **Oct 17**	Comparators **Midterm**	**LAB8**: Comparators	Review
9	Oct 22 Oct 24	Amux, 555 timer, digital logic I	**LAB9**: Logical gates	Class notes
10	Oct 29 Oct 31	Digital logic II, flip-flops	**LAB10**: Flip-flops	Class notes
11	~~Nov 5~~ Nov 7	Digital building-blocks		Class notes
12	Nov 12 Nov 14	Computers Intro to programmable logic	**LAB11**: Counters and Timers	Class notes
13	Nov 19 Nov 21	FW2 & Analog → Digital FW3 & Digital → Analog	**LAB12**: PYNQ Z2 counters/timers	Class notes
14	Nov 26 ~~Nov 28~~	**Writing workshop II**	**LAB13**: PYNQ Z2 exercises	Class notes
15	Dec 3 **Dec 5**	Student project work **Design review**	Student project work	
16	Dec 10 Dec 12 **Dec 13**	Student project work Deadline to submit report draft **Final presentations** (*to be confirmed…*)	Student project work	
17	**Dec 18**	**Project reports due 5pm**		