Computer Engineering @UML

Prof. D. B. Megherbi
What is Computer Engineering?

- The application of programmable digital computers to enhance and control complex systems and products.
- Requires mastery of both:
  - computer *hardware* (overlapping with Electrical Eng.)
  - computer *software* (overlapping with Computer Sci.)
- Computer engineers work with other professionals to adapt computer technology to provide, for example:
  - flexible and efficient programmable control
  - sophisticated user interfaces (e.g. graphical)
  - networked communications (e.g. to the Internet)
  - system modeling and data analysis
What do Computer Engineers do?

- Computer Engineers are expected to create, design and develop digital systems and to provide expertise (both hardware and software) to customers, other engineers, and organizations.
Key Technology: The Microprocessor

- The microprocessor (a computer on a silicon chip) is the device that underlies the computer revolution.
The Personal Computer Revolution
Cell Phones, PDAs, MP3 Players . . .
The World-Wide Internet

Internet Domain Survey Host Count

Source: Internet Software Consortium (www.isc.org)
“Hidden” or Embedded Computers

- Everybody is well aware of the large number of personal computers, cell phones, game consoles, etc.
- However, the vast majority of computers are hidden from view, doing their work quietly and efficiently:
  - A new model car contains dozens of computers to run the engine, brakes, entertainment system, navigation system, dashboard features, etc.
  - Computers run the telephone network, the banks, the stock market, as well as the Internet.
  - Computers keep people alive by running medical equipment, running diagnosis programs, and controlling implanted medical devices.
  - etc.
Embedded Computers in Cars

Dashboard of the 2004 Lexus LS
Computerized Control in Cars

- Ignition timing
- Fuel injection to ensure optimal fuel-air mixture
- Air bag deployment control
- “Black box” recording of speed and other factors
- Anti-lock brakes and anti-skid traction
- Dashboard controls
- Entertainment system
- Navigation system
- Communication systems
- Status indicators and diagnostic system
- Etc.
Computer Engineering vs. Computer Science

Computer Engineering
- concerned with both software and hardware issues
- more structured curriculum in the engineering tradition
  e.g. specification, verification, testing, product engineering, project management, prof. ethics
- an accredited program that greatly facilitates acquiring the designation “Professional Engineer”

Computer Science (or Computing Science)
- investigates the efficient use of computer systems
- mainly concerned with software (programming) issues
- course sequence is more flexible (no accreditation rules)
Computer Engineering vs. Electrical Engineering

**Electrical Engineering**
- applications of electricity and magnetism
  - e.g. circuit design, power systems, controls
- core problems tend to be *analogue* in nature
- analysis based on *continuous mathematics*
- (but communications is increasingly digital, like CE)

**Computer Engineering**
- applications of computer and related technologies
- emerged from EE and is now a separate discipline
- core problems tend to be *digital* and *algorithmic*
- analysis based on *discrete mathematics* and *logic*
- software development is a major focus
What skills does a Computer Engineer require?

- solid background in math and science
- excellent communication skills, both oral and written
- ability to work in teams and to get along with others
- logical and systematic approach to problem solving
- patience, persistence, and attention to detail
- willingness to put in long hours when necessary
- a commitment to lifelong learning and retraining
Computer Engineering Careers

- The computer industry has its ups and downs, but the medium and long-term trends are strongly upwards.

- The Computer Revolution is far from over . . .
  - silicon technology continues to improve dramatically
  - computers double in speed every 18 months
  - nanotechnology is expected to propel computer capabilities by many orders of magnitude
  - most of the world has yet to fully apply computers
  - exciting new applications of computers will keep appearing; entirely new careers will emerge

- Computer Engineering requires individuals who will enjoy an exciting (and sometimes unpredictable) ride with an important and rapidly evolving technology.
Computer Engineering Jobs

What is Engineering?
Creating something useful from other things using science and math
or
Turning ideas into reality

Bachelor's Degrees in Engineering

1966
Women: 1%
Men: 99%

Today
Women: 17%
Men: 83%

5. They want to do something good for the world!

Robot Hand Made With Conducting Polymer Actuators
Woman surpass men in Advanced Degrees

2010 was the first year where more women earned more advanced degrees than men.

10.6 M women versus 10.5 M men

2010 census reported 1.5 M more Bachelor’s degrees for women.

So: Women are earning more college degrees than men.

The issue: something must be done to attract more women into Engineering! This is a national initiative!
B.Sc in Computer Engineering

1. offers roughly an equal balance between computer digital hardware and computer software.

2. Available in both traditional 4-year B.Sc in CpE and 5-year combined B.Sc/M.Sc in Computer Engineering.
# Year 2 - B.Sc in CpE

<table>
<thead>
<tr>
<th>Term 3: (CpE)</th>
<th>Term 3: (EE)</th>
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<tbody>
<tr>
<td>Circuit Theory 1 &amp; Lab 1</td>
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# Year 3- B.Sc in CpE

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<td>• Signals &amp; Systems 1</td>
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<td>• Eng. Math</td>
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<td>• Data Structures</td>
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<td>• Eng. Math</td>
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<td>• Electronic Mat. Chem</td>
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<td>• Gen. Ed</td>
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<td>• Signals and Systems II</td>
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<td>• Eng. Values</td>
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<td>• Electronics II &amp; Lab.</td>
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<td>• Gen. Ed</td>
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<tr>
<td>• Microprocessors 1</td>
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<td>• Signals and Systems II</td>
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<td>• Eng. Values</td>
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<tr>
<td>• Electronics II &amp; Lab</td>
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<td>• Eng. Electromagnetics 1</td>
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## Year 4 - B.Sc in CpE

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<th>Term 7: (CpE)</th>
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<tr>
<td>• Engineering Perspectives</td>
<td>• Engineering Perspectives</td>
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<tr>
<td>• Adv. Dig. Sys. Design</td>
<td>• Eng. Electromagnetics II</td>
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<tr>
<td>• Capstone</td>
<td>• Capstone</td>
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<tr>
<td>• Computer Architecture</td>
<td>• Linear Feedback</td>
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<tr>
<td>• Network Design</td>
<td>• Technical Elective</td>
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<tr>
<td>• Technical Elective</td>
<td>• Gen Ed.</td>
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10 Great Engineering Achievements (past 30 years)

1. Space Travel
2. Application Satellites
3. Microprocessors
4. Jumbo Jet
5. Computerized Health Services/Image processing
6. Advanced Composite Materials
7. CAD/CAM/CAE
8. Lasers
9. Fiber Optics Communications
10. Genetic Engineering
Grand Challenges (Future) Engineering in the 21st century

1. Prediction of weather, climate, and global change
2. Computerized speech understanding
3. Human genome project
4. Improvements in vehicle performance
5. Enhanced oil and gas recovery
What these Grand Challenges for the Future have in Common?

- They all involve computer engineering (engineers) one way or another
Changing Engineering Environment

- Communications skills
- Design/process/manufacture path
- Interdisciplinary teams
- World experience
- Analyzing Synthesizing
- Societal context
Computing Systems

Computer Hardware
- Computer hardware boards
- Central processing unit
- PC
- Networks

Computer Software
- Operating Systems
- Mathematical computation
- Machine language
- Assembly language
- High level languages
- Compiler
- Execution
- Internetworking
The Internet, EMAIL, and the World Wide WEB

- Internet
- Electronic Mail
- Electronic Bulletin boards
- World Wide Web
- Uniform Resource Locator
- Ipod
- Iphone
- GPS
- Cell Phones
- Etc…
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<tr>
<td>Africa</td>
<td>955,206,348</td>
<td>4,514,400</td>
<td>51,065,630</td>
<td>5.3 %</td>
<td>3.5 %</td>
<td>1,031.2 %</td>
</tr>
<tr>
<td>Asia</td>
<td>3,776,181,949</td>
<td>114,304,000</td>
<td>578,538,257</td>
<td>15.3 %</td>
<td>39.5 %</td>
<td>406.1 %</td>
</tr>
<tr>
<td>Europe</td>
<td>800,401,065</td>
<td>105,096,093</td>
<td>384,633,765</td>
<td>48.1 %</td>
<td>26.3 %</td>
<td>266.0 %</td>
</tr>
<tr>
<td>Middle East</td>
<td>197,090,443</td>
<td>3,284,800</td>
<td>41,939,200</td>
<td>21.3 %</td>
<td>2.9 %</td>
<td>1,176.8 %</td>
</tr>
<tr>
<td>North America</td>
<td>337,167,248</td>
<td>108,096,800</td>
<td>248,241,969</td>
<td>73.6 %</td>
<td>17.0 %</td>
<td>129.6 %</td>
</tr>
<tr>
<td>Latin America/Caribbean</td>
<td>576,091,673</td>
<td>18,068,919</td>
<td>139,009,209</td>
<td>24.1 %</td>
<td>9.5 %</td>
<td>669.3 %</td>
</tr>
<tr>
<td>Oceania / Australia</td>
<td>33,981,562</td>
<td>7,620,480</td>
<td>20,204,331</td>
<td>59.5 %</td>
<td>1.4 %</td>
<td>165.1 %</td>
</tr>
<tr>
<td><strong>WORLD TOTAL</strong></td>
<td>6,676,120,288</td>
<td>360,985,492</td>
<td><strong>1,463,632,361</strong></td>
<td><strong>21.9 %</strong></td>
<td><strong>100.0 %</strong></td>
<td><strong>305.5 %</strong></td>
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Interesting Websites

http://www.careercornerstone.org/

Sloan Career Cornerstone Center

Computer Engineering Overview
The Field - Preparation - Accreditation -
Day in the Life - Professional Societies - Earnings

The Field

Computer engineers (or computer hardware engineers) research, design, develop, test, and oversee the manufacture and installation of computer hardware, including computer chips, circuit boards, computer systems, and related equipment such as keyboards, routers, and printers. This field should not be confused with computer software engineers, who design and develop the software systems that control computers.
Final Note and Comments

• The Computer Engineering Field is currently the Fastest Growing Field of All Engineering Fields
• Computer Engineers are in High Demand and Among the Most Highly paid Engineers From all Other Engineers
• Take a look at the Sunday Boston Globe Classified Job Opening Section
Thank you!

Questions?
If you have any question on the Computer Engineering program at UML, you can shoot me an e-mail at Dalila_megherbi@uml.edu.

Or come to see me in BL 421B during my office hours.
Research focus: to advance the analytical, experimental, and operational aspect of Computer Engineering and Information Technologies that have potential influence on the Acquisition, Management, and Storage of Knowledge and Data Engineering and Services

Biometrics: fingerprint, facial, and other object recognition with time-varying and challenging constraints (such as face disguise, or distortion) can be used for identification and authentication of individuals in many applications including airport security, and others.

Homeland Security: (above) Distributed Battlefield: Architecture for a Geographically Distributed Synthetic Battlefield: shown is the computational time, in millisecond, as a function of the number of computing nodes and processors for a distributed combat scenario, shown.

Homeland Security: Digital Secure Information Hiding: High Capacity, and Transparent Image Digital Information Hiding. (shown: the two images on the right are secretly hidden in the first image on the left (house), without being detected digitally or at the naked eye.

Bio-engineering: Medical Imaging Data Fusion: Data Knowledge Integration and Management Research in Medical Imaging uses the CMINDS High Performance Computing Engine for distributed image processing and data fusion.

Real-time US Traffic Road Signs Automatic Detection and Recognition with one direct application to assisting and alerting the senior drivers on the road (this application problem, lately, has become a crucial problem in Massachusetts and elsewhere in the nation.

Bio-Engineering: Translational Research Relating HIV Virus Geographical Communities to some Function; and sequence analysis. Shown are HIV DNA sequences human (78 from 15 African countries) before mutation. The different groups are shown with different colors to be able to distinguish them.

Hardware Embedded Systems: Experimental setup for an FPGA Embedded Ladar prototype system built in CMINDS, UML, with an FPGA-based Ladar controller system that fits a human hand.