Digital Electronics

**PHYS 432 - Spring 2020**

[http://pages.uoregon.edu/torrence/432/](http://pages.uoregon.edu/torrence/432/)

Updated Monday April 13, 2020

*Home | Syllabus | Lecture Notes | Labs | Arduino | Data Sheets | Homework | Projects | Canvas*

*HWK 2 is posted  
Lab 1 is posted  
HWK 3 is posted*

**Instructor**  
Prof. Eric Torrence  
Willamette 418, 346-4618  
torrence (at) uoregon  
Office Hours: F 1-3 or by appt.

**Lab Assistant**  
Rich Moraski

**Lecture**  
MW 2:00-3:50 Remote Only

**Labs**  
[Lab schedule](#)
Note: In person labs will not work. I am developing some alternatives.

**Textbook**

*Analog and Digital Electronics, Steck ([downloadable PDF](#))*

*Art of Electronics, 3rd Ed., Horowitz and Hill (not required)*

*Student Manual for A of E, Hayes and Horowitz (not required)*

A copy of each is on reserve in the **Science Library**.

**Overview**

This course will introduce the basic concepts of digital electronics. The emphasis will be on a basic working knowledge of electronics, suitable for experimental research in science. Due to the necessity of running this class remotely, I will need to rethink some aspects of the standard curriculum, particularly the labs. This page will be updated when that is completed.

The following topics will be covered:

- binary arithmetic and logic gates
- combinational logic: multiplexers, decoders
- sequential logic: flip-flops, counters
- analog-to-digital (A/D) and D/A conversions
- finite state machines
- programmable logic
- microprocessors

**Grading**

Course grades will be based on weekly homework assignments (25%), lab assignments (25%), two exams (20% each), and a final project (10%).

The grading scheme above may change depending upon how the various parts of this class have translated to remote instruction!

**Syllabus**

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This syllabus is highly tentative, and is subject to change as the quarter progresses.

**Virtual Lecture**

We will not be able to meet in person for this class. Instead I plan to record about an hour of material for each day (that I otherwise would have put into the lecture) broken up into several shorter video files. These will be uploaded to Canvas and will be numbered by day and segment. You should go through these videos before the nominal lecture time for that day. Most segments will give you a couple of tasks to complete on your own at the end. Please try to work through these tasks.

We will also meet interactively during our usual lecture time for about an hour. I will not repeat the information that was recorded, but I will probably go through some of the assigned tasks, answer any questions, and possibly follow up on some of these topics as warranted. For you to get something out of this, it is important to watch the recorded material for that day before our video meeting.

I will use Zoom to facilitate this meeting. There will be a single Zoom meeting for all of the activity for this class. This will include the virtual lectures, office hours, lab meetings, and so on. Connection details are posted to Canvas. Since most of your classes will likely be using this, I anticipate you will become very familiar with Zoom over the course of this quarter!

**Lecture Notes and other Resources**

There is no required textbook for this course. Our primary resource will be a virtual text written by Prof. Steck that is a downloadable PDF. These notes more than cover the topics we will discuss in the first half of the course.

There is an excellent set of online tutorials available [here](#). These are linked in the syllabus above, and each link gives several individual topics that are well aligned to the
topics we cover in the first half of the course. If you are looking for more information, I would strongly encourage you to read through these articles.

The canonical text for learning electronics as a Physics major is The Art of Electronics by Horowitz and Hill. AoE is a problematic book for undergraduates, as it contains far too much information. In many ways it is more of a reference than a textbook, and in fact you will find that most experimental physicists have a copy on their bookshelf. No other book that I know of, however, contains as much useful and practical information, and being able to pick it up and find what you need is a skill which any experimentalist should have. If you think you will be doing any kind of electronics work in the future, I would encourage you to follow along by doing some supplementary readings in AoE.

Before Prof. Steck wrote his tome, a more bare-bones set of notes was developed by Prof. Frey. These contain the key information you really need to understand, and may be another good resource (particularly for studying for exams). These notes cover rather closely the material we go over in class, without much additional material.

- Basic Digital Concepts
- Logic Gates and Combinational Logic
- Flip-Flops and Introductory Sequential Logic
- Counters, Registers, and State Machines
- Microprocessors
- Analog/Digital Conversion
- Counters, Registers, and State Machines II
- Memories and Processors

If you are having trouble accessing the notes, try going directly to the notes directory. Download the PDF files directly and open using a PDF viewer.

Finally, I should mention that another really good companion to AoE is the Student Manual for A of E by Hayes and Horowitz. This book is essentially the notes (and labs) for the Harvard electronics course taught by Prof. Hayes which has been published to supplement the deficiencies in AoE. Hayes really stresses an intuitive understanding of electronics, and the Student Manual contains a bare minimum of math, but lots of helpful discussion of practical circuits.

For the second part of the course (after the second midterm) I will be giving you an introduction to Arduino programming with an emphasis on interfacing. I don't yet have a good set of documentation for this, but I will collect some online links before we get to that part of the course.

Labs
More details can be found on the Lab Page.

I have decided to continue a lab component to this course. Each week (starting in week 2) there will be a lab assignment due the following Wednesday. These assignments will vary. In a few instances, I will post a recording of me doing the lab myself, and you will be required to do a typical lab summary report just as if you had done the lab yourself. Since this seems rather unsatisfactory, I am also going to send each of you a lab kit, and with this kit you will be able to do most of the labs yourself at home. In digital electronics, this is actually easier than you might think, but this approach is very much an experiment, and we may need to adapt.

To facilitate a feeling of normalcy, and to provide a way to get help if needed, I intend to have virtual lab sections when our TA is available on Zoom to answer questions. These times will probably not be as long as a usual lab session, but there will be several hours when the TA is online and can either answer questions or try to help debug circuits. We will need to decide on times during week 1.

Lab 'reports' are due on the Wednesday after labs are assigned. I really want to see proof that you did the lab (or watched the lab video) and understood the material. Neatly organized notes taken during the lab itself, answers to the questions posed in the lab writeup, plus a short summary afterwards in your notebook is perfectly adequate. Since you will be turning this in electronically, you probably should just type in some answers into your favorite text editor. Depending on the lab, we may request that you send pictures of your final circuit. We will figure out what exactly we want you to provide as we go along.

Most of the spec sheets needed for our labs can be found in the directory here and are also linked on the Lab Page. Typically, you only need the pin diagram on the first page, plus perhaps the truth table. Please don't print out 18 pages unless you really need them.

Some of the original TI data sheets can be found here. Search by part number (ie: 7402)

Many web sites have online pin diagrams, like here, here, or here (in Korean!). A Google search will turn up many more.

**Homework**

Homework will typically be assigned Monday and due on the following Monday at the start of class. I will hand out solutions and potentially discuss the problems on the Monday when they are due, so late homework will not be accepted. Many of the homework problems are simply to force you to work through a particular concept 'by hand' at least once. The exams will closely follow the homework assignments, so it is
worth making sure that you can do all of the homework problems. I reserve the right to not grade every single problem in detail.

- Homework #1
- Homework #2
- Homework #3
- Homework #4
- Homework #5
- Homework #6

Projects

A key part of this class is the opportunity for each student to pursue a term project of their own design. This will be much more difficult without access to our teaching lab and the large range of components available there. Instead, as part of the lab kits I send you there will be a couple of additional parts that can make a reasonable project in conjunction with the Arduino microprocessor you will receive. I plan for you to be able to at least build a temperature probe using a thermistor and an LCD display. If you would like to be more ambitious and do something else, I am willing to consider your proposal, but you must get this signed off by me first and you will be responsible for finding your own parts. I will have more information once I figure out what I really want to do here.

Project Grading

The final project grade will be based upon the checkout and the write up. You need to schedule an appointment with me to see your project in action before Tuesday June 9th at 5PM. The write up, which should provide a summary of your design, implementation, and a summary of the problems you had and what you would do differently next time, is due by 3PM on Thursday June 11th in lieu of a final exam. No late reports will be accepted!

The idea, execution, and write up will all be considered in the final project grade. You may feel free to work with another person, but please factorize the problem into identifiable pieces. You need to get this arrangement approved by me in advance.

Academic Misconduct

There is arguably a grey area between working together collaboratively on a homework assignment or lab, and just copying somebody else's work. In general, however, it is usually very apparent to the people involved whether a student is really contributing to a result, or just copying from others. Copying answers and passing them off as your own
work, either from another student or from any other source, is no different from plagiarism, and will be dealt with according to the UO rules and procedures for academic misconduct.

You are responsible for all the work you turn in for this course. You are encouraged to work with others to help your understanding, but anything you write down on your homework or you lab assignments needs to be your own work. You can certainly collect data with your lab partner and discuss the methods for analyzing the data and even compare your results, but all written work must be your own.

Campus Resources

Tutoring and Academic Engagement Center engage.uoregon.edu/services/ Drop-in math and writing support in addition to tutoring, study skills support, and Class Encore. Located in the 4th Floor Knight Library call (541) 346-3226 or engage@uoregon.edu.

Counseling Center Call anytime to speak with a therapist who can provide support and connect you with resources. Located on the 2nd Floor of the Health Center, call (541) 346-3227.

Center for Multicultural Academic Excellence CMAE mission is to promote student retention and persistence for historically underrepresented and underserved populations. We develop and implement programs and services that support retention, academic excellence, and success at the UO and beyond. We reaffirm our commitment to all students, including undocumented and tuition equity students. Located on the 1st Floor of Oregon Hall, call (541) 346-3479 or cmae@uoregon.edu.

The UO Access Shuttle is an on-campus ride service provided at no cost to students with conditions that limit mobility. More information and a sign-up form can be found on the parking & transportation department website: parking.uoregon.edu/content/access-shuttle.

Accessible Education

The University of Oregon is working to create inclusive learning environments. The instructor believes strongly in creating inclusive learning environments. If there are aspects of the instruction or design of this course that result in barriers to your participation, please notify us as soon as possible. You are also encouraged to contact the Accessible Education Center. If you are not a student with a documented disability, but you would like for us to know about class issues that will impact your ability to learn, we encourage you to come visit during office hours so that we can strategize how you
Prohibited Discrimination and Harassment

Any student who has experienced sexual assault, relationship violence, sex or gender-based bullying, stalking, and/or sexual harassment may seek resources and help at safe.uoregon.edu. To get help by phone, a student can also call either the UO's 24-hour hotline at 541-346-7244 [SAFE], or the non-confidential Title IX Coordinator at 541-346-8136. From the SAFE website, students may also connect to Callisto, a confidential, third-party reporting site that is not a part of the university.

Students experiencing any other form of prohibited discrimination or harassment can find information at respect.uoregon.edu or aaeo.uoregon.edu or contact the non-confidential AAEO office at 541-346-3123 or the Dean of Students Office at 541-346-3216 for help. As UO policy has different reporting requirements based on the nature of the reported harassment or discrimination, additional information about reporting requirements for discrimination or harassment unrelated to sexual assault, relationship violence, sex or gender based bullying, stalking, and/or sexual harassment is available at Discrimination & Harassment.

Reporting

The instructor of this class is a Student-Directed Employee. As such, if you disclose to me, I will respond to you with respect and kindness. I will listen to you, and will be sensitive to your needs and desires. I will not judge you. I will support you. As part of that support, I will direct students who disclose sexual harassment or sexual violence to resources that can help. I will only report the information shared to the university administration when you as the student requests that the information be reported (unless someone is in imminent risk of serious harm or is a minor). Please note the difference between ?privacy? and ?confidentiality.? As a Student-Directed Employee I can offer privacy because I am not required to report certain information to the university. However, I cannot be bound by confidentiality in the same way that a counselor or attorney is. Confidential resources such as these means that information shared is protected by federal and state laws. Any information that I as a student-directed employee receive may still be accessed by university or court proceedings. This means, for example, that I could still be called as a witness or required to turn over any related documents or notes that I keep. Please note also that I am required to report all other forms of prohibited discrimination or harassment to the university administration. Specific details about confidentiality of information and reporting obligations of employees can be found at titleix.uoregon.edu.
Mandatory Reporting of Child Abuse

UO employees, including faculty, staff, and GEs, are mandatory reporters of child abuse. This statement is to advise you that your disclosure of information about child abuse to a UO employee may trigger the UO employee’s duty to report that information to the designated authorities. Please refer to the following links for detailed information about mandatory reporting: Mandatory Reporting of Child Abuse and Neglect.