Embedded System Design

ECEN 5613 – Spring 2016

Monday Evenings, 6:30pm–9:00pm, ECCS 1B14
Instructor: Prof. Linden McClure, Dept. of Electrical, Computer, and Energy Engineering
E-mail: Linden.McClure@Colorado.EDU
Course Web Site: http://ecee.colorado.edu/~mcclurel/index.html

ECEN 5613 is also being offered through BBA (Be Boulder Anywhere) this semester. See the BBA web site for tuition and enrollment information:
http://beboulderanywhere.colorado.edu/craft-your-own-study/certificates/embedded-systems
http://beboulderanywhere.colorado.edu/enroll-or-apply-now
BBA enrollment will begin in December. Contact BBA for more information.

Course Description
In this class, the fundamentals of embedded system hardware and firmware design will be explored. Issues such as embedded processor selection, glue logic, circuit design, circuit layout, circuit debugging, development tools, firmware architecture, firmware design, and firmware debugging will be discussed. The Intel 8051, a very popular microcontroller family, will be studied. The architecture and instruction set of the microcontroller will be discussed, and a wirewrapped microcontroller board will be built and debugged by each student. Students will develop embedded software in C and assembly. The course will culminate with a significant final project which will extend the base microcontroller board completed earlier in the course. Learning may be supplemented with periodic guest lectures by embedded systems engineers from industry. This course serves as an excellent preparatory course for ECEN 4610/4620 (ECEE Capstone) and ECEN 4623/5623 (Real-Time Embedded Systems). This course also counts towards the Embedded Systems Certificate. See the course web site for more detailed information.

Required Background
Knowledge of and skills in microprocessor architecture and assembly language, microprocessor peripherals, digital design, and the C programming language are prerequisites for this course. The corresponding CU-Boulder courses include ECEN 2120/2350 and ECEN 3100/3350. Although not listed as formal prerequisites, circuits/electronics (ECEN 3250) and computer organization (ECEN 4593) are highly recommended. An understanding of compilers, assemblers, linkers, operating systems, analog design, diodes, transistors, and electromagnetic fields and waves will be useful.

Course Context
Embedded systems are involved in almost every facet of modern life. Cell phones, tablets, MP3 players, energy conversion systems, medical equipment, answering machines, microwave ovens, televisions, VCRs/DVRs, CD/DVD players, video game consoles, GPS devices, network routers, fax machines, cameras, music synthesizers, planes, spacecraft, boats, and cars all contain embedded processors. Late model cars may contain as many as 65 embedded microprocessors, controlling such tasks as antilock braking, climate control, engine control, entertainment system control, collision avoidance, airbag deployment, etc. The Boeing 777 aircraft contains over 1,200 processors and more than 4 million lines of software! Logic analyzers and digital storage oscilloscopes utilize embedded processors to support real-time operation. Even PCs, which are designed around powerful CPUs, contain embedded systems. Storage drives (hard disk, solid state, CD-RW, DVD-RW, Blu-ray), and external peripherals such as printers, scanners, and other SATA, SAS, USB, or IEEE 1394 devices all contain embedded processors. During 2007, microprocessor manufacturers sold on the order of 100 million processors for use as computer CPUs. In comparison, during the same time frame, microprocessor manufacturers sold more than 3 billion embedded processors, primarily consisting of 32-bit, 16-bit, 8-bit, and 4-bit devices. The tremendous number of applications for embedded computing has given rise to high demand for engineers with experience in designing and implementing embedded systems. This course will give students hands-on experience and opportunities for experimentation in this exciting field.