Department of Electrical and Computer Engineering
ECE 1161/2161 Embedded Computer System Design 2, Spring 2019

Instructor:
Dr. Wei Gao
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Office Hour: TuTh 3:30pm – 4:30pm or by appointment

Class/Laboratory Schedule:
Class: TuTh 4:30pm – 5:45pm, 226 Benedum
Laboratory: 1223 Benedum

Teaching Assistant:
Ruirong Chen
Office: 1237 Benedum
Office Hours: TBA

Course Description:

This course follows up with *ECE 1160/2160 Embedded Computer System Design 1*. Based on the primary concepts, methodology of embedded system design taught in ECE 1160/2160, this course aims to present the students with the more detailed and advanced techniques of designing, developing and implementing embedded computer systems with respect to emerging application paradigms, such as wearable and implantable computing, smart health, smart buildings, smart city, intelligent transportation systems, autonomous vehicles, innovative sensing, etc. The students will gain hands-on experiences to work with various types of modern hardware devices and software platforms for sensing, computation, communication and control, in order to realize their design ideas and practice their system development skills.

This course is organized with two parts. In the first part, a series of classroom lectures will be given to cover the recent techniques in different aspects of embedded computer system design, as well as the applications of these techniques in emerging scenarios. In the second part, students will work in teams on a semester-long project, which will involve the hands-on design, configuration, implementation and testing of an embedded system prototype of their choice. The students are expected to use the given lectures as guidelines to explore their system design ideas and technical approaches. A structured framework will be provided to aid in the success of each team, by dividing the project process into several key milestones throughout the semester. The class time in this part, then, will consist of regular bi-weekly team presentations and demos of key project milestones, each of which is followed by a team discussion with the instructor for detailed instructions and advices about the project progress, challenges, issues and plans. This course will concludes with a final project presentation and demo, and each team will need to deliver a final project report by the end of the semester.

This course assumes that students have the basic knowledge about different components of embedded computer systems, such as the digital system concepts, microcontroller architecture, wireless communication, etc, and are proficient in programming with at least one computer language, such as C, C++, Python or Java. The course project will utilize a synergistic mixture of skills in system architecture, modular system design, hardware prototyping, software engineering, subsystem integration, debugging and testing.

The following is a brief list of topics being covered by this course:

- Advanced embedded computing architecture
- Distributed and autonomous computing
- Mobile cloud and edge computing
- Advanced I/O interfaces

- Cross-technology communication
- Batteryless sensing and communication
- Innovative sensing techniques, including laser and wireless based sensing
- Energy harvesting

Textbooks and/or Other Material:
No textbook required.

Recommended references:
Introduction to Embedded Systems: A Cyber-Physical System Approach. Edward Ashford Lee and Sanjit Seshia, ISBN 978-0-557-70857-4, 2011. Download available at: http://leeseshia.org/releases/LeeSeshia_DigitalV1_06.pdf

Embedded Systems: A Contemporary Design Tool. James Peckol, Wiley, 2011.

Course Grading and Assignments:
Project proposal: 10%
4 Project interim milestones: 15% each
Project final presentation & report: 25%
Class participation: 5%

In general, your grade will be based on your performance in the course project, in particular, represented by your ability to

- Function on a collaborative and potentially multidisciplinary team
- Apply your accumulated knowledge within your major that is gained in this course and other courses towards the project design and development
- Design your system and establish the project milestone goals under practical constraints of space, time, and budget
- Identify issues, discuss possibilities and propose solutions as problems arise
- Apply engineering tools and methodologies for project completion
- Communicate thoroughly, clearly and concisely with the team members, the course instructor and other classmates in demonstrations, presentations and reports

Project proposal:
Every student team needs to submit their proposal presentation file and a 1-page proposal document to the instructor by the presentation day. Your grade on the project proposal will be decided from the following four aspects:

- *Design feasibility* – 20%. Your proposal should provide a high-level picture of your overall system design, and you should provide argument about why the design choices are feasible and practical with respect to the time scope and budget of your project.
- *Anticipated technical difficulty* – 20%. You will need to do comprehensive survey and literature reading about your project topic and your design choices, to anticipate any possible technical difficulty that you may encounter in advance. For each anticipated difficulty, a brief technical solution should be presented and discussed.
- *Project planning* – 40%. Each student team needs to outline *a project plan* in their project proposal, including a list of anticipated interim goals that should be reached at each interim milestone. This plan will then be used as the guideline of your later project development, as well as the grading of interim milestones. *You will have the chance to revise succeeding goals when you reach each interim milestone*.
- *Presentation clarity* – 20%. Your presentation and proposal document should be clear and easily understandable. Detailed instructions about what to be included will be provided in classroom lectures.

Project interim milestones:

Afterwards, you are expected to demonstrate your progress on project design and development in each interim milestone, and complete a final project report by the end of the semester. Your grades on interim project milestones and final presentation/report will be decided from the following four aspects:

- *Design feasibility* – 25%. Your detailed design choices of different subsystems of the project must be validated and justified, with respect to the time scope and budget of your project.
- *Technical difficulty and efforts* – 25%. The amount of technical efforts made to address more technical difficulties or accomplish advanced project goals, if being appropriately justified and demonstrated, will receive higher grades.
- *Development completeness* – 30%. At each milestone, your grade will depend on whether/how you completed the list of project goals that you established at the project proposal or the previous milestone.
- *Presentation clarity* – 20%. Your presentation and project report should be clear and easily understandable.

Grading on the project interim milestones will be conducted following a "challenge and defense" procedure. More specifically, every student team, after their project milestone presentation, will receive a list of questions related to their progress towards completing their project goals at this milestone (1-2 questions for each listed project goal). They will then have two days to prepare their responses to these questions and defend themselves against these questions in the following class of team discussions. Their grades will then be determined by their performance in both steps of this process, and during the discussion phase they will also receive detailed feedback about how to improve in the future.

Class participation:

Students are expected to attend every class, and get actively involved into the discussion of other teams' project work.

Laboratory:

The lab will open after the project proposal, and student teams have full access to 1223 Benedum during the designated lab hours. The lab has equipped with desktop computer workstations, oscilloscopes, signal generators, meters and other testing facilities that can be used by students. Small tools are also available for use in designated areas of the laboratory. The TA will be in the lab to help students with their technical problems. No separate lab lectures will be given.

Purchasing and Reimbursement:

In this course, students will have the flexibility to purchase the devices, parts and materials that they consider as necessary for their course projects, with a guideline upper limit of $250 (additional budget may be allowed upon approval of the instructor). The expense of these purchases will be reimbursed back to the students in the end of the semester. However, each team will need to create a proposed budget and get the instructor's approval for a final reimbursable project expense. At the end of the semester, the instructors keep all devices, parts and materials being reimbursed, and they will then be available for students in succeeding years. Note: Some electronic parts can be obtained from the ECE IT Staff (James Lyle or Will McGahey in 1214 Benedum).

Student Responsibility:

Students should be serious about taking this course. Students that drop the class late in the semester affect their team's progress. In the event of late drops or unavoidable problems, the instructor will try to compensate by adjusting the metrics for grading.

Each student team should work independently of other groups, and each team member should undertake an equitable portion of the technical tasks, which may include architecture design, software development, hardware prototyping and report writing. Preliminary information gathering or literature survey is not considered as technical workload. Since each student will be graded individually, it is important to decide and specify the responsibility of each team member in the early stage of the project. Students are also suggested to affiliate each project goal with the specific team member(s).

Students will have the flexibility to find teammates and form project teams by themselves, and diverse skillsets among team members are desirable for a successful project. Efficient collaboration as a team is important. In case of difficulties among the group members which cannot be handled by the group members, inform the instructors promptly. Waiting until the end of the term to bring up such problems is too late.

Academic Integrity:

All the academic integrity guidelines specified by the Swanson School of Engineering apply to this course: http://www.engineering.pitt.edu/Academic-Integrity-Guidelines/.

Disability Statement:

Any student who feels s/he may need an accommodation based on the impact of a disability should contact the Office of Disability Services at 412-648-7910 to coordinate reasonable accommodations for students with documented disabilities.