Carnegie Mellon University
Master of
Software Engineering

17-648: Sensor Based Systems
M, W 6:00pm-7:20pm Remote
A4, Spring 2021, 6 Units

Instructor	Email	Office Location & Hours
Prof. Scott Pavetti	spavetti@cmu.edu	Wed. 5-6pm or appointment

Course Description. This course will introduce students to sensor-based systems deployed in random wireless networks and work through developing working knowledge on the physical sensor, networking, security, and data concerns that a sensor-based system has. The course will also focus on building a sensor based IoT system from the RTOS up through a broker and a data consumer application as a project component of the course. It prepares students to engineer wireless sensor-based systems. Major components are the delivered engineering notebook, source code for the project and a set of presentations and regular deliverables.

Prior Knowledge. Students taking this course should have some prior experience with IoT devices, but it isn't a hard prerequisite. Having hobbyist or classroom experience working with Arduino or Raspberry PI is beneficial. The course has two programming components, one will require writing C/C++ code for the hardware platform, and another component writing code to interact with the IoT device. The language will be of the student's choosing, but experience with Python or Go are helpful. 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:

- Gain working knowledge of wireless sensor networks (WSN)s including topologies, sensor data, wireless technologies used in sensor nodes.
- Learn how to build a system around a sensor based IoT device, from the ground up.
- Learn how to use MQTT as a component for capturing sensor data
- Learn the fundamentals of RTOS development for IoT devices using FreeRTOS

Use of Zoom in the Class. In our class, we will be using Zoom. The link is available on **Canvas**. Please make sure that your Internet connection and equipment are set up to use Zoom and able to share audio and video during class meetings. (See this page for Computing Resources for information on the technology you are likely to need.) Let me know if there is a gap in your technology set-up [insert email address] as soon as possible, and we can see about finding solutions.

Sharing video: In this course, being able to see one another helps to facilitate a better learning environment and promote more engaging discussions. Therefore, our default will be to expect student to have their cameras on during lectures and discussions. However, I also completely understand there may be reasons students would not want to have their cameras on. If you have any concerns about sharing your video, please email me as soon as possible and we can discuss possible adjustments. Note: You may use a background image in your video if you wish; just check in advance that this works with your device(s) and internet bandwidth.

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

- **Four Class Project Checkpoints**: For each checkpoint, students will submit the current source code, engineering notebook, any assigned work, and give a short presentation of their work.
- **Final Presentation and Demo**: Students will present a fifteen-minute presentation and give a demonstration of their project.
- **Final Engineering Notebook:** Students will submit the final engineering notebook, source code for the project.
- **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 %
Checkpoints	40%
Final Notebook	10%
Final Presentation	20%
Final Code Submission	10%
Class participation	20%

Grade	Percentage Interval
A+, A, A-	97-100%, 93-96%, 90-92%
B+, B, B-	87-89%, 83-86%, 80-82%
C	70-79%
D	60-69%
R (F)	59% or below

Course and Grading Policies

- **Late-work policy**: All work is expected to be handed in at the indicated due date and time. For fairness to the whole class, no late submissions will be accepted for the group work. In the first week of classes, you should receive a course schedule for each course; please use them to plan ahead.

  Each student is allowed one late submission for the individual homework assignments. You should immediately notify the course TA(s) 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 Zoom so that students in this course (and only students in the course) can watch or re-watch past class sessions. Please not that breakout rooms will not be recorded. I will make recordings available on Canvas as soon as possible after each class session (usually within 3 hours 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.

Class	Topic and Readings	Assignments
1	Introduction	
2	Sensor Fundamentals Fraden Ch1	
3	Transfer Functions Agarwal Ch3	Checkpoint 1 Due
4	FreeRTOS and Tasks, Wireless Technologies Agarwal Ch1	
5	Break Day – No Class	
6	Coding Standards, Certification, Wireless Sensor Nodes and Clock Localization Agarwal Ch5	Checkpoint 2 Due
7	MQTT, WSN Topologies Agarwal Ch6	
8	Neighborhoods and Reliable Transport Agarwal, Ch7	

Class	Topic and Readings	Assignments
9	Connectivity and Coverage Agarwal Ch9	Checkpoint 3 Due
10	Medium Access and Routing Agarwal Ch10	
11	Sensor Data Agarwal Ch11	Checkpoint 4 Due
12	Sensor Data	
13	Security Agarwal Ch17, Ch13	
14	Final Presentations	Final Checkpoint

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.

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** if you need to. We can call benefit from support in times of stress, and this is 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 perspective 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.