ECE3140 / CS3420
Embedded Systems

Lecture 1. Introduction

Prof. José Martínez
Instructor

- Prof. José Martínez, ECE
  - Research area: computer architecture
  - Contact Information
    - 336 Rhodes Hall
    - martinez@cornell.edu
    - (607) 255-1874
  - Office Hours: TBD
    - If my door is closed, then knock!
  - Teaching
    - ECE 3140/CS 3420: Embedded Systems
    - ECE 5750: Advanced Computer Architecture
What is an Embedded System?

- A computer system: Hardware + Software
- Embedded in another device or physical world
Embedded Systems Attributes

- Interfacing with the world
  - Sense environment & control device

- Concurrency
  - Manage multiple activities

- Resource constraints
  - Costs, power/energy, weight, size
  - Often fixed/limited functionality

- Real-time constraints

- Reliability
  - Long lifetime, environmental conditions

- Security

- Diagnostics and maintenance
Abstraction Layers

- Programming languages
- Systems software (compilers, OS)
- VLSI circuits
- Computer organization
- Digital design
- Fundamental circuits
- Solid state devices
- Physics of the atom

higher levels of abstraction
3140: Hardware-Software Integration

Embedded System

Microcontroller

Device Fabrication

Circuit/VLSI Design

Logic Design
3140: Hardware-Software Integration

Embedded System

Microcontroller

Applications

Run-time System

Programming Language

Assembly Language

Machine Instructions
Hardware for This Class

NXP FRDM-K64F

Image from NXP, formerly Freescale Semiconductors
Programming Languages for Embedded Systems

Source: EETimes. 2017 Embedded Markets Study
Why Assembly and C?

Ten tiny examples – How many times slower?

Program time / fastest program time

benchmarks game

selected language implementations

21 Sep 2015 u64
Topics

- Assembly language programming
  - Link to a high-level programming language: C

- Interrupts and I/O

- Managing interrupts: Concurrency
  - Concurrency models
  - Tasks/threads
  - Synchronization

- Real-time constraints and scheduling

- Communication protocols
Computer Engineering Curriculum

- ECE/ENGRD 2300: Digital Logic and Computer Organization ← Required
- ECE 2400/ENGRD 2140: Computer Systems Programming ← Recommended
- ECE 3140/CS 3420 ← This class
- CS 4410: Operating Systems
- ECE 4740: Digital VLSI
- ECE 4750/CS 4420: Computer Architecture
- ECE 4760: Designing with Microcontrollers
- ECE 57xx/CS 54xx: Grad-level classes
Class Overview

- Lectures
  - TR 1:25-2:40pm in 155 Olin Hall

- Sections
  - Help with material, lab
  - Supplementary material

- Labs
  - Implementation of concepts covered in class

- Problem sets
  - Review material, preparation for prelims

- In-class quizzes
  - See if you are keeping up with the class
Grading

- Problem sets: 5%
- Quizzes: 10%
- Exams: 40%
  - Prelim 1: 17%
  - Prelim 2: 23%
- Labs: 45%
Textbook

- No required textbook
  - We will draw materials from many places

- References
  - “Embedded Systems Fundamentals with ARM Cortex-M based Microcontrollers: A Practical Approach” by Alexander G. Dean

- Reading
  - We will release papers and other resources as we cover each topics
Problem Sets and Quizzes

- **Problem sets: Paper-and-pencil problems**
  - Checked for completeness, but not graded for correctness

- **Quizzes**
  - Covers previous week’s lectures
  - At the beginning of a class (typ. Tuesday)
  - **Use iClicker**
  - No make-up
  - Lowest quiz score will be dropped
  - 25% participation, 75% performance
Exams

- Evening prelims
  - Prelim 1 (17%) - March 19th
  - Prelim 2 (23%) – April 30th
  - No books, notes, or electronics of any kind

- No Final Exam
Labs

- Six labs: 5 fixed assignments and 1 project
  - We will suggest topics
  - Whatever you want (within reason)

- All lab assignments are done as a group of two

- No scheduled lab sessions
  - You can do them at home
  - Open lab hours to provide help
Submission Guidelines

- Use CMS
  - http://cms.csuglab.cornell.edu/

- Make sure to include name and netid

- Submissions must be your own individual effort
  - Sharing written solutions strictly prohibited
  - Discussing problems, approaches, etc. permitted

- Check your submission
  - Hash value
Rules

- Late Policy
  - CMS marks submissions late the instant they are due
  - You must upload an assignment before the deadline
  - Marked late = ZERO (your lowest non-zero score)
  - You are allowed ONE “slip day” (24 hours)
    - No need to request it

- Re-grade Policy
  - Submit a re-grade request on CMS if you feel a grading mistake has been made
  - The re-grade request must be received within one week after a grade is released
Resources

- **Piazza:**
  - Announcements, material, questions (self-enroll)
  - Look up answers before posting a question
  - You may send questions privately to staff through Piazza, but *only* if they contain sensitive/private information

- **Email:** Generally not allowed (and ignored)
  - Exception: Email to instructor of sensitive/private nature
Course Expectations

- Engineering solves world problems by using technology creatively. I invite and expect every student to contribute creatively as part of their learning process.

- Success in engineering depends critically on teamwork. I invite and expect every student to engage in constructive discourse, to bring their perspective, and to be accepting of others’.

- Degrading, abusing, harassing, silencing, or dismissing others in the process is not acceptable behavior. It is also bad engineering.

- I invite and expect every student to maintain the highest ethical standards.
Academic Integrity

- Search for “Cornell AIC”
  - http://cuinfo.cornell.edu/Academic/AIC.html

- Discussions are encouraged

- Sharing solutions is not permitted
  - Not submitting far better than cheating
  - In case of doubt, refrain and ask

- Use discussion boards consistently with the AIC!