

That's a wrap

10 weeks, 28 classes, 4 programs, 2 exams, and 1 brutal winter...

Now, the last page of lecture notes for CSC 220, Winter 2014 term. Huzzah!

Last minute

Some last minute tidying:

- I just found these two quotes, and I like them:
 - Temporal locality - "If you used it, you'll use it again" (soon)
 - Spatial locality - "If you used it, you'll use something near it"
- Remember, two important jobs during linking:
 - Relocation problem - update jump addresses
 - Resolve external references - set addresses for all method calls

Do rhymes with New

We learned to **DO** a lot of **NEW** things this term:

- Encode binary numbers, positive and negative... add/subtract using 2's complement
- Convert between Boolean formats: truth table, equations and gates
- Design an ALU and datapath using logic gates and registers
- Describe and simulate hardware designs using Verilog HDL
- Create and encode microcode instructions
- Write Intel assembly code
- Write an assembler to create symbol tables and write object code from assembly code
- Link multiple object code files together to create a single executable
- Apply the Hamming code algorithm to correct bit errors in data transmission

Important themes

#1 - Abstraction is the key.

- Higher levels of abstraction dramatically improve productivity
- Examples: Software - Java v. assembly code; hardware - Verilog HDL v. transistor-level design
- Interface is separated from implementation => hiding complexity
- Higher levels are translated to lower levels => automation
- CSC 220: transistor -> logic gate -> latch/flipflop -> register -> datapath -> CPU -> micro-architecture -> instruction set architecture -> assembly language level -> high-level language

Addressing M things takes $\log_2 M$ bits. Or, addressing 2^N words requires N bits.

Hardware is petrified software... regardless of the medium, algorithms are the key!

RISC has beaten CISC because: simpler instructions mean 1) faster clock speed, 2) simpler hardware, 3) easier to pipeline

And Moore's Law marches on!

- [The web is now 25 years old and the equipment we use to surf the Internet is exponentially cheaper and faster than in 1989](#) - This is what your laptop today will look and feel like in 25 years.



Tandy 5000 MC Professional System

NEW FROM **89** **4999⁰⁰** Commercial Lease Available For Only \$180 Per Month (Plus Applicable Use/Sales Tax)

■ 20 MHz Intel® 80386™ Microprocessor ■ VGA Graphics ■ 2 MB RAM (16 MB Capacity) ■ Cache Memory

Our most powerful computer ever! The Tandy 5000 MC Micro Computer is strictly business, from the look of its 256,000-color VGA graphics to the tactile feel of its newly designed keyboard. Its Intel 80386 processor operates at a lightning-fast 20 MHz, and a memory cache controller provides RAM-fast access to your data. IBM® Micro Channel™ compatible architecture provides a 32-bit wide data path for virtually simultaneous data transfer between peripherals. Will operate MS-DOS® 3.3, MS® OS/2, SCO® XENIX® 386 and network operating software. The 5000 MC's technology, performance and price all add up to an incredible value. VGA graphics, serial and parallel ports and mouse support included. UL listed AC. 25-6000'

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| Tandy 5000 MC with 40 MB Hard Disk Drive | 4999.00 |
| Tandy 5000 MC with 84 MB Hard Disk Drive | 6999.00 |

MS, XENIX and MS-DOS/Reg. TM Microsoft Corp. SCO/Reg. TM The SCO Group. Operation Intel/Reg. TM and 386/TM Intel Corp. Micro Channel/TM and IBM/Reg. TM IBM Corp.

At the average hourly wage of \$9.75 in 1989, the "time cost" was 512 hours, which would be equivalent to \$10,500 today at the average wage of \$20.50.



Tandy 4000 and New Tandy 4000 LX

NEW FROM **89** **2599⁰⁰** Commercial Lease Available For Only \$145 Per Month (Plus Applicable Use/Sales Tax)

■ Intel 80386 Microprocessor ■ 16 and 20 MHz versions ■ 3 1/2" 1.44 MB Floppy Disk Drive ■ MS OS/2 ready

For superb 80386 power and performance at a surprisingly affordable price, look to the Tandy 4000 family. It's so cost effective, you can actually configure a 386 system for what you'd expect to pay for a competitor's 286 model. Easily expandable with six AT and two XT-style expansion boards for a variety of applications. 3 1/2" 1.44 MB floppy disk drive, plus room for two additional front-panel drives. UL listed AC.

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| Tandy 4000, 15 MHz clock speed, 1 MB RAM, 25-5000 | 2599.00 |
| Tandy 4000 with 40 MB Hard Disk Drive | 3799.00 |
| Tandy 4000 LX, The super-fast 4000 LX runs current PC/XT/AT software and MS OS/2 applications with amazing speed: 20 MHz clock speed, 2 MB RAM, 25-5100' | 3999.00 |
| Tandy 4000 LX with 40 MB Hard Disk Drive | 5199.00 |

At the average hourly wage of \$9.75 in 1989, the "time cost" was 266 hours, which would be equivalent to \$5,450 today at the average wage of \$20.50.

- [Save more with Google Drive](#) - Google Drive prices are cut 80%. 100GB of cloud storage now costs you \$2/month.

- Internet usage [How The Internet Has Grown In The Last 25 Years](#) - Internet usage has grown from 14% to 87%.