



Carnegie Mellon University  
Master of  
Software Engineering

### 17-648: Sensor Based Systems

M, W 3:30pm – 4:50pm In Person Expectation (IPE)  
A3, Spring 2023, 6 Units

#### Instructor

Prof. Scott Pavetti

#### Email

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#### Office Location & Hours

By Appointment

#### Teaching Assistant

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#### Office Location & Hours

TBD

**Course Description.** This course will introduce students to the design and implementation of sensor-based systems within an embedded systems context. The course's major components are design documentation and C based implementation based on that design. Throughout the course we will be discussing different design notions and study the workings of sensors, embedded systems, and wireless sensor nodes.

**Prior Knowledge.** Students taking this course should have some prior experience with IoT or embedded devices, but it isn't a hard prerequisite. Having hobbyist or classroom experience working with Arduino or Raspberry PI is beneficial but a prerequisite. The course has significant programming components, requiring writing C code compiled on the gcc compiler. The class will require proficiency with C/C++ to succeed. No prior knowledge of sensors or wireless systems is necessary.

**Learning Objectives.** After completing this course, you will be able to:

- Design system pieces using standard graphical notation in documentation as well as documenting code
- Build (code) parts of sensor based embedded systems from previously designed elements
- Evaluate the effectiveness of software designs in guiding software implementations

#### Learning Resources:

All readings will be provided via Canvas, no textbook is required for this course.

**Use of Zoom in the Class.** In our class, we will not be using Zoom unless circumstances change.

**Assessments.** Students learn more by applying and explaining ideas to others, thus, the course requires the following activities:

- **Programming Assignments:** Programming the designed parts of a system done in C.
- **Design Exercises:** Documenting and planning the work to-be-done.
- **Quizzes:** Three short quizzes to cover topics not included in the design and programming assessments.
- **Class participation,** to enrich the discussion with your insight, relevant experience, critical questions, and analysis of the material. The quality of contribution is more important than the quantity.

Assessment	Final Grade %	Grade	Percentage Interval
Programming Assignments	50%	A+, A, A-	98-100%, 92-98%, 90-92%
Design Exercises	30%	B+, B, B-	88-90%, 82-88%, 80-82%
Quizzes	10%	C	70-80%
Participation	10%	D	60-70%
		R (F)	Below 60%

### End of Semester Grade Bump Policy

We all know the frustration of being just a percentage point away from the next highest grade. This course has a grade bump policy that lets students have a chance to overcome this problem. Below are the criteria you can use to attempt the next highest grade.

If your final percentage is within 0.5% of the next grade increment, email the instructor and ask for a grade increase. The instructor will reply with a question that you must answer about the course. If the answer is accepted, you will receive the next highest grade.

If your final percentage is between 1% and 0.5% it is the instructor's discretion. At the instructor's discretion you may be declined or asked *two* bonus questions. To make it more likely to get the grade bump questions you should have participated in class, attended, and been timely with submissions.

All responses to bonus questions must be within 24 hours of the instructor's question email to receive credit. In addition to this stipulation, all bump requests must be made no less than 3 days prior to the end of semester grading deadline.

## Programming Assignments

Programming is a significant component of Sensor Based Systems. Programming assignments will be implementations of specific topics covered by in-class lectures. Coding will also include a coding standard, established by the instructor and included as a part of the programming assignment. Assignments will vary from year to year, but here are some titles of assignments to give you an idea of what to expect.

1. XOR Checksum
2. Transfer Functions
3. State Machines
4. Binary Protocols
5. Datalogging
6. Cyclic Executives
7. Calibration

## Design Exercises

A subset of programming assignments are supported with designs that students construct to guide the following implementation. These designs use established diagramming techniques used commonly in the embedded systems space. Students will also explore the challenges of designing for non object oriented systems.

## Quizzes

There are a small number of quizzes in this course, and will typically be a combination of quantitative and qualitative questions on recent topics from class. There are no exams in this class.

## Participation

There is a combination of several things used to assess class participation. Not surprisingly, participation is appreciated by coming to all classes, interacting with the instructor and other students on discussions, and the activity done in collaborating and maintaining a coding standard document.

The coding standard is a set of conventions and rules applied to source code to promote various qualities needed by the software development process. This standard is applied to programming assignments and is worth some points towards the final point total for that assignment.

## Course and Grading Policies

- **Late-work policy:** All work is expected to be handed in at the indicated due date and time. Every assignment has a one-day grace period. Work that is turned in after

the grace period may be assessed a daily penalty up to 5 days then the assignment will be assessed at a zero. In the first week of classes, you should receive a course schedule for each course; please use them to plan.

You should notify the course TA(s) and instructor before the submission deadline that you will submit late. Late work must be submitted as soon as circumstances allow, ordinarily within 24 hours of the due date. If you have any questions, you should raise them immediately rather than waiting for conflicts to arise.

- **Participation policy.** Class participation will be graded by in-class engagement, including asking relevant questions based on a critical review of required readings, lectures, and comments made by your peers. The lack of attendance, and the use of mobile devices, including phones and laptops, will count against your participation grade.

This semester involves regular use of technology during class — both for in-person and remote students. Research has shown that divided attention is detrimental to learning, so I encourage you to close any windows not directly related to what we are doing while you are in class. Please turn off your phone notifications and limit other likely sources of technology disruption, so that you can fully engage with the material, each other, and me. This will create a better learning environment for everyone.

**Recording of Class Sessions.** All synchronous classes will be recorded via Panopto so that students in this course (and only students in the course) can watch or re-watch past class sessions. Please note that breakout rooms will not be recorded. I will make recordings available on Canvas as soon as possible after each class session (usually within a day of the class meeting). Recordings will live [Canvas](#). Please note that you are not allowed to share these recordings. This is to protect your FERPA rights and those of your fellow students.

**Course Schedule.** The following schedule provides a general overview of topics and assignments. Please refer to the syllabus online in Canvas for specific lecture topics, reading assignments and due dates.

Schedule by Lecture Topic

Class	Topic
1	Introduction
2	Sensor Fundamentals
3	Transfer Functions
4	Design Notations
5	Data Filtering

Class	Topic
6	Communication Protocols
7	Aggregation and Analysis
8	On Device Datalogging
9	Wired Sensor Systems
10	Security, Jeep Hacking Discussion
11	Wireless Technologies
12	Wireless Sensor Nodes
13	In-Class Design Problems

**Accommodations for Students Disabilities.** If you have a disability and have an accommodations letter form the Disability Resources office, I encourage you to discuss your accommodations and needs with me as early in the semester as possible. I will work with you to ensure that accommodations are provided as appropriate. If you suspect that you may have a disability and would benefit from accommodations but are not yet registered with the Office of Disability Resources, I encourage you to contact them at [access@andrew.cmu.edu](mailto:access@andrew.cmu.edu).

**Academic Integrity.** Honesty and transparency are important to good scholarship. Plagiarism and cheating, however, are serious academic offenses with serious consequences. If you are discovered engaging in either behavior in this course, you will earn a failing grade on the assignment in question, and further disciplinary action may be taken.

For a clear description of what counts as plagiarism, cheating, and/or the use of unauthorized sources, please see the [University's Policy on Academic Integrity](#).

If you have any questions regarding plagiarism or cheating, please ask me as soon as possible to avoid any misunderstandings. For more information about Carnegie Mellon's standards with respect to academic integrity, you can also check out the [Office of Community Standards & Integrity](#) website.

**Student Wellness.** As a student, you may experience a range of challenges that can interfere with learning, such as strained relationships, increased anxiety, substance use, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may diminish your academic performance and/or reduce your ability to participate in daily activities. CMU services are available, and treatment does work. You can learn more about confidential mental health services available on campus at the [Counseling and Psychological Services](#) website. Support is always available (24/7) from Counseling and Psychological Services: 412-268-2922.

This semester is unlike any other. We are all under a lot of stress and uncertainty at this time. Attending Zoom classes all day can take its toll on our mental health. Make sure to move regularly, eat well, and reach out to your support system or me [spavetti@cmu.edu](mailto:spavetti@cmu.edu) if you need to. We can all benefit from support in times of stress, and this semester is no exception.

**Respect for Diversity.** [Please refer to the [Eberly Center's page on Diversity Statements](#) for other examples, if this one does suit your needs.] It is my intent that students from all diverse backgrounds and perspectives be well served by this course, that students' learning needs be addressed both in and out of class, and that the diversity that students bring to this class be viewed as a resource, strength, and benefit. It is my intent to present materials and activities that are respectful of diversity: gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture. Your suggestions are encouraged and appreciated. Please let me know if any of our class meetings conflict with your religious observations so that I can make alternate arrangements for you.