



Carnegie Mellon University
Master of
Software Engineering

17-638: ENGINEERING EMBEDDED SYSTEMS

IPE: T,R 5:00pm-6:20pm @ 3SC 265

A1 Fall 2024

6 Units

Instructor

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Office Location & Hours

By appointment
By appointment

Teaching Assistants

Email

Office Location & Hours

Course Description.

Software intensive embedded systems depend on the use of specific techniques and skills to reason about, design, and construct. This course considers a variety of essential industry skills on developing software for microcontrollers, real time constraints and requirements, toolchains, and real time operating systems. It shows how to create real time embedded firmware from scratch using a variety of engineering and system tools. Concepts such as real time operating systems, real time scheduling, embedded design standards and programming models are central themes for the course.

Prior Knowledge. Undergrad course on probability and statistics and some experience working teams in a professional or academic setting.

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

1. Create embedded software that runs on Cortex-M4 processors
2. Learn the use of compilers, linkers, make systems, and analysis tools
3. Evaluate tradeoffs between design, performance, power, and maintainability common in the embedded space
4. Analyze external environments that drive system timing and scheduling
5. Analyze software tasks to determine system schedulability

6. Knowledge of common embedded hardware components, communication mechanisms and protocols and how they work

Learning Resources. All reading material is provided via Canvas or the textbooks are freely available from <https://library.cmu.edu>. Some of the course readings are listed below, but the most up-to-date course literature is listed in a week by week reading page under the weekly course modules.

Hardware Kits. This course requires a hardware development kit as part of the coursework. A kit will be loaned to you for the duration of the course and is expected to be returned in working condition. If the kit is damaged or doesn't function, the student is responsible for replacing the kit. The kit used in the course is the STM32F3 Discovery board, which you can review here: <https://www.st.com/en/evaluation-tools/stm32f3discovery.html>

Course and Grading Policies

This course will be graded using a combination of points and pass/fail criteria on assignments as well as class engagement. Results from all assessment types are rolled up into a final grade as outlined in the table below.

Assessment	Final Grade %	Grade	Percentage Interval
Software Engineering	30%	A-, A, A+	90-92, 93-97, 98-100%
Tool Proficiency	15%	B-, B, B+	80-82, 83-87, 88-89%
Technical Analysis	30%	C-, C, C+	70-72, 72-77, 78-79%
Domain Knowledge	25%	D	60-69%
		R (F)	59% or below

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.

Assignments

- **Software Engineering** – A (mostly) weekly assessment of progress in building and deploying firmware to an embedded target.
- **Technical Analysis** – Problem sets that show skill at using analytical tools needed in the design and construction of embedded systems.
- **Tool Proficiency** – Demonstrated proficiency in using the system tools and vendor toolchains needed for constructing and analyzing embedded systems.
- **Domain Knowledge** – These assignments focus on knowing the terminology techniques and general domain of embedded systems.

Recording of Class Sessions. All lectures will be pre-recorded and posted to Canvas. The creation of recordings from Zoom class meetings is not planned.

Use of Zoom in the Class. This course is offered as an on-campus in person course only. Zoom will not be used for regular lectures.

Course Schedule. The following schedule provides a general overview of topics and assignments and may be updated during the course! For actual dates and changes, please refer to the online syllabus in Canvas.

Class	Topic
1	Intro to Embedded Systems
2	Embedded Hardware
3	Starting the Cortex M4
4	Real Time Embedded Systems
5	Real Time Operating Systems
6	Real Time Operating Systems

7	Real Time Scheduling
8	Real Time Scheduling
9	Messaging and Communication
10	On-Board Communication Busses and Channels
11	Interacting with Embedded Devices
12	Multiprocessor Systems
13	Design and Engineering Tradeoffs
14	In Class Presentations and Course Wrap Up

Late Assignments. Accommodations for handing in late assignments is done through emailing the instructor that assignment is going to be late prior to the due date of the assignment. Liberal grace periods are applied (i.e., points won't typically be deducted for handins that are minutes or hours late) All outstanding assignments have a final due date of 72 hours prior to the university grade deadline. No assignments will be accepted after that and will receive a grade of zero. There are no late accommodations for in-class assessments.

Academic Integrity. Honesty and transparency are important to good scholarship. Plagiarism, cheating, and unauthorized assistance, however, are serious academic offenses with serious consequences. AI use or assistance is strictly forbidden for any reason and this course has a zero-tolerance policy towards AI use or assistance of any kind. Detected AI use (unless specifically authorized) will result in an automatic AIV being filed, significant grade penalty and/or failure for the course. Any cheating, plagiarism, unauthorized assistance, or use of AI will result in a zero (and possibly negative points) for the assignment and an Academic Integrity Violation on the first offense. Second offense will result in course failure and possible dismissal from the program with the exception above for detected use of AI authoring tools.

Generative AI Exemption: Generative AI is permitted to produce code for the course but comes with the responsibility to report it on the assignment submission and stated during any in-class assessment. Students will be asked on details of prompts used and any experiential learning gained through the use of Generative AI in creating code.

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.

Accommodations for Students Disabilities. If you have a disability and have an accommodations letter from 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.

Student Well-Being. The last few years have been challenging. We are all under a lot of stress and uncertainty currently. I encourage you to find ways to move regularly, eat well, and reach out to your support system or me if you need to. We can all benefit from support in times of stress, and this semester is no exception.

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.

If you are worried about affording food or feeling insecure about food, there are resources on campus who can help. Email (cmu-pantry@andrew.cmu.edu) or call (412-268-8704) the CMU Food Pantry Coordinator to schedule an appointment.

We must treat every individual with respect. We are diverse in many ways, and this diversity is fundamental to building and maintaining an equitable and inclusive campus community. Diversity can refer to multiple ways that we identify ourselves, including but not limited to race, color, national origin, language, sex, disability, age, sexual orientation, gender identity, religion, creed, ancestry, belief, veteran status,

or genetic information. Each of these diverse identities, along with many others not mentioned here, shape the perspectives our students, faculty, and staff bring to our campus. We, at CMU, will work to promote diversity, equity and inclusion not only because diversity fuels excellence and innovation, but because we want to pursue justice. We acknowledge our imperfections while we also fully commit to the work, inside and outside of our classrooms, of building and sustaining a campus community that increasingly embraces these core values.

Each of us is responsible for creating a safer, more inclusive environment.

Unfortunately, incidents of bias or discrimination do occur, whether intentional or unintentional. They contribute to creating an unwelcoming environment for individuals and groups at the university. Therefore, the university encourages anyone who experiences or observes unfair or hostile treatment on the basis of identity to speak out for justice and support, within the moment of the incident or after the incident has passed. Anyone can share these experiences using the following resources:

- **Center for Student Diversity and Inclusion:** csdi@andrew.cmu.edu, (412) 268-2150
- **Ethics Reporting Hotline.** Students, faculty, and staff can anonymously file a report by calling **844-587-0793** or visiting **cmu.ethicspoint.com**.

All reports will be documented and deliberated to determine if there should be any following actions. Regardless of incident type, the university will use all shared experiences to transform our campus climate to be more equitable and just.