

# CE346: Microprocessor System Design

## Syllabus - Spring 2021

### Course Staff

#### Instructor

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### Overview

The Internet of Things promises a world of computers woven into our physical world. These computers do not look and function the same as the servers and desktops that have long dominated the computing world. Instead, they take the form of microcontrollers with a processor, memory, and peripherals all within a single chip. Microcontrollers are then embedded into circuit boards alongside sensors, batteries, and interfaces that connect it to the outside world.

In this course, we explore the design and use of these microcontroller-based systems. What are the requirements and capabilities of embedded software? How do we connect computation to real-world input and use it to output to actuators or other nearby computer systems? How can sensors be used and combined to understand a computer's physical environment? Along the way we'll discuss many aspects of software and electrical system designs and how they can be made to work together. The class will include lectures on these topics, practical hands-on lab sessions interacting with microcontroller systems, and an open-ended final project.

## Location and Time

Lecture time: 3:30-4:50 PM Central, Tuesdays and Thursdays

Location: [A110](#), Tech Hall

Lectures are in person. We will attempt to record all lecture sessions so that you can later review them if you want, but the current expectation is that students will attend class in person.

Lab time: 10:00-11:50 AM Central, Fridays

Location: [CG50](#), Tech Hall

Labs are in person and attendance is mandatory. If you will not be able to attend a lab session, you must reach out to the instructor to let them know and we will attempt to make arrangements.

## Pre-requisites

CS211 and either CS205 or CS213, or graduate standing.

This course also expects students to have a background in C programming and Unix shell. While we will deal with aspects of electrical engineering, computer engineering, and computer science, the course does not expect students to have experience in all of these areas and will teach what we expect you to know.

## Communication

All course materials will be posted to Canvas including grades, lecture materials, and class recordings. Campuswire will be used for course discussions and questions. **All questions should go to Campuswire rather than to email.** We will enroll you in Campuswire. Office hours will also be available, with the regular schedule available on Canvas. Office hour appointments can also be made with the instructor by Campuswire post to “instructors and TAs”.

## Class Structure

### Labs

These provide guided, hands-on experience with microcontroller systems. Labs will be started on Fridays during the lab session, with the goal of completing them during class time. Labs will be performed with a partner and will be due the following week before the next lab starts.

1. Memory-Mapped I/O and Interrupts
2. Timers
3. LED Matrix
4. Breadboarding
5. Audio
6. I2C Accelerometer/Magnetometer

Each lab will require a demonstration that the lab has been completed, usually in the form of multiple checkoffs throughout the lab procedure, as well as several post-lab questions demonstrating your knowledge.

## **Quizzes**

These will evaluate your understanding of course material. Quizzes will be given roughly every two weeks, with a total of four quizzes throughout the class. Students will be given a limited amount of time to complete several questions from the last two weeks of lecture.

## **Final Project**

These are open-ended and are a chance for you to show off your creativity. They will be performed in groups of 2-3 students (four is possible with approval). The labs should help give you some basis of knowledge for a project, but a large variety of projects are possible. Feel free to look around online for inspiration.

Various items on hand may be lent out to teams for use in their projects. Teams will also have a small budget for purchasing additional supplies for their project.

Example ideas:

- Game with motion controls (like bop-it)
- Music pad controller
- Morse code decoder
- Smartwatch
- Simple robot / mechanical platform

Project proposals will be due about 1/3rd of the way into class. They will include a short writeup of the project plan and the instructor will provide feedback about them.

Halfway through the class, students will give Project Design Presentations in class. These will be short presentations to the class on project goals, steps, and concerns and should take into account feedback from the proposal. Other students in the class, as well as the instructor, will be able to provide feedback on how to shape your project.

Updates meetings will occur once or twice between Design Presentation and submission, detailing completed work, unexpected challenges, and revisions to the project goals.

Finally, an in-class demonstration will be given for each project. The demo will be 5-10 minutes where the team will show off the relevant aspects of their project. These will take place the last week of class. This might be adjusted into a longer demo session open to the public.

The final projects themselves are also graded based on quality and difficulty. The proposal, presentation, and updates will be used to guide students so that they can anticipate how their project will be judged.

## Schedule

The course schedule is available on the Canvas homepage for the course. Be aware that it is subject to change, although warnings will be given to students for any major changes.

## Grades

Percentage grades will be converted to letter grades using the standard letter grade system (93% A, 90% A-, 87% B+, etc.). However, these grade bins may be moved at the instructor's discretion for the advantage of students. Note that the percent grade displayed by Canvas is not always accurate and may not take late penalties into account, as described below.

Each category of assignment has a total value, which is divided evenly between assignments.

Category	Count	Total Value
Labs	6	42%
Quizzes	4	20%
Project Proposal	1	3%
Project Design Presentation	1	5%
Project Demonstration	1	5%
Final Project	1	25%

## Late Policy

Quizzes and items that are part of the final project may not be submitted late.

Labs may be submitted late at a penalty of 10% reduction in maximum points per day late. For example, a lab submitted two days late has a maximum score of 80%. Lateness is rounded up to the whole day, so an assignment that is five minutes late has the same penalty as an assignment 23 hours late.

## Academic Integrity

Students in this course are required to comply with the policies found in the booklet, "Academic Integrity at Northwestern University: A Basic Guide". All papers submitted for credit in this course must be submitted electronically unless otherwise instructed by the professor. Your written work may be tested for plagiarized content. For details regarding academic integrity at Northwestern or to download the guide, visit:

<https://www.northwestern.edu/provost/policies/academic-integrity/index.html>

## Accessibility

Northwestern University is committed to providing the most accessible learning environment as possible for students with disabilities. Should you anticipate or experience disability-related barriers, please contact AccessibleNU to move forward with the university's established accommodation process ([accessiblenu@northwestern.edu](mailto:accessiblenu@northwestern.edu); 847-467-5530). If you already have established accommodations with AccessibleNU, please let me know as soon as possible, preferably within the first two weeks of the term, so we can work together to implement your disability accommodations. Disability information, including academic accommodations, is confidential under the Family Educational Rights and Privacy Act.

Should you need them, additional campus resources are available, including, but not limited to:

- Accessible NU: [www.northwestern.edu/accessiblenu/](http://www.northwestern.edu/accessiblenu/)
- CAPS: [www.northwestern.edu/counseling/index.html](http://www.northwestern.edu/counseling/index.html)
- Student Enrichment Services: [www.northwestern.edu/enrichment/](http://www.northwestern.edu/enrichment/)

I believe in providing reasonable accommodations that allow for full access to learning for all. Please contact me if there is anything that I should be aware of that might have an impact on your participation in this course (documented disability, language challenges, absences for religious observations, etc.).

## Diversity and Inclusion

I consider this classroom to be a place where you will be treated with respect, and I welcome individuals of all ages, backgrounds, beliefs, ethnicities, genders, gender identities, gender expressions, national origins, religious affiliations, sexual orientations, ability—and other visible and nonvisible differences. All members of this class are expected to contribute to a respectful, welcoming, and inclusive environment for every other member of the class.

This course will also include a mix of undergraduates and graduate students with differing backgrounds in embedded systems, computer science, and electrical engineering. Do not feel discouraged by this. Each student will bring a different aspect of their knowledge to discussions, and we'll all be contributing towards increasing each other's understanding.

## Support for Wellness and Mental Health

Northwestern University is committed to supporting the wellness of our students. Student Affairs has multiple resources to support student wellness and mental health. If you are feeling distressed or overwhelmed, please reach out for help. Students can access confidential resources through the Counseling and Psychological Services (CAPS), Religious and Spiritual Life (RSL) and the Center for Awareness, Response and Education (CARE). Additional information on all of the resources mentioned above can be found here:

- <https://www.northwestern.edu/counseling/>
- <https://www.northwestern.edu/religious-life/>
- <https://www.northwestern.edu/care/>

## COVID-19 Compliance

Students, faculty, and staff must comply with University expectations regarding appropriate classroom behavior, including those outlined below and in the COVID-19 Code of Conduct. With respect to classroom procedures, this includes:

- Policies regarding masking and social distancing evolve as the public health situation changes. Students are responsible for understanding and complying with current masking, testing, Symptom Tracking, and social distancing requirements.
- In some classes, masking and/or social distancing may be required as a result of an Americans with Disabilities Act (ADA) accommodation for the instructor or a student in the class even when not generally required on campus. In such cases, the instructor will notify the class.
- No food is allowed inside classrooms. Drinks are permitted, but please keep your face covering on and use a straw.
- Faculty may assign seats in some classes to help facilitate contact tracing in the event that a student tests positive for COVID-19. Students must sit in their assigned seats.

If a student fails to comply with the [COVID-19 Code of Conduct](#) or other University expectations related to COVID-19, the instructor may ask the student to leave the class. The instructor is asked to report the incident to the Office of Community Standards for additional follow-up.

To protect the health of our community, Northwestern University requires unvaccinated students who are in on-campus programs to be tested for COVID-19 twice per week.

Students who fail to comply with current or future COVID-19 testing protocols will be referred to the Office of Community standards to face disciplinary action, including escalation up to restriction from campus and suspension.

Class sessions for this course will occur in person. Individual students will not be granted permission to attend remotely except as the result of an Americans with Disabilities Act (ADA) accommodation as determined by AccessibleNU.

Maintaining the health of the community remains our priority. If you are experiencing any symptoms of COVID do not attend class and update your Symptom Tracker application right away to connect with Northwestern's Case Management Team for guidance on next steps. Also contact the instructor as soon as possible to arrange to complete coursework.

Students who experience a personal emergency should contact the instructor as soon as possible to arrange to complete coursework.

Should public health recommendations prevent in person class from being held on a given day, the instructor or the university will notify students.

## **Class Recordings**

This class or portions of this class will be recorded by the instructor for educational purpose and available to the class during the quarter. Your instructor will communicate how you can access the recordings. Portions of the course that contain images, questions or commentary/discussion by students will be edited out of any recordings that are saved beyond the current term.

Unauthorized student recording of classroom or other academic activities (including advising sessions or office hours) is prohibited. Unauthorized recording is unethical and may also be a violation of University policy and state law. Students requesting the use of assistive technology as an accommodation should contact [AccessibleNU](#). Unauthorized use of classroom recordings – including distributing or posting them – is also prohibited. Under the University's [Copyright Policy](#), faculty own the copyright to instructional materials – including those resources created specifically for the purposes of instruction, such as syllabi, lectures and lecture notes, and presentations. Students cannot copy, reproduce, display, or distribute these materials. Students who engage in unauthorized recording, unauthorized use of a recording, or unauthorized distribution of instructional materials will be referred to the appropriate University office for follow-up.