ECE 150 Digital Logic Design

Fall 2023

Department of Electrical Engineering

The Cooper Union for the Advancement of Science and Art

Instructor	Nikola Janjušević
Contact	nikola.janjusevic@cooper.edu
Class Hours	Wednesdays 6-9pm, 41 Cooper Sq. (NAB) Room 306
Office Hours	Wednesdays 5-6pm NAB Room 214 + by appointment
TA	Noam Shuck, noam.schuck@cooper.edu, Office hours (TBD) Junior-Lab (NAB)
Textbook	*Digital Electronics: A Practical Approach with VHDL 9th edition*, by William Kleitz, Pearson Prentice Hall, 2011. (Not Required)
Course website	nikopj.github.io/teaching/dld23/

Course Description: Theoretical and practical issues concerning design with combinational and sequential logic circuits. Number systems, Boolean algebra, representation and simplification of Boolean functions, universal logic families. Finite-state machines, state tables and state diagrams, flip-flops, counters, registers. Adders, decoders, comparators, multiplexers, memories and applications. Course work involves individual and team projects in which digital circuits are constructed and tested on breadboards. The projects are used to assess technical writing, teamwork, and project management skills.

Overview: This 3-credit course introduces students to the fundamental concepts of digital logic, starting with numbering systems, Boolean algebra, then circuit design using combinatorial and sequential elements. Weekly lectures are reinforced with practical applications through three projects. These will consist of two smaller projects where the students will be required to make combinatorial and sequential circuits. The last project will require the students to design a system according specifications. Design, construction, and testing of circuits are a major component of this course. Students will have opportunities to develop good habits for methodical circuit construction and disciplined troubleshooting. There will be a mid-term and a final.

The topics covered in this course have applications in many fields within electrical engineering and computer science. Therefore ECE-150 is a prerequisite for the following courses:

- ECE-251 Computer Architecture
- ECE-264 Data Structures and Algorithms I
- ECE-291 Electrical Engineering Sophomore Projects
- ECE-303 Communication Networks
- ECE-314 Audio Engineering Projects
- ECE-413 Music and Engineering

Course Learning Objectives:

1. Design, build, and test combinatorial logic circuits.
2. Design, build, and test sequential logic circuits.
3. Communicate design solutions in a logical manner.

ABET Outcomes for this Course: ABET is a nonprofit, non-governmental organization that accredits college and university programs in the disciplines of applied science, computing, engineering, and engineering technology. As part of the accreditation process, engineering programs are required to assess student outcomes which are acquired by students who are enrolled in the program. Student outcomes are succinct statements that describe what students are expected to know and be able to do by the time of graduation. These outcomes relate to skills, knowledge and behaviors that students acquire as they progress through the program. The outcomes most closely associated with this course (taken from the ABET website) are:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Grading Scheme:

Class Conduct and Participation	10%
Homework and Quizzes	10%
Midterm Exam	15%
Final Exam	20%
Project 1	10%
Project 2	10%
Final Project	25%

1. **Class Conduct, Lab Conduct, and Participation**: You are expected to contribute to discussions related to course material throughout the semester in a manner respectful to your instructor and classmates. This can be in the form of answering/posing questions during class and/or office hours.

   You are expected to keep the lab spaces clean and return cables, soldering irons, and unused components to their homes. Turn off equipment and clean up your station (tables and floor) before leaving.

   You are expected to attend all lectures. Please notify me beforehand of any planned absence.

   Deductions may incur for violations of classroom conduct and/or technology policy (see Grading Scale below).

2. **Homework and Quizzes**: Four quizzes will be given throughout the semester, and will be taken at the beginning of class. Two homeworks will be given. They will be collected at the beginning of class. Late homework will not be accepted. Homework may require lab work.
3. **Projects**: Three projects will be assigned during the semester. Projects 1 and 2 will be individual, however in the final project you may work in groups of up to two and each student will receive the same grade. For the final project, you will have the option to choose between completing a pre-specified project or a project your team specifies. If your team chooses to specify their own

project, you will be required to submit a specification for approval. Approval is contingent on the project containing the same core themes/principles as the pre-specified project (ex. memory component, adjustable clock, etc.) and a similarly manageable scope.

Projects will be demoed before lecture for correctness on days they are due. Projects will be accompanied by reports documenting their purpose and design. Reports must be handed in in PDF format. Logic simulations in Logisim/Logisim-Evolution are required for some projects.

Projects submitted late will be subject to a penalty of 1 letter grade for each 24hrs late. Extensions may be granted on request with sufficient reason.

4. **Exams**: Written midterm and final exams will test your understanding of course material and principles. Exams will be administered during class hours.

Grading Scale:

90 - 100	A – superior and comprehensive understanding of the course principles
80 - 89	B – good degree of familiarity of the course principles
70 - 79	C – average knowledge of course principles and fair performance
60 - 69	D – minimum working knowledge of the course principles
< 60	F – unsatisfactory understanding of the course principles

The following section is from Associate Dean Shay's ECE-291 Syllabus, which I adopt and endorse for this course.

Issues and Concerns: I try to create course policies that support a fair and equitable classroom environment and set high performance standards for all students. I hope to create an inclusive learning environment where you feel both challenged but also constantly respected and recognized within the course. Please make an appointment with me if you are having any issues related to me, the course, or your fellow students.

While I want you to feel comfortable coming to me with issues you may be struggling with or concerns you have, please be aware that I have reporting requirements that are part of my responsibilities as a member of the faculty. If you inform me of an issue of sexual harassment, sexual assault, or discrimination, I will keep the information as private as I can, but I am required to report the basic facts of the incident to Cooper's Title IX Coordinator. The Cooper Union Title IX policy on sexual misconduct can be found here.

Counseling Services at The Cooper Union are coordinated through the Office of Student Affairs. Cooper's counseling and mental health services website can be found here.

Technology Policy: You may not use electronic devices (laptops, tablets, phones) during lecture without my permission.

Accommodations: Students with disabilities or who need special accommodations for this class are required to notify the Dean of Students and meet with me so that arrangements can be made. The Cooper Union has limited resources and extra lead time is required for such arrangements to be feasible. In order to receive accommodations for an exam, you must notify me in writing at least two weeks before the accommodations are needed and you must also be registered with the Dean of Students. Students will not be afforded any special accommodations retroactively, i.e., for academic work completed prior to disclosure of the disability to me. Support services for students are described here.

Group Work and Academic Integrity: You are encouraged to discuss your homework and projects outside of class time with your classmates, however, all work submitted must be your own. You are required to acknowledge collaboration with other parties (including a website or textbook reference) in

arriving at your answers/explanations in homework and projects. Submitted work that is strongly suspected of being misrepresented as your own (i.e. plagiarism, including copying the output of generative AI) will be reported to the Dean's Office and may result in a zero on the assignment/exam and/or a D/F in the course.

Course Schedule (tentative): Below is an outline of the course schedule, subject to change. I will update this table with lecture notes (if they exist) as the semester progresses.

#	Date	Topics	Textbook Sections	Assignments
1	08/30	Course overview, Circuit Basics, Numbering Systems and Arithmetic	Ch1	HW 1 assigned
2	09/06	Logic Gates and Boolean Algebra		
3	09/13	Combinatorial Circuits		Quiz 1, HW 1 due, Project 1 assigned
4	09/20	Latches and Flip-Flops 1		
5	09/27	555 Timers, Latches and Flip-Flops 2		HW 2 assigned
6	10/04	Project 1 demo, Finite State Machines 1		Quiz 2, Project 1 report due
7	10/11	Midterm Exam		
8	10/18	Finite State Machines 2		HW 2 due, Project 2 assigned
9	10/25	Tri-state logic, Busses, Memory		Quiz 3
10	11/01	Intro to Microprocessors		Project 2 simulation due
11	11/08	Project 2 demo, Final project discussion		Project 2 report due, Final project assigned
12	11/15	Slack time		Quiz 4
13	11/22	No class (Friday classes meet)		
14	11/29	Final Exam		
15	12/06	Final project work time		
16	12/13	Final project demo		
17	12/20	No class		Final project report due