

ECEN 4613/5613 Embedded System Design FAQ

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

The Embedded System Design course was offered for the first time during the fall of 1999. During the Spring 2000 semester, the course was substantially improved and was offered for the first time through Continuing Education. Student feedback has been incorporated into the course design, and the course format has been modified to fit the needs of Continuing Education students better. The course is further refined each semester it is offered. The course has been described by students as valuable, fun, and challenging.

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

ECEN 5613 will meet on Wednesday evenings 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 the first 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 design and construction of an embedded system by each student, utilizing the 8051 microcontroller and an 8051 assembler and C compiler. 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 EPROM programmer and eraser are available in the lab.

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.

Students may use the free SDCC compiler and AS31 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, as earlier versions may have known bugs. You may need to download the correct revision from sourceforge.net (as of Fall 2009, we use version 2.6.0). Students may find that SDCC provides a more standard C development environment than MICRO-C. In addition, the free Eclipse framework with SDCC plug-in provides an IDE for students who prefer such a development tool. **In Spring 2007, 75% of the students in ECEN 4613/5613 used SDCC, and starting in Fall 2007, SDCC is the primary C compiler.**

Free demo versions of the Dunfield Emily52 simulator and ASM51 assembler (but not the 8051 MICRO-C compiler) are available at the Dunfield web site. Optionally (not required!), a student can purchase the DDS MICRO-C 8051 developer's kit (including an 8051 C cross compiler, 8051 cross assembler, and 8051 monitor) for \$99.95 plus shipping from <http://www.dunfield.com>. Also available is the Emily52 simulator (\$49.95), which can be used to debug code before hardware is available. **Note:** If you order, I suggest downloading the software directly from Dunfield Development Services (located in Canada); otherwise, it may not arrive in time for the course.

SDCC, Eclipse, and fully licensed versions of the Dunfield MICRO-C and Emily52 development tools are installed on the computers in the on-campus embedded systems laboratory.

Students can fully develop their hardware off-campus using the class parts kit, if they have their own soldering iron (students may sign out a wire wrap tool for the semester). Additionally, students can learn

how to debug their systems off-campus, if they have access to a +5V DC power supply (a small +9V DC, 1200 mA wall adapter is sufficient) and optionally, a logic analyzer. Communication to the hardware can be done with a simple RS-232 connection 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 an EPROM and getting hardware to run with code stored in that EPROM, 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. Several embedded systems books have been placed on reserve in the engineering library on campus. 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 8051 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, and a high level of motivation. 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.

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?

As of Fall 2009, the course is structured with four lab assignments that are common for all ECEN 4613/5613 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. 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.

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 some ongoing discussions about developing a distance learning version of some embedded systems courses.

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 computer design engineer at HP in Fort Collins 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 immediately after class on Wednesday nights, and at another time mutually acceptable to the instructor and the class (most likely on Saturdays). A graduate teaching assistant (TA) will be available to assist students in the lab and to answer questions by e-mail. 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.

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. 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.

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

Starting in Fall 2005, 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) students, such as some students from industry, a guest Buff OneCard will be available for about \$25. Students will need to go to the Buff OneCard (<http://www.buffonecard.com/>) 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 labs for those cards can be granted.

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 ECE 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://ece.colorado.edu/~mcclurel/grading.html>

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

The Department of Electrical and Computer Engineering has begun a certificate program in embedded systems. To obtain a certificate, students must successfully complete three embedded systems courses, consisting of two core courses and one elective course. The first core course is ECEN 4613/5613 Embedded System Design, in which students are exposed to the fundamentals of embedded systems and get experience in developing hardware and firmware around the popular 8-bit 8051 microcontroller. In the second core course, ECEN 4623/5623 Real-Time Embedded Systems, students learn real-time theory and gain experience in developing code using the popular VxWorks real-time operating system and various 32-bit targets (along with learning about the PCI bus).

Students may choose the third course from a set of approved electives. Currently, the approved electives include ECEN 4033/5543 Software Engineering of Stand-Alone Programs, ECEN 4633/5633 Embedded Systems Laboratory (redesigned in 2004 as Hybrid Embedded Systems, a.k.a. Hybrid Reconfigurable Systems), and ECEN 4573 ECE Capstone (now known as ECEN 4610 Capstone Laboratory). Students are encouraged to take ECEN 4033/5543 prior to ECEN 4623/5623 in order to maximize leverage of software engineering concepts.

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 student 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 Laboratory. If students want to purchase a copy of tools for use at home or work, they are welcome to order directly from the developer. Wire wrap tools, digital logic probes, 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, EPROM erasers, and a printer (TBD) 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 offered through CAETE (Continuing Education) and the ECE 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 several semesters ago. The major differences are:

- Registration priority differs. Students from industry have priority for the 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 for the CAETE section of the course, 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.
- Following the normal academic calendar is not a firm requirement for courses offered through CAETE, although the normal academic calendar is usually followed to enable full-time students to take the class.
- Tuition for the CAETE section is different than for the regular section. However, the course material for the two sections is identical and the two sections meet at the same time and in the same location.

16. Are the Embedded System Design courses ECEN 4613/5613 different from ECEN 4013/5013?

ECEN 4613/5613 are the new course numbers replacing ECEN 4013/5013 as of Fall 2002.

17. 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 ECE web page at:

<http://ece.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, including the CAETE & Continuing Education web sites.

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?

ECEN 4613 and ECEN 5613 are taught concurrently, so students in both classes fit into the same lecture room and lab, with a total enrollment limit of about 24-28 students. Registration for ECEN 5613 is done through normal CU channels as well as through CAETE (formerly 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 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?

Note: Please check with the ECE Department for the most recent policy regarding this matter, as it may change from time to time. The answer below is from November 2004.

As you may know, getting into ECEN 5613 (Embedded System Design), ECEN 5623 (Real-Time Embedded Systems), and ECEN 5633 (Hybrid Embedded Systems) is quite a challenge. The ECE Department is doing its best to rectify this situation. Unfortunately, it will not be rectified for spring 2005. This means that there will be 6 spaces each in ECEN 5613, ECEN 5623, and ECEN 5633 for graduate students. Below is the way that enrollment in these courses will be handled in spring 2005.

When you try to register for either 5613 or 5623 you will see that the enrollment limit has been changed to "0". You will be able to add your name to the wait list only.

After graduate students have registered on Friday, November 5, the wait list will be reviewed for each course. Students needing one of the above courses to graduate in May, 2005 will be given first priority.

Second priority will be given to students who were still on the wait list for the course as of September 10, 2004. If a student has two or more semesters left to complete before he/she expects to graduate, that student's chances of getting into the course from the wait list are minimal.

ECEN 5613 and ECEN 5623 will also be offered via CAETE in spring 2005. This is a cost effective way for non-Colorado resident students to take these courses. Cost for each Embedded System Course taken through CAETE is \$1,995.00. If you are interested in registering via the CAETE program you can get registration information at: <http://caete.colorado.edu/registration/default.aspx>

Students will not be allowed to wait list for ECEN 5613 and ECEN 5623 on campus and enroll for the course via CAETE. You must choose one or the other.

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

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

3. I want to take ECEN 5613 through CAETE 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?

[Note: Please verify this answer with the ECE Department if you are in this situation.]

The CAETE version of ECEN 5613 is exactly the same as the CU version of ECEN 5613. The 3-course transfer limit applies to courses taken through Continuing Education, but not through CAETE. Credits from courses taken through CAETE automatically show up on the student's transcript, without any transfer request needing to be made.

The CU administration has decided to let ECEN 5613 count towards degree programs without regard to the normal 3-course transfer limit. A student who has already transferred three courses from Continuing Education or CAETE to their degree program may still take ECEN 5613 through CAETE and have the course count toward their degree.

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 while on the wait list 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. 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 consider whether you can enroll in the CAETE section. The two sections are identical except for the tuition structure and enrollment process.