ECEN 5613 Embedded System Design FAQ

1. Has this Embedded System Design course been taught at CU in the past?

Yes, the Embedded System Design course was the first course designed for the Embedded Systems program. The course is further refined each semester it is offered. The course has been described by students as valuable, fun, and challenging. Starting in Fall 2014 the course was offered using a live video feed during lecture. The instructor has significant industry experience and brings his experience into the classroom.

2. When will this class meet and is attendance required?

ECEN 5613 will meet one evening per week at the time and place shown on the syllabus. Attendance and class participation is expected from all students. It is understood that time conflicts may prevent a student from attending every class. In the event that a class is missed, it is the student's responsibility to obtain handouts or notes from that class. Most class materials will be posted on the course web site. There is no scheduled lab time for this class. Students have access to lab space and equipment 24 hours per day every day of the week using card access. Note: many of the campus parking lots are free after 5:00pm.

3. What is the scope of this course? Will class members need to work in teams? Will there be lab work that must be done on campus?

Embedded System Design is focused at the fundamentals of embedded system design, and is meant to give students experience in both hardware and firmware. As a core course in the Embedded Systems Certificate Program, it is meant to provide a foundation of knowledge for students to utilize in future embedded systems courses and in their professional work environments. For the student who already has significant hardware and firmware experience, the course offers a framework within which the student can pursue an embedded systems project of interest to that student.

As far as the laboratory is concerned, the course is centered around the fundamentals of embedded system hardware and firmware design. Multiple processors are used to learn these fundamentals. Each student will learn about the design and construction of an embedded system. Students are required to demonstrate that their hardware works in the on-campus laboratory, and must demonstrate that they know how to use an oscilloscope and logic analyzer to debug their systems. The software tools, test equipment, and device programmer are available in the lab. The 8051 and ARM architectures are used in this course, including lab experiments utilizing a student-built 8051 board and an ARM-based developer kit.

Students who prefer to work off-campus can complete most of their work off-campus, but must demo their work in the on-campus laboratory.

The laboratory computers transitioned to a Windows 10 64-bit environment during the Fall 2016 semester and all software used in this course works in a robust fashion in this lab environment. Full instructor and TA support is limited to the computers and configurations used in the on-campus lab. Some students choose to use a Linux development environment.

Students may use the free SDCC compiler and ASX51 assembler, available via the course web site. Use of SDCC is encouraged; however, students should make sure to use the version recommended by the instructor.

Students may use an IDE, makefile, and/or a command line based approach to building their code. Students and TA's have reported good experiences with the Code::Blocks IDE, and this is a recommended development environment in a Windows 10 configuration. *The free Eclipse framework with SDCC plug-in also provides an IDE and was successfully used for many semesters in a Windows XP 32-bit environment; however, several students have experienced difficulties when trying to run Eclipse-SDCC under Windows 64-bit.* ***Modifications to some software revisions and some processes are required for students attempting their work in a Vista/Win10 32-bit/64-bit environment. No instructor/TA support is promised for such configurations.***

Free demo versions of the Dunfield Emily52 simulator and ASM51 assembler (but not the 8051 MICRO-C compiler) are available at the course web site http://ecee.colorado.edu/~mcclurel/. These DOS tools will run

in an emulator such as DOSBox on Windows 7 or Vista. Use of these legacy tools will be limited to a small portion of the course.

SDCC, Code::Blocks, Eclipse, and the Dunfield Emily52 simulator are installed on the computers in the on-campus embedded systems laboratory.

Schematics can be drawn using any schematic capture tool, including the free KiCad tools or the demo version of OrCad.

Students can fully develop and debug their hardware off-campus using the class parts kit, if they have their own soldering iron. Students may sign out a tool kit (including several items such as a wire wrap tool and power supply) and a portable PC-based logic analyzer for the semester. Communication to the hardware can be done with a simple RS-232 connection (potentially requiring a USB to RS-232 converter module) and a terminal emulator program running on a host computer. An 8051 monitor program will be available to students to aid in debugging hardware and firmware. Students who are comfortable with hardware and software design and debugging should be able to complete their assignments with a relatively small amount of time on-campus outside of class. On-campus time would include learning how to program a non-volatile code storage IC (e.g. an NVSRAM) and getting hardware to run with code stored in that IC, as well as demonstrating knowledge of how to use the oscilloscope and logic analyzer to debug microcontroller hardware, and demonstrating to the instructor or the TA that student-built hardware works.

The majority of the course will be taught using data sheets, application notes, and article reprints. In addition, notes and assignments will be provided to guide the students through the material. A formal text is not required for the course in addition to these materials; however, a list of recommended books will be provided with the course syllabus.

During the first half of the course, students will individually develop similar hardware platforms and firmware. Due to the common design of the hardware platforms, students can benefit from the experiences of other students in the class. Sharing of knowledge between students is highly encouraged; however, each student is expected to independently implement his/her own hardware and firmware. Students are encouraged to help other students solve problems, since significant learning can result from such activities. Students may find that they are able to leverage hardware or firmware designs from books, magazines, the Internet, or their work environments; however, in these cases, students are expected and required to credit the source of the information clearly and completely. Plagiarism is not acceptable.

Since it may be difficult for students taking the course to get together to work on team projects, students will be given the option to complete individual final projects if desired. If students prefer to work in teams, groups of up to three (3) students will be allowed. As examples of past projects, student teams have developed a device programmer, a graphic calculator, a multi-player tank battle game, an embedded operating system, an automated checkers game, a small mobile robot, a motor controller, a remote control billboard display, an MP3 player with compact flash memory interface, a USB device, a wireless pager, a VOIP system, and a home security system. Final projects will be presented during the last class period.

A preliminary syllabus will be posted on the course web site. The course will be a blend of hardware and firmware issues. Weekly lecture topics will parallel the hardware and firmware assignments, and will be scheduled to enable each student to develop a functional basic embedded system within the first six weeks of the class. Students enrolling in the class will be encouraged to start reading the data sheets for the processor before the class starts, as the schedule for the class will be somewhat challenging.

4. I haven't done hardware (software) design for a long time. Will I be able to complete this course successfully?

In order for a student to be successful in the course, the most important things are that the student has a good engineering background, an interest in the material, a high level of motivation, and enough time to devote to the course. Much of the course learning comes from the actual implementation of the hardware and firmware by each student. Although the implementation is challenging for some students, feedback from former students has indicated that the act of going through all the steps in the implementation has provided them a learning experience unmatched by pure theory courses. The complexity of the C and assembly programming required for success in the course is not great; however, all students are encouraged to review the basics of C and assembly programming before the class starts. In addition, students are highly encouraged to review basic EE concepts such as Ohm's law, RC circuits, digital logic, and basic microprocessor architecture before the course begins. This course will focus on the fundamentals of embedded systems, so extensive hardware or firmware knowledge is not a prerequisite for the course. However, the amount of material covered in the course is substantial, and students who are weak in one or more of the prerequisites may find the course difficult. The limited amount of instructor and TA office hour time will be shared among all the students in the class and may not be monopolized by a student who does not possess the prerequisite knowledge. It is common for students in this class to have diverse backgrounds, and for students with strengths in particular areas to share information and to work with students who have complementary strengths. Former students with backgrounds specific to software or to analog/digital electronics have successfully completed this course, and have commented that one of the best things about the course is that it gave them exposure to and experience in a technical area in which they were not strong.

5. What should I do if I start falling behind in the course, perhaps due to my lack of experience in embedded systems or due to increased work or travel requirements?

As soon as you realize that you're falling behind, you should plan on talking with the instructor and TAs, so that they can provide suggestions on how you can successfully complete the requirements of the course. The worst thing you can do is to fall further behind and get stressed out, so please talk with the instructor immediately once you realize there is an issue. If you miss the due dates for any assignments, talk with the instructor ASAP.

6. I have a lot of experience in the field of embedded systems and am already quite familiar with the 8051 family architecture. Is there any flexibility in the course structure that will allow me to explore other processors or areas of embedded systems?

The course is structured with four lab assignments that are common for all ECEN 5613 students, plus a final project that allows students to pursue a design area of their choosing. In order to maximize some aspects of learning and class support from the TAs and instructor, the first four labs are common for all the students in the class and these labs include learning elements that utilize both the 8051 and ARM architectures. If a student has significant experience in embedded systems and can easily complete the first three lab assignments, the instructor is willing to discuss options that allow the student more flexibility in the second half of the course. That flexibility may allow the student to pursue a more advanced final project, or to spend more time working with a different processor architecture. If you feel like you are in this category, talk with the instructor early in the semester.

Many students who previously used the 8051 before taking this course have remarked about how much more they learned about 8051 hardware and software design while taking this course. Even if a student has used the 8051 in the past, there is much to learn about embedded system design using this architecture. The addition of ARM architecture content to the lectures and lab assignments has increased the experience students will get in this course.

7. I'm really interested in taking the CU Embedded System Design class, but I live far from Boulder, Colorado. Can I take this course through some distance learning method?

Currently, the CU Embedded System Design course is not offered through distance learning. Since a large part of the course learning comes from the lab assignments and since TA and instructor assistance is commonly needed to debug student hardware/software issues, the course currently is only offered as an on-campus offering in Boulder. There are currently no plans to offer this course through distance learning in the future, although there are distance learning versions of many other embedded systems courses offered by the ECEE Department. Participation in some lectures via teleconferencing is being explored.

8. I work full time. How will I be able to get help in this class?

The instructor also has a full time job as a Director of Systems Engineering at Intel and understands the challenges of managing professional, academic, and personal commitments. Efforts will be made to clearly describe assignments to minimize student confusion. The instructor will hold office hours at a time mutually acceptable to the instructor and the class. A graduate teaching assistant (TA) will be available to assist students in the lab and to answer questions by e-mail and via our course's Slack team (https://slack.com). The instructor will also periodically distribute e-mail with information useful to the class, and will answer questions by e-mail in the event that the TA is not available. In addition, teleconferencing tools like Zoom (http://www.zoom.us), Google Hangouts, and Skype can be used to discuss issues at any mutually agreeable time during the semester.

9. About how many hours of work per week can be expected for this course?

This is a standard 16-week semester, 3 credit hour course. Average students with good knowledge of the prerequisite material can expect to spend 8-16 hours per week on the course for an average grade. The actual time required depends on each student's individual capabilities and the grade they would like to earn in the course. Many students indicate that this is a time consuming course. It is expected that this class will be a priority for students; however, it is understood that it is impossible for this class to be the top priority for all students due to their work and personal/family responsibilities. Efforts will be made to distribute assignments far in advance of the due date to allow students to fit this workload into their schedules. There will not be a final exam for this class. Students must exercise good time management skills while taking this course.

10. How will I get access to the lab areas? The doors are locked.

The labs are accessed 24 hours per day, 7 days per week, using a Buff OneCard, which is provided to all matriculated students. For non-matriculated (not enrolled in a degree program) or CU Connect/Continuing Education students, such as some students from industry, a Buff OneCard will be available for about $30. Students will need to go to the Buff OneCard (https://services.jsatech.com/index.php?cid=59) office in order to get this guest card. [Note, this dollar amount and process may change slightly from semester to semester.] Students are encouraged to get their cards before the first day of class. The Buff OneCard numbers will be collected during the first week, so that access to the embedded systems lab can be granted by the third week of the semester.

11. What is the grading criteria for the class?

The normal CU grading standards as shown below will be applied to this class.

A	Superior, outstanding
A-	
B+	
B	Above average
B-	
C+	
C	Average, has adequately met course requirements
C-	
D+	
D	Below average
D-	Minimum passing grade
F	Fail, has not met course requirements

ECEN 5613 is a graduate level class, and expectations for students will be high. Student performance in this class will be compared to student performance across ECEE graduate classes. A grade of 'A' will be reserved for students who have delivered outstanding work and who have clearly demonstrated a superior mastery of the course material. The majority of each student's course grade will be determined by the quality of the hardware and firmware assignments and the final project completed by the student during the semester. More grading information is available at: **http://ecee.colorado.edu/~mcclurel/grading.html**

12. How do the courses in the Embedded Systems Certificate Program fit together?

The Department of Electrical and Computer Engineering has a certificate program and a Master's degree program in embedded systems engineering. To obtain a certificate, students must successfully complete a set of courses specified by the Department.

See the ECEE Department web site for more details about the certificate and current requirements before working toward or applying for the certificate.

Note: As of Fall 2015, there is a new Embedded Systems Engineering Program in the ECEE Department. The Certificate structure is in the process of changing, and new embedded systems courses are being added. Several new courses were offered starting in Spring 2016, and there are new requirements regarding the enrollment restrictions and processes for each of these courses. Check with the ECEE Department for the current details.

13. What grades in the Embedded System Design class will count toward the embedded systems certificate?

Students may take this course for credit with standard 'A'-'F' grading, for credit with 'pass/fail' grading, or for no credit. This course will count toward the embedded systems certificate only for students who take the course for credit and earn a passing grade of 'B-' or better. This policy was changed in fall 2004. Prior to fall 2004, grades of 'C' or higher counted toward the certificate.

Counts toward certificate
- Grade of 'B-' or higher

Does not count toward certificate
- Grade of 'C+' or lower
- Grade of 'pass' or 'fail'
- No credit

14. What materials are required for the class?

Students will need a parts kit, which will be available in the first few weeks of the semester. The cost of the parts kit is the financial responsibility of the student. Additional parts required for projects and optional text books will also be the financial responsibility of the student. Data sheets and application notes will be freely available via the Internet. The software development tools will be available on the computers in the Embedded Systems Lab. Wire wrap tools, digital logic probes, portable PC-based logic analyzers, and other items may be checked out to each student and will be collected at the end of the semester. Computers, lab stations, logic analyzers, oscilloscopes, power supplies, device programmers, and a printer will be available in the on-campus lab area. A Buff OneCard will be needed for access to the laboratory.

15. I see that ECEN 5613 is sometimes offered through CU Boulder Connect/Continuing Education and the ECEE Department each semester. How do these two sections of the course differ?

These days, the two sections of the course have fewer differences than when the course was first offered many semesters ago. The major differences are:

- Registration priority differs. Students from industry have priority for the CU Boulder Connect (Continuing Education) section of the course. Full-time degree-seeking students have priority for the regular section of the course.
- An attempt is made to have more TA help available on the weekends, since students from industry tend to use the weekends to complete much of the course work, while full-time students often prefer weekdays and evenings.
- Tuition for the sections may be different. However, the course material for the two sections is identical and the two sections meet at the same time and in the same location.
- *To be confirmed:* CU handles registrations and credit earned through CU Boulder Connect/Continuing Education differently. There are limits regarding how many Continuing Education hours count towards a degree program. Some international students find that CU has requirement regarding the minimum number of credit hours that must be earned via main campus each semester; apparently Continuing Education courses do not count towards this minimum even if the courses meet on campus. It is the responsibility of the student to understand the details of the rules in effect during any particular semester.

16. Where can I find on-line information related to this Embedded System Design course?

The primary course web site can be found on the instructor's ECEE web page at:

http://ecee.colorado.edu/~mcclurel/index.html

This primary course web site will be updated often throughout the semester. Students will be able to obtain course information and documentation from this site. This web site includes links to many other useful web sites related to embedded systems.

WAIT LIST AND REGISTRATION FAQ - QUESTIONS AND ANSWERS

1. **The course is currently full and I'm number X on the wait list. What are my chances of getting into the class? Can you increase the enrollment limit?**

Sections of ECEN 5613 are taught concurrently, so students in all course sections fit into the same lecture room and lab, with a total enrollment limit of about 24 students. Registration for ECEN 5613 is done through normal CU-Boulder channels as well as through Continuing Education, with separate wait lists for each registration channel. Due to limits on the lecture room size, limits on the lab space, limits on lab equipment, and limits on the time available for the TA and instructor to help each enrolled student, the total enrollment limit of the course is typically not increased. Each semester, it is common for a couple of enrolled students to drop the course either before the semester starts or within the first three weeks of the semester; however, one cannot predict the exact number of students who will drop each semester. Therefore, it is likely that at least some of the students on the wait list will be able to enroll in the course. If you are on the wait list, the best advice is to wait until the beginning of the semester to see if space opens up. **Attending class and staying current with the course assignments while on the wait list and showing interest can increase your chances of being enrolled**.

2. **I'm graduating soon and I need this course in order to get the Embedded Systems Certificate. How can I register?**

Please check with the ECEE Department for the most recent policy regarding this matter, as it may change from time to time. The Department tries to prioritize student enrollment based on multiple factors, including whether the student needs the course in order to graduate.

As you may know, getting into the embedded systems courses can be quite a challenge. The ECEE Department is trying to rectify this situation.

Continuing Education registration typically starts about a month before the start of the semester.

Contact the ECEE Advisor if you have more questions regarding the wait list for the embedded systems courses.

3. **I want to take ECEN 5613 through Continuing Education and have the credits transferred to CU so that the course will count towards my degree, but I've already reached the 3-course limit on the number of courses that can be transferred to a degree program. What can I do?**

Please check with the ECEE Department if you are in this situation.

4. The course is currently full and other people are ahead of me on the wait list, but I really want to take the course this semester. Can you let me in anyway?

Unless there is some administrative error that needs to be corrected or some policy that gives a certain classification of student priority for taking the course, adjustments to the wait list are not generally made for this type of reason. Other people on the wait list also really want to take the course, so putting you ahead of them would not be fair. Your best bet is to let the administration know that you're very interested in taking the course this semester, and then stay on the wait list. **Attending class and staying current with the course assignments while on the wait list and showing interest can increase your chances of being enrolled**.

5. I'm really interested in the course, but I can't take it because the course has a wait list or because I don't have time to commit to the lab work. Can I sit in on the class?

No, there are reasons why students may not sit in on the class. First, since the course usually has a wait list, it would not be fair to those students on the wait list to allow other students to sit in on the class. If any space becomes available, it should go to students on the wait list. Second, since a great deal of the course learning comes from doing all the labs, the educational objectives of the course would not be met if students were allowed to sit in on the class but not complete the lab work.

6. Is it common to see a wait list for this course?

Yes, there is often a wait list as this has been a popular course. If you really want to take this class, enroll as early as possible. If you get on the wait list, **stay on the wait list and attend class**, since seats in the class sometimes open after the first week or two. Even if you are not near the top of the wait list, you may still get into the course, since students ahead of you on the wait list may sign up for other courses and will therefore drop off the wait list. Attending class and showing interest can increase your chances of being enrolled. If you don't get into the course, being on the wait list may give you priority in a future semester when you want to take the course. If you are on a wait list for the CU-Boulder section of the course, you may want to check into whether you can enroll in the Continuing Education section. The two sections are identical except for the tuition structure and enrollment process.