ECE 2020-IE3: Digital System Design

Georgia Institute of Technology

Fall 2024

Instructor: Samuel Talkington — E-mail: talkington@gatech.edu
Additional resource: Kevin Johnson — E-mail: KJohnson@gatech.edu
Class Room: Van Leer C241 — **Class Hours:** T/Th 5-6:15pm
Instructor Office: Van Leer C248 — **Office Hours:** Th/F 11:30am-1pm

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Course Description

ECE 2020 introduces the many *levels of abstraction* that enable today's digital systems. It explores digital design at the layers from switches and wire to a programmable machine. At each layer, the design process of transforming a specification into an implementation is introduced and practiced.

Course Objectives and Outcomes

At the end of this course, you should ideally be able to:

- Use Boolean logic and be able to produce desired logic functions in truth-table, schematic, and algebraic forms.
- Design physical implementations of digital logic, be able to produce logic functions using it, and analyze its timing behavior.
- Manipulate number systems and representations in digital logic.
- Analyze digital building blocks such as multiplexers and encoders and be able to use them to build larger digital devices.
- Analyze digital storage elements and sequential logic and be able to create finite-state machines to implement a desired behavior.
- Analyze basic processor operation and be able to create simple programs in assembly code.

Resources

- **Main textbook:** Wakerly, Digital Design: Principles and Practice 5th Edition
- **Course notes:** Will be made periodically available on Canvas.
- **Additional resources:**
  - Harris & Harris, Digital Design and Computer Architecture (available through library)
  - Wills & Wills, Digital Computer Systems (free e-book)
  - Course website: http://ece2020.ece.gatech.edu/
  - Beta new course website: http://ece2020.ece.gatech.edu/new/

Prerequisites/Corequisites

An open mind, coupled with a desire to learn and grow.

Course Structure

Problem sets

There will be a problem set assigned approximately every 1-2 weeks. Problem sets are intended to assess both basic knowledge of the course material and to encourage a deeper understanding, so it is likely that some additional research will be required beyond coming to class. Each problem in a problem set will be graded from 0-2 for understanding and completion. Credit will be assigned as follows:

- Solution is complete and correct: 2/2
- Solution shows understanding of the problem, and is partially correct: 1/2
- Solution cannot be understood or was not attempted: 0/2

The minimum of your problem set scores will not be considered in your final grade.

Lecture participation puzzles

Beginning the second week of class, we will occasionally solve problem(s) together in class. This will be followed by a period of group discussion and peer feedback, and then reviewing the solution together. These quiz problems will be graded on a binary scale, where full credit is earned for any submission. This will be followed up by group discussions and peer feedback. The goal of these problems is to promote peer discussion and encourage attendance, and I expect all students to receive full points in this section.

Lab

There are two labs during the semester, which will each have some lecture time dedicated to them but may require additional time to complete outside of lecture. Students will be given pre-lab assignments and lab instructions before the in-lecture periods. Any hardware needed will be provided by the school.

Exams

There will be four exams given in-person during scheduled class times. Each test will take approximately 50 minutes, to allow for setup and wrap-up and possibly some discussion before the test within the 75-minute class period. Tests are graded for correctness, with partial credit possible (e.g. for work shown or to account for minor errors).

Optional redemption exam

The fourth exam is optional and is intended to encourage a growth mindset and to serve as a redemption opportunity for those who wish to improve their final grade. The test will revisit the topics most commonly misunderstood in the semester. If you choose to not take the fourth exam, the weight of the prior three exams will be appropriately redistributed.

Final Exam

The final exam will be on the date, time, and location scheduled by the Institute; see the Georgia Tech final exam matrix for details. The final exam will be cumulative through the topics of state machines (i.e. it will not include memory, computer architecture, or programming).

Credit

Credit will be awarded for the work you do according to the following distribution:

- **30%**: Final exam
- **40%**: Midterm exams (x4, 10% each)
- **10%**: Labs (x2, 5% each)
- **15%**: Take-home problem sets (x5-6, percentages evenly distributed)
- **5%**: Lecture participation quizzes

Credit will be recorded on Canvas. Please contact me if anything on Canvas is incorrect. Your grade will be calculated based on the following credit thresholds:

$$A \geq 90.0\%, \quad B \geq 80.0\%, \quad C \geq 70.0\%, \quad D \geq 60.0\%, \quad F < 60\%.$$

Course Expectations and Guidelines

Support for student health and well-being

I would like to ask that you please be kind to yourself. The past few years have been challenging. I affirm my support for your well-being and I am thrilled that you have joined us to learn something new together this semester.

Office Hours

If possible, please email me before coming so that I can ensure I'm there. Walk-ins are welcome when my door is open, and other times can be arranged by email. Especially for a virtual meeting, email me and we can find a time.

Communication

There will be a Piazza section set up and linked to Canvas. That is the preferred place to ask technical questions so that everyone in the class can see the answer (or answer themselves) and ask follow-up questions in the same place. Find our class signup link at: https://piazza.com/gatech/fall2024/ece2020ie3

If you need to contact me for non-technical reasons (course logistics, scheduling meetings, etc.), I prefer email, but it is also possible to message me through Canvas. If I need to contact you personally, I will use your GT email address. Announcements will be sent through Canvas. You are responsible for information sent in those announcements, so I recommend configuring Canvas to notify you of them.

Attendance

Real-time in-person lecture attendance is expected. If you miss a lecture with a valid excuse, feel free to email me to check what you missed that day. In particular, excused absences include, but are *not limited to* religious observations, illnesses, job search obligations, or housing instability.

Late Work Guidelines

- **Homework:** Without prior arrangements, cannot be submitted late. Complete homework well before the deadline so that any issues can be fixed before it's too late. Email me with excused delays to work out submission details.
- **Lecture participation quizzes:** If unexcused, and you miss a lecture participation quiz, you will receive a 0.
- **Tests:** With a valid excuse, tests can be made up for full credit as soon as possible. Tests missed without a valid excuse can be made up as soon as possible with a penalty of up to 20% per day (adjusted based on ability to make up the test). Make-up tests may be different than the original and might not receive the same curve.
- **Labs:** Labs are due one week after the in-class period. If the in-class portion is missed or is not completed within the lecture period, the lab must be finished outside of lecture. Late submissions will not be accepted beyond the one-week period.

Academic Integrity and Honesty

At Georgia Tech, we believe that it is important to strive for an atmosphere of mutual respect, acknowledgement, and responsibility between faculty members and the student body. See http://www.catalog.gatech.edu/rules/22/ for an articulation of some basic expectations that you can have of me and that I have of you. In the end, simple respect for knowledge, hard work, and cordial interactions will help build the environment we seek. Therefore, I encourage you to remain committed to the ideals of Georgia Tech while in this class.

- **You may not:**
  - Collaborate at all during tests and in-class quizzes, unless otherwise specified.
  - Share solutions to any assignment before its due date.
  - Discuss tests until they have been returned, in case someone has not taken it yet.
  - Use or reference lab work from previous semesters.
- **You may:**
  - Work with instructors, tutors, and other students to discuss course material, including current homework and lab problems, as long as solutions are not shared.
  - Use previous semesters' exams, homeworks, or other resources, from my 2020 sections, from other 2020 sections, from the general 2020 website, or from other sources.
  - Use CAD or simulation software such as http://lushprojects.com/circuitjs/circuitjs.html.

Accommodations for Disabilities

If you are a student with learning needs that require special accommodation, contact the Office of Disability Services at (404) 894-2563 or http://disabilityservices.gatech.edu/ as soon as possible to make an appointment to discuss your special needs and to obtain an accommodations letter. Please also e-mail me as soon as possible to set up a time to discuss your learning needs.