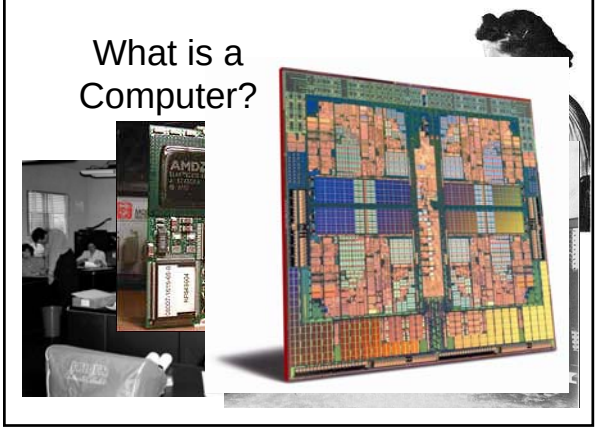
Introduction to Computer Engineering

ECE/CS 252, Fall 2011
Prof. Mikko Lipasti
Department of Electrical and Computer Engineering
University of Wisconsin – Madison

What is a Computer?



Computers!

- Engineers and scientists of all disciplines rely on computers for many aspects of their work
  - Not just word processing, spreadsheets, CAD, etc.
  - Computational methods, data mining, analysis/synthesis are fundamental to advances in many fields
- Many of the advanced techniques used in today's microprocessors were invented right here at UW
- Some of the most renowned computer design researchers in the world are on our faculty
- There is a near-100% likelihood that a Wisconsin graduate helped design the computer or processor that you own

1987 vs. 2010

System	IBM PC/AT	Motorola Droid X
Year	1987	2010
Cost	$2000	$199 (w/contract)
Form factor	½ desktop	Pocket
CPU	12 MHz 80286	1GHz TI OMAP
Memory	512KB	512MB
Storage	20MB hard disk, 1.2MB floppy	8+ GB
Display	80x25 monochrome text	480x854 pixel color
Peripherals	Keyboard	Camera, phone, web
Connectivity	1200 baud dialup modem	3G, WiFi

$10 base; 60% growth

Year	Salary	Comments
0	$10	Base
3	$40	Still live at home
16	$18K	Buy car
21	$193K	Buy median house in Madison
36	$223M	Need fundamentally new ways to spend money
51	$2.5T	Replace US Federal Government

Performance Growth

Unmatched by any other industry !
[John Crawford, Intel]

- Doubling every 18 months (1982-1996): 800x
  - Cars travel at 44,000 mph and get 16,000 mpg
  - Air travel: LA to NY in 22 seconds (MACH 800)
  - Wheat yield: 80,000 bushels per acre
- Doubling every 24 months (1971-1996): 9,000x
  - Cars travel at 600,000 mph, get 150,000 mpg
  - Air travel: LA to NY in 2 seconds (MACH 9,000)
  - Wheat yield: 900,000 bushels per acre

This Course

This course will:

- Help you understand the significance and pervasiveness of computers in today's society and economy
- Teach you how computers really operate and how they are designed
- Introduce you to concepts that students in the Computer Engineering and Computer Science degree programs learn in depth over four years
- Prepare and motivate you for study in these degree programs (CMPE, EE, CS)
- Counts towards GCR introduction to engineering requirement

Course Outline

- **Prerequisite** – none
- **Major topics in course**
  - Introduction to computers and computing
  - Information representation and manipulation
  - Logic elements and combinational Logic
  - Sequential Logic and Memory
  - Simple computer organization, design and operation
  - Machine language and instruction set architecture
  - Assembly language
  - Programming constructs

Typical Weekly Structure

- **Monday lecture Ani Sci 212**
  - Prepare by reading text beforehand
- **On your own**
  - Watch online lecture + examples
- **Wed discussion**
  - Individual & team quiz
  - Review
- **Fri discussion**
  - Quiz or applied homework
  - Review, homework help

Web Page & Syllabus

http://ece252.ece.wisc.edu

Instructor & TAs
Textbook
Lecture Notes
Discussion sections
Schedule
LC-3 Simulator
Grading
Exams
Homework

Reminders/Advice

- **Textbook** – read BEFORE corresponding lecture
- **Online lectures** – view before discussion
  - Quizzes will assume that you have
- **Homework** – completed in *groups (not hw1)*
  - Will reinforce in-class coverage
  - Will help you prepare for midterm exams
- **Study Groups of ~4**
  - Assigned in your discussion section
  - Should meet weekly outside of discussion
  - Review material, complete homework assignments

Technology

- Technology advances at astounding rate
  - 19th century: attempts to build mechanical computers
  - Early 20th century: mechanical counting systems (cash registers, etc.)
  - Mid 20th century: vacuum tubes as switches
  - Since: transistors, integrated circuits
- 1965: Moore's law [Gordon Moore]
  - Predicted doubling of capacity every 18 months
  - Has held and will continue to hold
- Drives functionality, performance, cost
  - Exponential improvement for 40 years

Some History

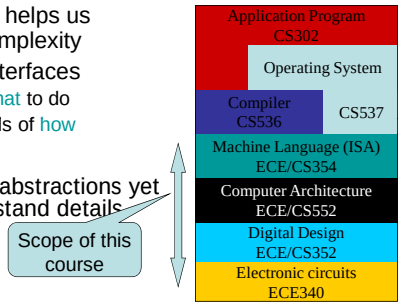
Date	Event	Comments
1947	1st transistor	Bell Labs
1958	1st IC	Jack Kilby (MSEE '50) @TI Winner of 2000 Nobel prize
1971	1st microprocessor	Intel (calculator market)
1974	Intel 4004	2300 transistors
1978	Intel 8086	29K transistors
1989	Intel 80486	1M transistors
1995	Intel Pentium Pro	5.5M transistors
2006	Intel Montecito	1.7B transistors
201x	IBM	50B transistors

Applications

- Corollary to Moore's Law:
  Cost halves every two years
- Computers cost-effective for
  - National security – weapons design
  - Enterprise computing – banking
  - Departmental computing – computer-aided design
  - Personal computer – spreadsheets, email, web
  - Smartphone – camera, calendar, email, web, games
  - Pervasive computing – computers everywhere
- Countless industries revolutionized

Abstraction and Complexity

- Abstraction helps us manage complexity
- Complex interfaces
  - Specify what to do
  - Hide details of how
- Goal: Use abstractions yet still understand details



Programmable Computers

- Many computers today are embedded
  - Fixed functionality
  - Appliance-like
  - Not really programmable by end user
- Not the focus of this course!
  - Instead, programmable computers
    - Embedded/appliance computers still programmed!
  - Learn to think of computer as a programmable device
- Program?
  - Algorithm or set of steps that computer follows
  - Human brains wired to work this way

Additional Information

- **Resources for Special Help**
  - McBurney Center – alternative testing or other arrangements
  - Course problem consultation: Prof. Lipasti
  - Broader problem consultation: advisor or counselor
- **Academic Misconduct**
  - We really don't expect it to happen
  - Please don't disappoint us
  - Serious repercussions
    - Academic record, dismissal from university
    - Only hurting yourself and your future

Wrapping Up

- **Readings**
  - Chapter 1: Welcome Aboard
- **Homework 1 on the course web site**
  - Due Monday 9/12 in class (week after Labor day)
- **Schedule for next few weeks**

Week	Dates	Monday	Wednesday	Friday
1	9/5,9/7,9/9	Labor Day	Ch 1 lecture AniSci 212	Ch1 discussion EHxxxx
2	9/12,9/14,9/16	Ch 2 lecture AniSci 212	Ch 2 discussion EHxxxx	Ch 2 discussion EHxxxx
3	9/19,9/21,9/23	Ch 2 lecture AniSci 212	Ch 2 discussion	Exam I review EHxxxx
4	9/26,9/28,9/30	Ch 3 lecture AniSci 212	Midterm I AniSci 212	Ch 3 discussion EHxxxx