ECE/CS 5780/6780: Embedded System Design

Credits and Contact Hours: 4.0 Credit Hours
15 weeks: Two 80-minute lectures and one 3-hour lab per week

Instructor’s Name: Andrew N. Fisher

Text Book(s) and/or Required Material:

Catalog Description: Introduction to issues in embedded system design using microcontrollers. Topics include: microcontroller architecture, memory interfacing, serial and parallel I/O interfacing, analog interfacing, interrupt synchronization, and embedded software.

Prerequisites:
- Full major status in Computer Science or Computer Engineering; and
- C- or better in ((CS 3810 or ECE 3810) and (CS 2000 or CS 4400))

Designation: Required

Contribution of Course to Meeting the Requirements of ABET Criterion 5: Engineering sciences and engineering design: This course teaches electrical engineering science and electrical engineering design.

Specific Outcomes of Instruction:
After this course, students should be able to:
1. Learn how the hardware and software components of a microprocessor-based system work together to implement system-level features;
2. Learn both hardware and software aspects of integrating digital devices (such as memory and I/O interfaces) into microprocessor-based systems;
3. Learn the operating principles of, and gain hands-on experience with, common microprocessor peripherals such as UARTs, timers, and analog-to-digital and digital-to-analog converters;
4. Get practical experience in applied digital logic design, assembly-language, and higher level C programming; and
5. Be exposed to the tools and techniques used by practicing engineers to design, implement, and debug microprocessor-based systems.

Relationship of the Course to the Program Outcomes:
(a) An ability to apply knowledge of mathematics, science, and engineering. This course is not highly mathematical or scientific. It is nearly pure engineering: how can we use a microcontroller to achieve a desired effect with minimal cost, effort, and risk?
(b) An ability to design and conduct experiments, to analyze and interpret data, and to debug and analyze software. The ability to analyze and debug software is a critical skill that this course attempts to cultivate in students. Students complete a number of laboratory assignments requiring increasingly difficult problem solving in order to create correct solutions.

(c) An ability to design a system, component, process or software package to meet desired needs. The high-level purpose of this course is to meet this exact outcome. That is, students must begin the processing of learning to map a collection of requirements (available hardware, power budget, dollar budget, features, etc.) onto a collection of discrete components including one or more microcontrollers running embedded software.

(d) An ability to function on multidisciplinary teams. All students in 5780/6780 complete a collection of labs working in groups of two. However, teams are not necessarily multidisciplinary by default, but they could be comprised of students in electrical engineering, computer engineering, and/or computer science. Enrollment in the course is typically skewed toward electrical engineering students.

(e) An ability to identify, formulate and solve engineering problems. As part of the second phase of the course, students must complete a project. As part of the project, students must identify a problem that they wish to solve, come up with their approach to solving it, and then implement their approach. This includes researching what type of peripherals are available to suit their needs, such as motors and sensor. Then identifying what type of microcontroller they will need to interact with the peripheral they chose. And finally programming and assembling the device.

(g) An ability to communicate effectively in written and oral form. At the conclusion of their project, students are required to prepare a report that details their project’s goal, the challenges they faced, and how they solved them.

(i) A recognition of the need for, and an ability to engage in life-long learning. Throughout the course, it is emphasized that the material covered in lecture is not nearly 100% of the material required to complete the labs. There are many details that the students must uncover for themselves by making resourceful use of the available documentation. Some of the most useful documents are linked to the course web page and a few hard copies of the most important documents are available in the lab.

(k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice. Effective engineering of embedded systems is tool-intensive. Students must be able to understand and use, for example, PCB design suites, compilers, assemblers, linkers, bootstrap loaders, debuggers, and verifiers.

Topics Covered in the Course:
- Computer architecture beyond the CPU
- Fundamentals of the hardware/software interface
- Techniques for sensing and controlling the physical world
- Design and implementation of non-trivial, open-ended projects involving both hardware and software