Course Information

Physics 127B Winter 2024

1 About Your Instructor

I grew up in West Lafayette, Indiana, home of Purdue University. I decided to become a physicist when I was fourteen years old, and in 1991 I graduated with a bachelor's degree in physics from the University of Chicago. By that point I was tired of the midwest, so I set out for the University of California, Berkeley, where I received my Ph.D., also in physics, in 1998. I did five years of postdoctoral research at the National Institutes of Health in Bethesda, Maryland and taught at George Washington University before joining the physics faculty here at UCSB in July 2003.

My research involves using very sensitive light detection to study the assembly and behavior of single biological molecules.

2 Contacting Your Instructor

The best ways to reach me this quarter are by email and at my office hours.

I will try to answer all email questions within no more than one day. The address you should use is `lipm1@elo.physics.ucsb.edu` . **Please use the following subject line:**

`Subject: 127B - question`

This will help me to spot important messages from you as I delete hundreds of unimportant messages from elsewhere at UCSB.

My office hours will be Tuesdays from 12:15–1:30 P.M. in Broida 2409.

3 Graduate Student Instructors

The physics graduate students here at UCSB are some of the best in the world. Not only are your TAs brilliant, they are eager to help you learn.

Your TAs will hold lab sessions and office hours, during which you can ask questions about the course material. Details about these sessions and contact information for your TAs can be found on the

4 Course Web Page

The course web page is located here:

http://web.physics.ucsb.edu/~phys127B/lipman/

All announcements, lecture videos, homework, and other course information will be posted there. **I will assume that everyone has read announcements on the web page two days after I post them, so please check frequently to keep yourself well-informed.**

5 Textbook

Information about the textbook you need to have for the course can be found here:

http://web.physics.ucsb.edu/~phys127B/lipman/materials.html

6 Lecture

Physics 127BL is a 4-unit lab class with 5 hours of supervised lab time per week, so lectures are not the main focus, but will be given to supplement the material you learn from reading assignments and in lab. We will have one lecture most weeks, from 12:30–1:45 P.M. on Thursdays in Broida 5223.

7 Course Components

- **Lab reports — 80% of course grade.**
  We will do one required lab each week. You must complete all of the labs to pass the class. Lab instructions and due dates will be posted on the course web page. Guidelines for preparing and submitting lab reports and homework are in a handout that is also on the course web page.

- **Homework — 20% of course grade.**
  We will have four homework assignments during the quarter, intended to reinforce the material we will be covering in the reading assignments and the lab. Homework assignments will be posted on the course web page.

- **Lab attendance.**
  You are expected to be present for the first hour of each lab session so your TA can provide you with background information, detailed instructions for using the equipment, and demonstrations of the experiments. Attendance will be taken. You are allowed two unexcused lab absences, after which you will be penalized one letter grade increment for each additional absence. **If you have any symptoms of illness at all, email the instructor in advance and you will be excused from in-person lab.** Please don't risk infecting others by showing up if you don't feel well. The instructors will make sure you have the opportunity to do the lab work even if you cannot come in.

8 Course Grade

Your course grade will be based on your percentage score, computed using the weights listed above. I will determine grade cutoffs based on my expectations for your mastery of the course

material, historical performance of students in this class, and whether the grading was unusually lenient or harsh.

Often just after the end of a quarter, someone writes to me asking if there is any way they can do extra work to raise their grade. **Under no circumstances will there be any opportunity to raise your grade after the last assignment is turned in.** If you want to get a good grade, start working early and set aside the necessary time to learn the material and work on your experiments, reports, reading, and homework.

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9 Course Content

Here is a summary of what I intend to cover this quarter, subject to change. Please see the course web page for the most up-to-date information.

Horowitz & Hill is *The Art of Electronics, third edition* by Paul Horowitz and Winfield Hill.

Week	Topics	Reading
1.	Topics: basic logic gates, truth tables Lab 1: Quartus test drive	Horowitz & Hill: 10.1 & 10.3
2.	Topics: binary and hexadecimal math, combinational logic Lab 2: Discrete combinational logic	None
3.	Lab 3: FPGA gates, adder, multiplier	Horowitz & Hill: 10.2.4
4.	Topics: digital feedback and flip-flops Lab 4: Discrete sequential logic	Horowitz & Hill: 10.4.1–10.4.4
5.	Topic: sequential logic Lab 5: Counters	Horowitz & Hill: 10.5.1–10.5.3
6.	Lab 6: State machine and stopwatch	None
7.	Lab 7: Digital to Analog Conversion	Horowitz & Hill: 13.1.1, 13.2.1–2, 13.5–6
8.	Lab 8: Function generator and ROM	None
9.	Lab 9: RS-232 interface	Horowitz & Hill: 12.10.4
10.	Lab 10: Music player	None

10 Course Policy

- Requests for due date extensions will be considered on an individual basis, and will only be granted in the case of serious illness, death in the family, or unavoidable circumstances of similar severity.
- Academic dishonesty will be dealt with severely. Among the prohibited activities are:
  - Turning in code, solutions, or reports you did not write. Students shown to have cheated will receive a grade of "0" for the relevant assignment. Turning in solutions you found on the Internet is cheating. It also short-circuits your learning, which in the long run is more damaging.
  - Attempting to misuse any course-related computer system.
  - Tampering with another student's coursework or equipment.
  - Making false claims of lost and/or ungraded coursework.
  - **Distributing assignments or your solutions to others in any way.**

  NOTE: You are encouraged to discuss the coursework with other students in the class, but be sure to write your own solutions and 100% of the reports you turn in!

11 DSP Accommodations

I am committed to providing every student the opportunity to fully participate in this class, and reasonable accommodations will be granted to students with disabilities. I am also committed to ensuring that all students are held to the same standards, and I will not grant requests for *unreasonable* accommodations or exceptions to course policy. If I feel that a particular accommodation is unreasonable or fundamentally alters what you are required to do for the course, I will contest it. All requests for accommodation must be submitted to the DSP office, according to their procedures, well in advance of when the accommodation is needed.

12 Why Bother?

When I was growing up, a telephone was a simple device with a primitive carbon microphone and electromechanical bell that hung on the wall. It dialed by sending a series of pulses as cams on a spring-loaded rotary dial, turning at a speed regulated by a centrifugal governor, opened and closed a pair of metal contacts. Today you carry in your pocket a phone containing several *billion* CMOS transistors, with more computing power than one got from a $10 million supercomputer the year I graduated from high school. Even a toaster or toothbrush may contain a microcontroller with hundreds of thousands of transistors. The revolution in digital electronics and computing, which seems likely to bring about more profound change than even the printing press, now touches almost every aspect of modern life.

The basic idea of digital electronics, which is as relevant to physics as to any other field, is that we can transform physical quantities via analog sensors into numbers. Then with digital computers we can process this information in any way imaginable, transforming it with actuators

back to physical quantities if we desire. In other words, digital electronics transforms physical problems into math problems.

In this course you will learn the nuts and bolts of how the analog world you have already studied is connected to the computing world. You will see how simple digital functions can be combined to produce a variety of complex devices that are the building blocks of general purpose computers. Along the way, you will learn how to use a field programmable gate array, a powerful device that enables every aspect of modern digital design.

A deep understanding of digital electronics will make you a more powerful physicist, and will immensely increase your ability and value to employers no matter what technical field you choose to pursue.