

## UNC - Charlotte, Department of Electrical and Computer Eng.

### Syllabus for ECGR 4101/5101 - Embedded Systems – Spring 2012

Instructor: James M. Conrad, Associate Professor of ECE

Office: Woodward 210C

Office hours: Whenever the door is open. Also: Tue 2-4 pm., Wed 2-3:30 pm

Email: [jmconrad@uncc.edu](mailto:jmconrad@uncc.edu)

Lecture: Pre-recorded lectures viewed at the student's convenience.

Lab Assistant: Michael McLain, [mamclain@student.uncc.edu](mailto:mamclain@student.uncc.edu), hours: F 10-11:30, 2-6:15.

Website: <http://www.coe.uncc.edu/~jmconrad/ECGR4101-2012-01> (also Moodle site)

*Check the web site frequently!*

### Prerequisite

Course: ITCS3182, ECGR3183, or departmental approval.

- Knowledge of C, C++, Java, or other high-level programming
- Knowledge of complex digital circuits, including computer architectures
- Knowledge of analog circuits
- Knowledge of modern computer-based design tools

### Textbook and Class Materials

Required: Students will be required to purchase a Renesas RX62N microcontroller evaluation board with software tools to use for the laboratory; they will keep this board after the class ends for use in other classes (e.g. Senior Design, Advanced Embedded Systems). The cost per student is about \$100 ([www.digikey.com](http://www.digikey.com), [www.renesas.com](http://www.renesas.com) ).

Required book: Embedded Systems, Jam M. Conrad and Alexander G. Dean, Micrium Press, 2011. ISBN: 978-1-935772-99-6. This book is available as a pdf for free online (Moodle site). You can print off a copy, or buy a hard copy via the internet.

Required: Note that you will be required to read articles off of the class website.

Optional: Remote students may need a webcam for lab demos and office hours.

Optional: Class notes are available online. Since tests are open book, open notes, it is recommended you obtain a copy.

### An “Internet” class?

This class is unusual in the ECE department in that the lectures are not live –they are recorded from the fall 2011 semester. All interaction with the professor is via email or office hours. The TA can also answer questions. We will also allow questions to be posted on the Moodle site.

### Catalog Description

Introduction to designing microcontroller-based embedded computer systems using assembly and C

programs. Examination of Real-time Operating Systems and their impact on performance. Computer engineering applications will be emphasized.

## **Purpose of Course**

The goal of this course is to solidify and build upon a student's knowledge of computer organization by presenting hands-on experience with microcontrollers. Students will also examine a few sensors that are used in commercial and medical products and learn how to interface them in a microcontroller system. Students will:

1. Recognize and identify the constraints facing embedded system designers, and determine how to assess them.
2. Program a modern microcontroller in assembly language and operate its peripheral devices.
3. Interpret how the assembly code generated by a compiler relates to the original C code.
4. Implement embedded systems using different peripheral devices, input, and communications devices.
5. Practice thread-based program design with a real-time operating system.
6. Develop programs controlling embedded systems using quick and efficient methods.

Students should be able to demonstrate the following competencies and knowledge:

1. An ability to design an embedded system (including hardware and software) that meet a written set of requirements.
2. An ability to identify, design, and implement an embedded system (including hardware and software) that solves a real world problem using engineering processes.
3. An ability to use hardware and software development techniques, skills, and computer tools to solve a real-world problem.

## **Course Topics**

1. Introduction to Embedded Systems and Microcontroller-based Circuit Design
2. Concepts of Microcontrollers
3. C Programming Review and Dissection
4. C Start-Up Module and Simple Digital I/O
5. Analog to Digital Conversion
6. Disciplined Software Development
7. Serial Communications
8. Timers and Pulse-Width Modulation (PWM)
9. Interrupt concepts and behavior and how to program with them in C
10. Software Testing
11. Non-Preemptive Scheduling
12. Preemptive Scheduling
13. Process Coordination and Scheduling

## **Labs**

The laboratory projects are an integral part of the course and are intended to provide experience in the application of the design techniques discussed in lecture. These projects will utilize the embedded systems board required for the class. There will be six exercises assigned. Lab exercises can be done in the Embedded Systems Teaching Lab (Woodward 203) or on your own home PC.

Because almost all of us learn by doing, the laboratory will probably be the most effective method for learning the material, and will help you on homeworks and exams. Also, ask yourself questions while preparing for the lab and during the lab. Do not just passively and monotonously follow the lab write-up-- ask some of your own questions and then find out the answers with your computer. To learn, you need to do it and you need to creatively think about what you are doing! Lab grades will be based on lab write-ups and demonstrated functionality of problem requirements. One lab report per lab pair is due at the specified time.

All lab assignments will require demonstrating the exercise working on the board. This will be done during the time scheduled for the class, or by appointment. If you are not on campus, you should arrange with the TA to use a video conference facility (i.e. Skype) to demonstrate the lab.

## Homework

Homework is another example of learning by doing. Although not as exciting as a lab, homework is essential to learning the concepts in this course. Homework will be in the form of reading assignments and problem sets. **No late homework will be accepted.** Homework must be done individually (you will learn the most from this). Any evidence of group participation will be interpreted as academic dishonesty. There will be 11 assignments, of which the highest 10 will be used in your final grade. Here are some guidelines for homework assignments:

- Homework must be uploaded to Moodle by a specific time, as announced on the class website.
- You will typically get better grades on homework if they are typed
- Do not repeat the question on the homework sheet.
- You should turn in a pdf version only, EXCEPT homework #11.
- Check the class web site for a MS Word file which is a template for homework. Replace the information in the header with your particular information.

If you have a dispute with how an assignment is graded, you should follow this procedure:

1. Get the solution to the assignment off the class web site and examine it. You may have just got the problem wrong.
2. If you really believe that your answer is correct (matches the answer given in the solution), contact the TA who graded your assignment and discuss it with them. They will listen to your concern, and act on it, at their discretion. In any case, they will sign the homework verifying that they saw it again.
3. If you are still not satisfied with the resolution, you may bring the homework to me for review. I will not review homework that has not been seen and signed by the TA.

We record all "disputed" points in a separate column. We contend that "disputed" points never add up to a change in your final grade, and we will examine this when final grades are assigned. Note that TA addition errors should follow the above procedure, but will not be figured in the "disputed" column.

## Exams

There will be two mid-semester exams and one final exam. **No calculators or computers** may be used on exams. Exams are open-book, open-notes. Exams will include material from the lecture, the readings, homework, and laboratories. Questions you may have during a test will not be answered -

most are just asking for hints. If you have a question about something on the tests, state your assumptions on the test paper when you answer the problem.

The exams will be held Exam dates/times:

- Midterm Exam 1: 5:00 – 6:15 pm, Friday, February 10, 2012, Woodward 140.
- Midterm Exam 2: 5:00 – 6:15 pm, Friday, March 23, 2012, Woodward 140.
- Final Exam: 5:00 – 7:30 pm, Friday, May 4, 2012, Woodward 140.

Local students will take the test in one room at the same time. Remote students will take the test at an approved location at about the same time, or they may travel to Charlotte to take the exams. Remote students will accept the responsibility of finding a suitable test site and will be responsible for any costs associated with taking a test at the site.

**Missed exams:** Attendance at all exams is mandatory. Only legal or debilitating medical excuses will be accepted (read: prison time, major blood loss, etc.), provided that they are accompanied by the appropriate official documentation. Makeup exams are more difficult than the exams they replace; few have passed. Failure to satisfy these criteria will result in a zero grade for the exam.

## **Course Lectures.**

This course uses video of lectures recorded during the fall 2011 semester. You will be expected to view the lectures before completing homework and lab assignments, so make sure you keep up with them. The professor uses transparencies and the document camera to teach this class. You can download these and print them from the web before viewing the lectures. See the web for the course lecture outline and specific video lectures. The lectures are on YouTube in high-definition, so make sure to choose the better resolution option (and perhaps make it full screen) for the best viewing experience.

## **Missing Assignments**

Throughout the semester, a student may miss assignments due to many reasons. None of the reasons will be accepted as an "excuse" for missing the assignment submission. . That is why one homework assignment is dropped when determining your final grade. Since this is an internet-based course and all assignments are turned in electronically instead of live, students must commit to viewing the lectures and completing the homework/lab assignments on time.

## **Project for ECGR5101 (Grad Students)**

It is expected that students registered for ECGR5101 will do an additional project.

The deliverables include:

- March 2, 6:15 pm: A one-page write-up on the proposed work. You should talk to the instructor BEFORE you decide on a project. You will be graded on content and proper use of English. (20 points)
- April 5, 6:15 pm: A report on initial activity of the project, including project plans,

bibliographical references, code listing, designs, etc. You will be graded on content and proper use of English. You also will be graded on progress made (40 points)

- May 7, 6:15 pm: A final report on activity of the project, including biographical references, code listing, designs, etc. You will be graded on content and proper use of English. (40 points)
- May 7, 6:15 pm: Demonstration of the project. The activity of the project will be graded as follows:
  - Value to the professor of the work: 20 points
  - Completeness of the activity – adherence to the plan: 60 points
  - Quality of the work: 20 points

## **Grading Percentages**

	<b>ECGR4101</b>	<b>ECGR5101</b>
Homework assignments	20% (200 points)	16.6% (200 points)
Lab assignments	20% (200 points)	16.6% (200 points)
Midterm Exams (2)	30% (300 points)	12.5% (300 points)
Final Exam	30% (300 points)	25% (300 points)
Project	None	16.6% (200 points)
Total	100% (1000 points)	100% (1200 points)

## **Academic Dishonesty**

All the provisions of the University code of academic integrity apply to this course. In addition, it is my understanding and expectation that your signature on any test or assignment means that you neither gave nor received unauthorized aid.

Please read the discourse on cheating and ECGR 4101/5101 on the web page. For homework and laboratory projects, while discussion is allowed, direct copying is not and students must turn in individual submissions. Realize that mastery of the material in the homework and lab assignments will be essential for a good performance on the exams! The only exception is that lab partners work closely on the lab assignment and turn in one lab report.

*All UNC Charlotte students have the responsibility to be familiar with and to observe the requirements of The UNC Charlotte Code of Student Academic Integrity (see the Catalog). This Code forbids cheating, fabrication or falsification of information, multiple submission of academic work, plagiarism, abuse of academic materials (such as Library books on reserve), and complicity in academic dishonesty (helping others to violate the Code). Any further specific requirements or permission regarding academic integrity in this course will be stated by the instructor, and are also binding on the students in this course. Students who violate the Code can be punished to the extent of being permanently expelled from UNC Charlotte and having this fact recorded on their official transcripts. The normal penalty is zero credit on the work involving dishonesty and further*

*substantial reduction of the course grade. In almost all cases, the course grade is reduced to "F." If you do not have a copy of the Code, you can obtain one from the Dean of Students Office or access it online at [www.legal.uncc.edu/policies/ps-105.html](http://www.legal.uncc.edu/policies/ps-105.html) . Standards of academic integrity will be enforced in this course. Students are expected to report cases of academic dishonesty they become aware of to the course instructor who is responsible for dealing with them.*

## **Course Calendar**

Refer to the web page: <http://www.registrar.uncc.edu/calendar.htm> for the academic calendar.

## **Instructor and Student Conduct**

**Syllabus Revisions:** The standards and requirements set forth in this syllabus may be modified at any time by the course instructor. Notice of such changes will be by announcement in class and/or by email to your UNCC email address.

**Disability Services/Special Needs:** If you have a documented disability and require accommodation in this course, contact the Disability Services office, located in Fretwell building, room 230. Phone 704/687.4355 (voice/TDD). Information about available services can be found at: <http://www.ds.uncc.edu> . Students in this course seeking accommodations to disabilities must first consult with the Office of Disability Services and follow the instructions of that office for obtaining accommodations. Please initiate this process and inform me during the first two weeks of class.

**Diversity:** UNC Charlotte strives to create an academic climate in which the dignity of all individuals is respected and maintained. Therefore, we celebrate diversity that includes, but is not limited to ability/disability, age, culture, ethnicity, gender, language, race, religion, sexual orientation, and socioeconomic status.

**Communication:** I will try and answer emails and phone calls received during the hours of Monday – Friday, 9 am to 4 pm within 24 hours. If you email and/or call at any other times, it is strictly a random chance that I'll respond in a timely manner. You should check your UNCC email every day as that is the primary way that I will communicate with you when not in class. When communicating with me via email, please put in the subject line the course number so I can readily identify who you are. *If your communication via email is rude, has grammatical, and/or spelling mistakes, I will not respond at all.* If I have not responded to your email within 24 hours as stated within the conditions above, perhaps you need to resend it and/or reword it. You are to conduct yourselves in a professional manner at all times.

**Turnitin.com:** As a condition of taking this course, some required assignments may be subject to submission for textual similarity review to Turnitin.com for the detection of plagiarism. All submitted papers will be included as source documents in the Turnitin.com reference database solely for the purpose of detecting plagiarism of such papers. No student papers will be submitted to Turnitin.com without a student's written consent (<http://www.legal.uncc.edu/turnitinconsentform.pdf> ) and permission. If a student does not provide such written consent and permission, the instructor may: (i) require a short reflection paper on research methodology; (ii) require a draft bibliography prior to submission of the final paper; or (iii) require the cover page and first cited page of each reference source to be photocopied and submitted with the final paper.

**Sexual Harassment:** All students are required to abide by the UNC Charlotte Sexual Harassment Policy ( <http://www.legal.uncc.edu/policies/ps-61.html> ) and the policy on Responsible Use of University Computing and Electronic Communication Resources ( <http://www.legal.uncc.edu/policies/ps66.html> ). Sexual harassment, as defined in the UNC Charlotte Sexual Harassment Policy, is prohibited, even when carried out through computers or other electronic communications systems, including course-based chat rooms or message boards.

**Religious Accommodations for Students:** UNC Charlotte Policy #134 in part states: Students who, acting in accordance with this Policy, miss classes, examinations or other assignments because of a religious practice or belief must be provided with a reasonable alternative opportunity to complete such academic responsibilities. It is the obligation of students to provide faculty with reasonable notice of the dates of religious observances on which they will be absent by submitting a Request for Religious Accommodation Form to their instructor prior to the census date for enrollment for a given semester. The census date for each semester (typically the tenth day of instruction) can be found in UNC Charlotte's academic calendar. A student who submits a Request for Religious Accommodation Form after the census date must show good cause for the late submission, and the late submission itself may be taken into account in determining whether the student has a religious practice or belief requiring accommodation and whether granting the request would create undue hardship. ( <http://legal.uncc.edu/policies/ps-134.html> ). Read the policy webpage for specific details and the form.