

ESE3500 - Microcontroller and Embedded Systems Laboratory

Course Number & Title (A.1)	ESE3500 - Microcontroller and Embedded Systems Laboratory
Credit Units (A.2)	1.5CU
Class/Laboratory Schedule	Lecture: Monday & Wednesday, 12-1:30 pm in Amy Gutmann Hall (AGH) 105 Lab: Fridays, 10:15 am - 1:15 pm or 1:45-4:44 pm in AGH Detkin Lab
Instructor (A.3)	Nicholas McGill-Gardner (he/him) < nmcgill@seas.upenn.edu >
Text(s)/Required Materials (A.4)	None. The textbooks listed below are excellent supplements to the course materials. UPenn students get free online access through the Lean Library extension. • Introduction to Embedded Systems by Lee and Seshia • Making Embedded Systems by Elecia White • The Art of Electronics by Horowitz & Hill
Catalog Description (A.5a)	An embedded system is the product of a marriage between hardware and software. Embedded systems have become ubiquitous in the modern world - from simple temperature-controlled kettles to intricate smartwatches with many functions squeezed into a tiny package to complex rovers for space exploration. This course introduces the theory and practice of developing embedded systems by exploring microcontroller architectures. It culminates in a final project where students have the opportunity to synthesize and apply their knowledge in a project of their design.
Prerequisites (A.5b)	Prerequisites: • ESE2150: Electrical Circuits and Systems • CIS1200: Programming Languages and Techniques (or similar programming experience) Students who have not taken CIS1200 or ESE2150, but believe they have comparable knowledge, may apply through Waitlisty for permission to enroll.
Course Satisfies (A.5c)	[] Math [] Science ☒ Engineering [] Technical Elective [] TBS (check only one, UG curriculum impact only) CMPE ☒ Required [] Selected Elective [] Elective (check only one) EE [] Required ☒ Selected Elective [] Elective (check only one) SSE [] Required ☒ Selected Elective [] Elective (check only one) Engineering Design Component: 80% Note: ABET EAC Criterion 5b: Engineering design is devising a system, component, or process to meet desired needs. It is a decision-making process (often iterative), in which the basic sciences, mathematics, and engineering sciences are applied to convert resources optimally to meet these stated needs.
Course Web	Ed Discussion, Gradescope, GitHub Classroom, Google Drive
Course Outcomes (A.6a)	• Program microcontrollers via bit manipulation in C (“bare-metal programming”)

	• Interface with sensors and transducers using analog-to-digital conversion and/or serial communication • Communicate with devices through serial or wireless protocols • Control actuators using a variety of output compare methods, such as pulse width modulation • Synthesize and apply concepts learned over the course of the semester in a team-based final project • Learn to develop hardware and software requirement specifications
Contribution towards Program Outcomes (A.6b)	1) identify/formulate/solve/apply math – H 2) design for needs/constraints – N/A 3) communicate – M 4) ethics/contemporary context – N/A 5) teamwork - M 6) conduct/analyze/interpret experiments – N/A 7) effective learning strategies – H
Topics Covered (A.7)	Power management circuits, bit manipulation, analog-to-digital conversion, interrupts, timers, interfacing with sensors and transducers, device communication protocols
Weekly/Session Schedule (A.7)	Week 1: Introduction and review Week 2: Power management circuits and bootloading Week 3: General purpose input output (GPIO) pins and interrupts Week 4: Input capture and timers Week 5: Timers and output compare, pulse width modulation Week 6: Analog-to-digital conversion, transducers and sensors Week 7: Serial communication, computer architecture and memory Week 8: Assembly and stacks Week 9: Wireless communication I Week 10: Wireless Communication II Week 11: Final project proposal presentations Week 12: Special topics TBD Week 13: Milestone presentations Week 14: Special topics TBD Week 15: Final project demonstrations
Grading Details	The following show approximately assignment types make up the final grade, subject to change as needed during the semester. 23% Worksheets 33% Labs 06% Quizzes 33% Final Project 05% Participation
Prepared By/Date	Nicholas McGill-Gardner/January 2026

Course Aspirations

This course aims to prepare students for a career in engineering by giving them a sense of belonging within the field. This can only happen if all members of the course community – the instructor, TAs, and students – work together to create a supportive, inclusive environment that welcomes all students, regardless of their race, ethnicity, gender identity, sexuality, religious beliefs, physical or mental health status, or socioeconomic status. Diversity, inclusion, and belonging are all core values of this course. All participants in this course deserve to and should expect to be treated with respect by other community members.

Lectures, office hours, and group working time should be spaces where everyone feels welcome and safe. In order to facilitate a welcoming environment, students of this course are expected to :

- Exercise consideration and respect in their speech and actions.
- Attempt collaboration and consideration, including listening to opposing perspectives and authentically and respectfully raising concerns, before conflict.
- Refrain from demeaning, discriminatory, or harassing behavior and speech.

Attendance

Participation in our in-person lectures is a critical component of this class. In-class activities and preparatory work for these activities depend on the student's attendance in class; no credit will be awarded if the student fails to attend.

If a student is unable to attend a lecture due to illness, a family emergency, or other unforeseen circumstances, they should submit an absence notice through Path@Penn. See [Class Attendance](#).

Grading

Students will be graded using the following table:

A+	98% - 100%	B+	88% - 89.9%	C+	78% - 79.9%	D+	67% - 69%
A	94% - 97.9%	B	84% - 87.9%	C	74% - 77.9%	D	60% - 66%
A-	90% - 93.9%	B-	80% - 83.9%	C-	70% - 73.9%	F	< 59%

Classwork includes, but is not limited to: worksheets, labs, in-class activities, quizzes, and final project work. There is no weighting to these assignment grades. You can see the expected point values for each assignment in a tab on the course schedule spreadsheet, though these are subject to change as the semester progresses.

In addition to assignments, students are evaluated based on their participation. Participation will be based on interactions during lectures (on-time attendance and engagement), guest lectures, labs, office hours, and Ed Discussion.

Group assignments will have a feedback mechanism to help understand the distribution of work and collaboration. If there is a large disparity in work, grades may differ between students in the same group.

Quiz Policy

This course may leverage quizzes to reinforce course content. These will be given in person during the class period, unless otherwise noted. Students will be notified of the quiz at least a week prior. No technology use is permitted during the quiz. The

proctored testing environment and time atmosphere stem from this. For this reason, we do not accept make-up quiz requests for any reason that would not reasonably hold for requesting a make-up midterm. Acceptable reasons include:

- Illness
- Death in the family
- Religious observance
- More than two quizzes or exams scheduled on the same day

The teaching team reserves the right to approve or deny any unusual event. Quiz rescheduling requests must be made with reasonable notice.

Late Policy

Life happens and this class will make space for it. A total of **4 late days** can be used for any worksheet. You may not use any late days on quizzes or final project assignments. Assignments submitted within 24 hours after the due date are counted as 1 day, within 48 hours is 2 days, etc. Multiple late days can be used on assignments. Late days are **not permitted** on final project assignments, labs, or quizzes.

If a late assignment is submitted without enough late days, a score of 0 will be given. It is the student's responsibility to keep track of their late days. For extenuating circumstances, contact the instructor before the due date. Students must use the late-day request form linked at the top of all worksheet assignments.

If assignments or exams fall due on a religious holiday, please make arrangements with the instructor to accommodate before the posted due date.

Grade Adjustments

Regrade requests must be submitted via Gradescope within 1 week of when grades for the specific assignment are posted, or they may not be reviewed. Students are responsible for checking posted grades in a timely manner. The teaching team reserves the right to regrade the entire assignment. There are no regrades on assignments in the final project category.

Collaboration

Each student is expected to do their work individually, including but not limited to schematics, explanations, code, performing simulations, and writing solutions. All work, except labs and the final project, must be submitted individually. Students are free to discuss basic strategies and approaches with classmates and others, but the final submission must be individually written and submitted. If you feel that your answers may be influenced by individuals you worked with, note the names of the people you worked with on your submission document.

Artificial Intelligence Tools

The purpose of this course is to develop skills within the embedded hardware and firmware space. Using software, such as Claude or GPT-4, may or may not be useful to the learning student. If such language models are used when developing submissions, **this must be disclosed**. These exciting new tools are rapidly evolving and, as such, policies will evolve alongside.

University Policies and Resources

My objective is to build a comfortable and supportive learning environment. To do so, there are several policies that we will abide by and resources available to improve learning in the course. Please reach out to me or the TA with any questions or concerns.

Academic Integrity Policy

All students must correctly attribute the ideas, words, and data generated by others through proper citation. All course work submitted in this class must be authentically your own. I and the University hold a zero-tolerance policy for cheating and plagiarism. There will be a penalty if cheating is suspected and the offense may be reported to the Office of Student Conduct. Such offenses permanently mark your academic record. The Code of Academic Integrity can be found [here](#). Violation of the University Code of Academic Integrity may result in failure of the course.

Counseling and Psychological Services (CAPS)

Your mental health and wellness are of utmost importance to the course instruction staff. All members of the instruction staff will be happy to chat or just listen if you need someone to talk to, even if it's not specifically about this course.

If you or someone you know is in distress and urgently needs to speak with someone, please do not hesitate to contact [CAPS](#): 215-898-7021; 3624 Market St. If you are uncomfortable reaching out to CAPS, any member of the instruction staff will be happy to contact them on your behalf.

Sexual Harassment and Related Policies

All forms of sexual violence, relationship violence and stalking and attempts to commit such acts are considered to be serious misconduct and may result in disciplinary action up to and including expulsion or termination of employment. In addition, such acts may violate federal, state and local laws and perpetrators of such acts may be subject to criminal prosecution. For more information, please refer to [Penn's Sexual Harassment Policy](#), as well as the other related policies available at this link.

Students with Disabilities and Learning Differences

Students with disabilities are encouraged to contact Weingarten Learning Resource Center's Office for Student Disabilities Services for information and assistance with the process of accessing reasonable accommodations. For more information, visit <http://www.vpul.upenn.edu/lrc/sds/> or email lrcmail@pobox.upenn.edu.

[More Wellness Resources](#)