Embedded Design: Enabling Robotics

EECE2160 + Lab EECE2161, Fall 14

Instructor: **Prof. Gunar Schirner**
Office: 328 Dana Research Center
Northeastern University
Phone: +1 (617) 373 5707
Email: schirner@ece.neu.edu
Please use a Northeastern email ID for communication and include "**EECE2160**" in the subject. Both help categorizing the email.

Teaching Assistant:
Nasibeh Teimouri Teimouri.N@husky.neu.edu
James Massucco massucco.j@husky.neu.edu

Lectures: **Mon, Wed, Thurs: 10:30 AM to 11:35 AM**
Location: 009 Hayden (ECE Labs) map

Laboratory: **Mon 11:45 AM to 12:55 PM (as well as during class)**
Location: 009 Hayden Hall, Room 009C

Web page: on Blackboard, plus online forum on blackboard Discussion Board

Office Hours: **Tuesday 1:30pm – 2:30pm, Thursday, 2:45pm –3:45pm, 328DA**

Course Overview

This class presents many of the fundamental concepts of Computer Engineering. The course covers programming, operating systems, digital design, embedded systems, or networking. The course provides students with an introduction to each of these areas so that students can combine them together in a complete system design/implementation. The interaction between digital hardware and software is emphasized in the class. This class also prepares you for some of the fundamentals classes in Computer Engineering.
The class is taught in our integrated lab / classrooms in 009 Hayden. This allows the class to move easily between concepts and practice of the concepts, whether they are hardware or software concepts. We will utilize an embedded platform that controls a robotic arm to allow students to learn about the hardware/software interface.

Course Objectives

To introduce ECE students to many of the fundamental concepts in Computer Engineering.

1. To become familiar with Unix/Linux and embedded programming.
2. To introduce students to digital design principles.
3. To acquire knowledge of embedded system design.
4. To be exposed to wireless networking and robotic control.
5. To develop an appreciation for the software/hardware interface.

Textbooks

- Yale Patt and Sanjay Patel, **Introduction to Computing Systems: From Bits and Gates to C and Beyond**, 2nd edition, Publication Date: August 5, 2003 | ISBN-10: 0072467509 | ISBN-13: 978- 0072467505.

Homework Assignments

Students will learn to navigate Linux, develop C/C++ programs on Linux, and will design and simulate digital designs in software (Simulink). Homework exercises will allow students to demonstrate their mastery of the theory presented in class.

Technical Writing

While students are expected to submit high quality laboratory reports, we will also focus on improving your technical writing skills in this class. One of the laboratory reports will be selected to teach students proper technical writing practices. The report will be graded based on a well-defined set of rubrics provided as part of the assignment. Students will have the opportunity to receive feedback on their writing and will revise their report.

Quizzes

The class will include quizzes that can be given during any class during the semester. The quizzes will be given in the first 5-10 minutes of class, so please be prompt to class. Quizzes cannot be made up unless the student informs the instructor of their planned absence prior to the start of class.

Labs

This class includes 10 laboratory assignments (0-9). The lab provides students with hands-on experience on an actual embedded platform: the Zedboard based on Xilinx Zynq System-on-Chip (SoC). The platform runs xiLinux, an Ubuntu Linux derivative. The assignments guide students writing C programs in Linux running on the embedded processor (ARM Cortex A9), how to develop digital designs using Simulink run in programmable logic of the Zynq (a FPGA). Assignments range from basic programming, general purpose input / output, interfacing via Bluetooth with a WiiMote to controlling a robotic arm with the Zedboard. Lab exercises are designed to follow the classroom topics, and will provide open-ended design experience.
Students will be assigned a pre-lab, which they should complete before coming to the laboratory. The grade received in the lab will be a combination of the pre-lab preparation, progress made on the laboratory report.

Lab assignment overview:

0) Linux fundamentals, SSH Login, First C Program
1) Compiler handling of different types of data
2) Debugging
3) Memory mapped I/O on the ZedBoard: Embedded Hello World
4) Introduction Bluetooth and WiiMote interfacing
5) Introduction to Simulink and develop a digital design.
6) Simulink HDL Coder to program the FPGA on the ZedBoard
7) Pulse Width Modulation (PWM) signals in SW for servo control
8) PWM in HW for robot control
9) Control robot arm via WiiMote

Computing

All homework that involves a computer should be done on the College of Engineering Linux systems or on the Zedboard. Students may use their own computer for development, but need to verify that each assignment compiles and runs on the COE systems. All Northeastern COE students have an account on the COE Linux system. It is your responsibility to obtain this account and use it to complete homework assignments. If you are not familiar with Linux, now is the time to become so. Do not wait until the work has been assigned. A Linux tutorial will be provided in the first week of the semester.

Final

There will be a final exam. The exam will be open notes, but closed book.

Grading

Both the **EECE2160 – Lecture** and **EECE2161 – Lab** receive identical grades as both components are tightly integrated. The weight distribution is as follows:

Homework Assignments:	25%
Technical Paper:	05%
Quizzes:	10%
Laboratory:	40%
Final:	20%

Late submissions will receive 0 points from the time the reference solution has been posted. Otherwise, a late penalty applies dependent on the submission delay as following:

< 01 hour	5%
< 24 hours	30%
< 48 hours	50%
>= 48 hours	100%

Academic Honesty

Plagiarism, cheating, and any form of unauthorized collaboration will not be tolerated and will be handled in accordance with University policies described in the Student Handbook. You are expected to be familiar with the University's policies about academic honesty: http://www.northeastern.edu/osccr/academichonesty.html.

Although students are encouraged to discuss some homework assignments and work together to develop a deeper understanding of the topics presented in this course, submission of others' work, efforts, or ideas as your own is not permitted. Each student is expected to prepare and submit his/her own programs, reports, drawings, and other materials unless otherwise designated as collaborative work.

Copying and sharing of student work such as computer files, documents, spreadsheets, or drawings is not allowed. If multiple students' work is suspiciously similar, a penalty may be assessed to all students involved. If a situation arises in which you are uncertain whether cooperation with another student would constitute cheating or some other violation of the honor code, please ask the instructor for guidance and clarification of these rules. Any evidence of cheating will be referred to the Office of Student Conduct.

[Thanks to Prof. Leeser for the academic honesty policy.]

Other Class Policies

For questions about class material including assignments, please use the Discussion Board on Blackboard. You may get an answer sooner, and it gives your fellow classmates the opportunity also benefit from your learning experience. I highly encourage you to read the Discussion Board and also answer questions to help your classmates.
The issuance of incomplete grades will strictly follow the College of Engineering guidelines. An incomplete will only be given for missed work at the end of the term due to illness. A request for an incomplete grade must be made two weeks before the final.

Schedule (subject to change)

Week	Date	Topic
1	09/03	Data types, Zedboard, Linux – bits/bytes/types, abstraction levels
2	09/08	Linux and C programming – shells, OS principles, compiling/debugging
3	09/15	Linux and C programming – make, memory-mapped I/O
4	09/22	Data structures and algorithms – arrays, linked lists, sorting
5	09/29	Boolean logic, simple gates – truth tables, AND/OR/INV/XOR/NOR/NAND
6	10/06	Simulink intro, compound gates – encoders/decoders, muxes, adders
7	10/13	Bluetooth overview, motor control – pulse width modulation
8	10/20	Simulink cont., digital simulation – adders
9	10/27	Programmable logic and CPU overview – FPGA and ARM
10	11/03	Hardware/software interfacing – interfacing/communication, polling
11	11/10	Memory systems – addressing, SRAM, DRAM
12	11/17	Sequential logic – clocks, latches, counters
13	11/24	CPU architectures – ARM vs. X86
14	12/01	Review, Last day of class Wed 12/03
15		Finals week, Final date TBA

Holidays: Mon 10/13: Columbus Day, Wed 11/26 – Fri 11/30 Thanksgiving

Enjoy the course!
Please contact me if you find any errors or have any constructive suggestions.