Contact Information

- Dr. Durant
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- Office hours (CC-27)
  - Monday at 3 P.M.
  - Tuesday at 4 P.M.
  - Wednesday at 5 P.M.
  - Thursday at 2 P.M.
- 277-7439 (x7439)

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Course Information

- http://people.msoe.edu/~durant/courses/cs280/
- No Textbook
- FOX11 68HC11 Board
  - Purchase from Bookstore with keypad/display kit
  - Also used in CS-384

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Grading

Labs (alone or in groups of 2)	35%
Quizzes (most Fridays, about 7 total, lowest dropped)	10%
Higher test	20%
Lower test	10%
Comprehensive final exam	25%

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Course Prerequisites

- Synchronous logic (EE-290)
- Binary arithmetic
- Good program design techniques
- C++ programming fundamentals including functions with arguments (CS-1030)

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Applications of Embedded Systems

- Appliances: microwaves, VCRs, ...
- Medical devices: hearing aids, pacemakers, ...
- Car systems: antilock brakes, engine timing and monitoring, ...
- Space vehicles: satellites, Mars rover, ...
- Many more...

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Course Objectives

- Understand the role of assembly language programming
- Understand the instruction set of a typical embedded processor (Motorola 68HC11)
- Be able to employ a modular approach to assembly language programming with code reuse
- Be able to use embedded systems development tools

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Course Objectives

- Understand memory addressing and use various addressing modes
- Understand hardware interrupts and be able to use them
- Be able to integrate assembly language subroutines into a high-level language program

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"Why am I taking this course?"

- Because you have to?

- Understand software at the most basic level, where it meets hardware
- Understand capabilities and constraints of basic computing hardware
- Insight into why certain high-level language (*e.g.*, Java, C++) operations are expensive or cheap

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Lab Assignments

- Create a .zip file containing
  - Report: Microsoft Word or PDF
  - Assembly code (.s), executable (.s19), and listing (.rst)
- Email to <durant@msoe.edu>

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The tools

- Free tools!
  - WBUG11 2003 (comes with Fox11, program downloader)
  - Wookie 1.71 (simulator)
  - GNU Development Chain for 68HC11
    - GNU C++ compiler 3.3.5
    - GNU Binutils 2.15 (assembler, linker, and more)
- You will install and use these in lab 1.

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Types of Processors

- Microcomputer
  - General purpose
  - Mainly a CPU
- Microcontroller
  - Special purpose?
  - "1-chip" solution
  - Additional components (M68HC11 may have all)
    - Memory: RAM, EEPROM/EPROM/PROM/ROM
    - Peripherals (serial/parallel I/O, A/D, timers, ...)

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The M68HC11

- 68HC11 is an 8-bit microcontroller
  - 8-bit data bus
  - 16-bit address bus
    - Up to 64 kB memory
  - I/O ports A–E

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Number Systems Terminology

- Bit (Binary digIT)
- 8 bits = 1 byte = 2 nibbles
- 16 bits = 2 bytes = 1 word (16-bit processors)
- Bits are binary (0 or 1), and represent powers of two

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Binary/Decimal/Hexadecimal

- 0000 = 0 = 0x0
- 0001 = 1 = 0x1
- 0010 = 2 = 0x2
- 0011 = 3 = 0x3
- ...
- 1000 = 8 = 0x8
- 1001 = 9 = 0x9
- 1010 = 10 = 0xA
- 1011 = 11 = 0xB
- 1100 = 12 = 0xC
- 1101 = 13 = 0xD
- 1110 = 14 = 0xE
- 1111 = 15 = 0xF

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Numbers

- Signed
  - Usually bit 7 (MSB) indicates sign
  - If bit 7 = 0, positive (+) or 0
  - If bit 7 = 1, negative (–)
- Unsigned

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Two's Complement

- Two's complement is both an:
  - Operation
  - Numbering system
- Can have a two's complement number
- Can take the two's complement **of** a number

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Properties of Two's Complement number systems

- Asymmetric: 1 more – than +
- A positive number added to its two's complement is equal to 0
- Shifted range: (about) half + and half -
- Zero is always all zeroes
- -1 is always all ones
- number a – number b = number a + complement number b

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Two's complement operation

- ...or finding the negative of a two's complement number
- Step 1
  - Flip all bits (1s to 0s and 0s to 1s)
- Step 2
  - Add one (1)
- Step 3
  - Ignore any carry outs

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Examples

- Finding a two's complement
- Number circle
- Adding
- Subtracting

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Next time

- Microcontroller parts
- Tools demo

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