



Introduction to Computer Engineering

CS/ECE 252, Spring 2008
Prof. David A. Wood
Computer Sciences Department
University of Wisconsin – Madison

Notes adapted from Mark D. Hill's notes

Computer as a tool

- Hammer
 - Arguably the most useful tool in human history
 - Pounds, pries, and useful as weapon
- Computer
 - Arguably supplanting the hammer as most useful tool

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

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	1 st transistor	Bell Labs
1958	1 st IC	Jack Kilby (MSEE '50) @TI Winner of 2000 Nobel prize
1971	1 st 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

Applications

- Corollary to Moore's Law:
Cost halves every two years
In a decade you can buy a computer for less than its sales tax today. –Jim Gray
- Computers cost-effective for
 - National security – weapons design
 - Enterprise computing – banking, Amazon.com
 - Web Search – Google & Yahoo!
 - Departmental computing – computer-aided design
 - Personal computer – word processing, email, web
 - Pervasive computing – iPhone
- Countless industries revolutionized

Place on Desk

- 7MB Disk Pack
- 6' Disk
- iPod (30GB)
- (30GB/7MB = 4,000x)
- 32KB PDP-11 memory board
- 512MB DIMM
- Computer useful & then 10,000x better!

\$16 base; 60% growth

Year	Salary	Comments
0	\$16	Base
3	\$64	Still live at home
15	\$16K	Buy car
24	\$100K	Buy house
36	\$300M	Need fundamentally new ways to spend money

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

Place On Desk

- iPod
 - Laptop
 - Treo
 - Etc.
-
- All Computers
 - Software/Hardware separation key

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 Sciences and Computer Engineering degree program learn in depth over four years
- Prepare and motivate you for study in this degree program
- Will count towards GCR introduction to engineering requirement

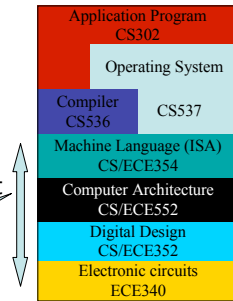
Course Outline

- **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

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

Scope of this course



Go Over Web Page

<http://www.cs.wisc.edu/~david/courses/cs252/Spring2008/>

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

Advice

- **Textbook** – read BEFORE corresponding lecture
- **Lecture** – attend!
 - book does NOT have all the material
- **Homework** – best completed in *study groups*
 - Will reinforce in-class coverage
 - Will help you prepare for midterm exams
- **Study Groups**
 - Groups of 2-3
 - Should meet weekly, learn from each other
 - Review material & discuss homework assignments
 - Each student should *submit* his/her own homework

Computer As a Tool

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