Where does CS61C fit in?

- We will be enforcing the CS61B prerequisite this semester.
- I will be teaching CS61C in Fall 2006 and Spring 2007.

http://bkn.eecs.berkeley.edu/student/cs-prereq-chart1.gif

Are Computers Smart?

- To a programmer:
  - Very complex operations / functions:
    - (map (lambda (x) (* x x)) '(1 2 3 4))
  - Automatic memory management:
    - List l = new List;
  - “Basic” structures:
    - Integers, floats, characters, plus, minus, print commands

Are Computers Smart?

- In real life:
  - Only a handful of operations:
    - {and, or, not}
  - No memory management.
  - Only 2 values:
    - {0, 1} or {low, high} or {off, on}

What are “Machine Structures”?

- Coordination of many levels (layers) of abstraction
**61C Levels of Representation**

- High Level Language Program (e.g., C)
  - Compiler
- Assembly Language Program (e.g., MIPS)
  - Assembler
- Machine Language Program (MIPS)

**Overview of Physical Implementations**

The hardware out of which we make systems.

- Integrated Circuits (ICs)
  - Combinational logic circuits, memory elements, analog interfaces.
- Printed Circuits (PC) boards
  - Substrate for ICs and interconnection, distribution of CLK, Vdd, and GND signals, heat dissipation.
- Power Supplies
  - Converts line AC voltage to regulated DC low voltage levels.
- Chassis (rack, card case, ...)
  - Holds boards, power supply, provides physical interface to user or other systems.
- Connectors and Cables.

**Printed Circuit Boards**

- Fiberglass or ceramic
- 1-20 conductive layers
- 1-20 in on a side
- IC packages are soldered down.

- Provides:
  - Mechanical support
  - Distribution of power and heat.

**61C Levels of Representation**

- High Level Language Program (e.g., C)
- Compiler
- Assembly Language Program (e.g., MIPS)
- Assembler
- Machine Language Program (MIPS)

**Overview of Physical Implementations**

The hardware out of which we make systems.

- Integrated Circuits (ICs)
  - Combinational logic circuits, memory elements, analog interfaces.
- Printed Circuits (PC) boards
  - Substrate for ICs and interconnection, distribution of CLK, Vdd, and GND signals, heat dissipation.
- Power Supplies
  - Converts line AC voltage to regulated DC low voltage levels.
- Chassis (rack, card case, ...)
  - Holds boards, power supply, provides physical interface to user or other systems.
- Connectors and Cables.

**Printed Circuit Boards**

- Fiberglass or ceramic
- 1-20 conductive layers
- 1-20 in on a side
- IC packages are soldered down.

- Provides:
  - Mechanical support
  - Distribution of power and heat.
Technology Trends:
Memory Capacity (Single-Chip DRAM)

- Now 1.4X/yr, or 2X every 2 years.
- 8000X since 1980!

<table>
<thead>
<tr>
<th>Year</th>
<th>size (Mbit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td>0.0625</td>
</tr>
<tr>
<td>1983</td>
<td>0.25</td>
</tr>
<tr>
<td>1986</td>
<td>1</td>
</tr>
<tr>
<td>1989</td>
<td>4</td>
</tr>
<tr>
<td>1992</td>
<td>16</td>
</tr>
<tr>
<td>1996</td>
<td>64</td>
</tr>
<tr>
<td>1998</td>
<td>128</td>
</tr>
<tr>
<td>2000</td>
<td>256</td>
</tr>
<tr>
<td>2002</td>
<td>512</td>
</tr>
<tr>
<td>2004</td>
<td>1024 (1Gbit)</td>
</tr>
</tbody>
</table>

Computer Technology - Dramatic Change!
- Memory
  - DRAM capacity: 2X / 2 years (since '96); 64X size improvement in last decade.
- Processor
  - Speed 2X / 1.5 years (since '85); [slowing!]
  - 100X performance in last decade.
- Disk
  - Capacity: 2X / 1 year (since '97)
  - 250X size in last decade.

Computer Technology - Dramatic Change!
- We’ll see that Kilo, Mega, etc. are incorrect later!

- State-of-the-art PC when you graduate:
  (at least…)
  - Processor clock speed: 5000 MegaHertz
  - Memory capacity: 8000 MegaBytes
  - Disk capacity: 2000 GigaBytes
  - New units! Mega ➔ Giga, Giga ➔ Tera
  (Tera ➔ Peta, Peta ➔ Exa, Exa ➔ Zetta
  Zetta ➔ Yotta = 10^24

CS61C: So what’s in it for me?
- Learn some of the big ideas in CS & engineering:
  - Principle of abstraction, used to build systems as layers
  - 5 Classic components of a Computer
  - Data can be anything (integers, floating point, characters): a program determines what it is
  - Stored program concept: instructions just data
  - Principle of Locality, exploited via a memory hierarchy (cache)
  - Greater performance by exploiting parallelism
  - Compilation v. interpretation thru system layers
  - Principles/Pitfalls of Performance Measurement

Others Skills learned in 61C
- Learning C
  - If you know one, you should be able to learn another programming language largely on your own
  - Given that you know C++ or Java, should be easy to pick up their ancestor, C

- Assembly Language Programming
  - This is a skill you will pick up, as a side effect of understanding the Big Ideas

- Hardware design
  - We’ll learn just the basics of hardware design
  - CS 150, 152 teach this in more detail
Course Lecture Outline

- Number representations
- C-Language (basics + pointers)
- Storage management
- Assembly Programming
- Floating Point
- make-ing an Executable (compilation, assembly)
- Logic Circuit Design
- CPU organization
- Pipelining
- Caches
- Virtual Memory
- Performance
- I/O Interrupts
- Disks, Networks
- Advanced Topics

Yoda says...

“Always in motion is the future…”

Our schedule may change slightly depending on some factors. This includes lectures, assignments & labs...

Texts

- Required: *Computer Organization and Design: The Hardware/Software Interface, Third Edition*, Patterson and Hennessy (COD). The second edition is far inferior, and is not suggested.
- Required: *The C Programming Language*, Kernighan and Ritchie (K&R), 2nd edition
- Reading assignments on web page

What is this?

Attention over time!

What is this?!

Attention over time!

Tried-and-True Technique: Peer Instruction

- Increase real-time learning in lecture, test understanding of concepts vs. details
- As complete a “segment” ask multiple choice question
  - 1-2 minutes to decide yourself
  - 3 minutes in pairs/triples to reach consensus. Teach others!
  - 5-7 minute discussion of answers, questions, clarifications
- You’ll get transmitters from ASUC bookstore (or Neds, hopefully they’re in!)
Peer Instruction

- Read textbook
  - Reduces examples have to do in class
  - Get more from lecture (also good advice)
- Fill out 3-question Web Form on reading (released Mondays, due every Friday before lecture)
  - Graded for effort, not correctness...
  - This counts toward “E”ffort in EPA score

Homeworks, Labs and Projects

- **Lab exercises** (every wk; due in that lab session unless extension given by TA) – extra point if you finish in 1st hour!
- **Homework exercises** (~ every week; HW 0 out now, due in section next week)
- **Projects** (every 2 to 3 weeks)
  - All exercises, reading, homeworks, projects on course web page
  - We will DROP your lowest HW, Lab!
  - Only one {HW, Project, Midterm} / week

Weekly Schedule

We are having discussion, lab and office hours this week...

2 Course Exams

- **Midterm:** Monday 2006-10-16 @ 7-10pm
  - Give 3 hours for 2 hour exam
  - One “review sheet” allowed
  - Review session Sun beforehand, time/place TBA
- **Final:** Thu 2006-12-14 @ 12:30-3:30pm (grp 8)
  - You can clobber your midterm grade!
  - (students last semester LOVED this...)

Your final grade

- **Grading (could change before 1st midterm)**
  - 15pts = 5% Labs
  - 30pts = 10% Homework
  - 60pts = 20% Projects
  - 75pts = 25% Midterm* [can be clobbered by Final]
  - 120pts = 40% Final
  - Extra credit for EPA. What’s EPA?

- **Grade distributions**
  - Similar to CS61[AB], in the absolute scale.
  - Perfect score is 300 points. 10-20-10 for A+, A, A-
  - Similar for B+ and C+ (40 pts per letter-grade)
  - No F will be given if all-but-one (hw, lab), all projects submitted and all exams taken

Extra Credit: EPA!

- **Effort**
  - Attending Dan’s and TA’s office hours, completing all assignments, turning in HW0, doing reading quizzes
- **Participation**
  - Attending lecture and voting using the PRS system
  - Asking great questions in discussion and lecture and making it more interactive
- **Altruism**
  - Helping others in lab or on the newsgroup
- **EPA! extra credit points have the potential to bump students up to the next grade level!** (but actual EPA! scores are internal)
Course Problems...Cheating

• What is cheating?
  - **Studying** together in groups is **encouraged**.
  - **Turned-in** work must be **completely** your own.
  - Common examples of cheating: running out of time on an assignment and then pick up output, take homework from box and copy, person asks to borrow solution "just to take a look", copying an exam question, ...
  - You're not allowed to work on homework/projects/exams with **everyone** (other than ask Qs walking out of lecture)
  - Both "giver" and "receiver" are equally culpable

• Cheating points: negative points for that assignment/project/exam (e.g., if it's worth 10 pts, you get -10) in most cases, **F in the course.**

• Every offense will be referred to the Office of Student Judicial Affairs.

www.eecs.berkeley.edu/Policies/acad.dis.shtml

My goal as an instructor

• To make your experience in CS61C as enjoyable & informative as possible
  - Humor, enthusiasm, graphics & technology-in-the-news in lecture
  - Fun, challenging projects & HW
  - Pro-student policies (exam clobbering)

• To maintain Cal & EECS standards of excellence
  - Your projects & exams will be just as rigorous as every year. Overall: B- avg

• To be an HKN "7.0" man
  - I know I speak fast when I get excited about material. I'm told every semester. Help me slow down when I go toooo fast.
  - Please give me feedback so I improve!
  - Why am I not 7.0 for you? I will listen!!

Teaching Assistants

• Scott Beamer (also Head TA)
• Sameer Iyengar
• David Jacobs
• David Poll
• Aaron Staley

Summary

• Continued rapid improvement in computing
  - 2X every 2.0 years in memory size;
  - every 1.5 years in processor speed;
  - every 1.0 year in disk capacity;
  - Moore's Law enables processor (2X transistors/chip ~1.5-2 yrs)

• 5 classic components of all computers
  - Control
  - Datapath
  - Memory
  - Input
  - Output

Processor