Electrical Engineering
Computer & Systems Engineering
Electric Power Engineering

Curricular & Career Information
What Is?

From Wikipedia:

**Computer engineering** deals with the design of computers and computer systems. This may involve the design of new hardware, the design of PDAs or the use of computers to control an industrial plant. Computer engineers may also work on a system's software. However, the design of complex software systems is often the domain of software engineering, which is usually considered a separate discipline. Desktop computers represent a tiny fraction of the devices a computer engineer might work on, as computer-like architectures are now found in a range of devices including video game consoles and DVD players.

Power engineers may also work on systems that do not connect to the grid, called off-grid power systems, which in some cases are preferable to on-grid systems.
Wide Variety of Opportunities

- Consider the diversity of topics covered by divisions of our professional society – The IEEE.
- Not addressed by the IEEE – jobs in the finance industry, which has been a growing sector in recent years.
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(366,000 Members)

- Aerospace and Electronic Systems Society
- Antennas and Propagation Society (9,000 Members)
- Broadcast Technology Society
- Circuits and Systems Society (16,000 Members)
- Communications Society (50,000 Members)
- Components Packaging, and Manufacturing Technology Society
- Computer Society (88,000 Members)
- Consumer Electronics Society
- Control Systems Society (10,000 Members)
- Council on Super Conductivity
- Dielectrics and Electrical Insulation Society
- Education Society
IEEE

- Electromagnetic Compatibility Society
- **Electron Devices Society (13,000 Members)**
- Engineering Management Society
- Engineering in Medicine and Biology Society
- Geoscience & Remote Sensing Society
- Industrial Electronics Society
- Industry Applications Society
- Information Theory Society
- Intelligent Transportation Systems Council
- Instrumentation and Measurement Society
- **Lasers & Electro-Optics Society (9,000 Members)**
- Magnetics Society
- **Microwave Theory and Techniques Society (12,000 Members)**
- Nuclear and Plasma Sciences Society
- Neural Networks Council

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- Oceanic Engineering Society
- Power Electronics Society
- Power Engineering Society (22,000 Members)
- Professional Communication Society
- Reliability Society
- Robotics & Automation Society
- Sensors Council
- Signal Processing Society (18,000 Members)
- Society on Social Implications of Technology
- Solid-State Circuits Society (14,000 Members)
- Systems, Man, and Cybernetics Society
- Ultrasonics, Ferroelectrics, and Frequency Control Society
- Vehicular Technology Society
Where EE Jobs Are – IEEE Spectrum 1/04

- Power
- Communications
- Semiconductors
- Transportation
- Computers
- Bioengineering
Dream Jobs (as presented in the IEEE Spectrum) are not typical but the skills they require are representative.

It should always be your goal to have fun and get paid well.
EE CSE EPE Dream Jobs (2006)

Manni Wong (M)

AGE: 46.
WHAT SHE DOES: Designs electronics and control systems for rides and attractions at Disney parks worldwide.
FOR WHOM: Walt Disney Imagineering.
WHERE SHE DOES IT: Glendale, Calif.
FUN FACTORS: Has worked and lived in Paris and Hong Kong while building attractions for Disney theme parks; gets to ride Space Mountain with the lights on.

MANNI WONG: Serious Fun

Enjoying the Ride:
For Manni Wong, having fun is part of the job.
EE CSE EPE Dream Jobs (2006)

Wade Bortz (M)

AGE: 32.
WHAT HE DOES: Designs, installs, and troubleshoots infrasonic arrays used to monitor the Comprehensive Nuclear Test-Ban Treaty.
FOR WHOM: Infrasound Laboratory, University of Hawai‘i, Kailua-Kona.
WHERE HE DOES IT: Various installations across the South Pacific and Indian oceans.
FUN FACTORS: Travels to remote destinations like Tahiti and Palau—and has the freedom to pursue his hobby, kiteboarding, both on the road and back home.

Ajay Royyuru (M)

AGE: 41.
WHAT HE DOES: Manages a computational biology lab and runs the computing research for the Genographic Project, a five-year effort to map human migration, from its origins to the present, using clues in human DNA.
FOR WHOM: IBM Corp.
WHERE HE DOES IT: IBM’s Thomas J. Watson Research Center, in Yorktown Heights, N.Y.
FUN FACTOR: His computational algorithms could tell us where we all came from and how we got here.

ISLAND HOPPER: Wade Bortz crisscrosses the Pacific installing acoustic arrays.

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EE CSE EPE Dream Jobs (2006)

GRANT IMAHARA: Debunker in The Box

Grant Imahara (M)
AGE: 35.
WHAT HE DOES: Builder for the Discovery Channel’s “MythBusters.”
WHERE HE DOES IT: San Francisco.
FUN FACTORS: Enjoys working on the eclectic “MythBusters” set, which features a motorized surfboard, a row of first-class airplane seats, and a larger-than-life rubber cast of a human rear end.

EXPLODING POODLES: Grant Imahara puts urban legends to the test.

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EE CSE EPE Dream Jobs (2006)

Martin Cooper
AGE: 38.
WHAT HE DOES: Works with lasers and three-dimensional scanners to restore and replicate priceless artwork.
FOR WHOM: The Conservation Centre of the National Museums Liverpool, England.
FUN FACTORS: Makes the world prettier one artifact at a time. Has few deadlines, an actual 40-hour week that leaves time for family, varying challenges with each job, and beautiful, art-filled surroundings.

BEAUTY TREATMENT: Martin Cooper uses lasers to restore fine artwork.
EE CSE EPE Dream Jobs (2006)

Jim Benya (M)

AGE: 55.
WHAT HE DOES: Designs energy-efficient lighting systems for commercial, public, and residential projects.
FOR WHOM: Benya Lighting.
WHERE HE DOES IT: California’s Yosemite National Park; Maui, Hawaii; California wine country.
FUN FACTORS: Lighting design "involves a wonderful mix of art and science, amazing clients, travel—and an opportunity to make a difference."

LIGHT WORK: Jim Benya designs lighting that’s environmentally friendly.

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Louis Liebenberg

AGE: 45.

WHAT HE DOES: Runs a software company that offers an animal-tracking program for handheld devices; trains and evaluates animal trackers.

FOR WHOM: CyberTracker Software Ltd.

WHERE HE DOES IT: Noordhoek, Cape Town, South Africa, and in game parks and reserves all over the world.

FUN FACTORS: Tracks exotic animals, evaluates state-of-the-art handhelds, sleeps and dines free of charge in the world’s most exclusive game reserves.
Some Interesting Application Areas
Smart Lighting

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Robotic Surgery

• A doctor in New York removing a woman’s gallbladder in France.
Sensor Networks

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Telemedicine Hub

- Retired satellites have new uses
Climate Changes

Development of Accurate Modeling Tools

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Medical Imaging
Fuel Cell Power

- Toyota Fuel Cell Hybrid Vehicle
Linking With Light

- **Today**
  - Optical connection between individual computers are commercially available.

- **2-5 Years**
  - Optical communications will enter the computer, connecting one circuit board to another.

- **6-10 Years**
  - Chip-to-chip communications will enter the market.

- **15+ Years**
  - Experts disagree on whether optical interconnects will ever connect the subsystems within a ship.

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The Shrinking Transistor

- Intel Transistor
ECSE Degrees

- Electrical Engineering
- Computer and Systems Engineering
- Electric Power Engineering
- Popular Dual Degrees
  - EE/CSE Dual Degree
  - EE/EPE Dual Degree
  - CSE/CS Dual Degree
  - EE/Applied Physics Dual Degree
Electrical Engineering

Courses Not Generally Taken by Other Majors: Computer Science I, Multivariable Calculus, Multidisciplinary Elective (Materials Science for Engineers, Engineering Dynamics, Thermal Fluids I, Strength of Materials – all of which are parts of other programs). First three terms are standard except for Computer Science I.

- Chem I
- Calculus I&II
- Differential Eqns
- Physics I&II
- **CS I (1st Year)**
- H&SS (5) + PD II
- **Multivariable Calculus (3rd Year)**
- IEA
- IEE (or Processes)
- EG&CAD
- IED
- Embedded Control
- PD I&III
- **Multidisciplinary Elective (3rd Year)**
Electrical Engineering

ECSE Core

- Electric Circuits
- Computer Components and Operations
- Signals & Systems
- Probability for Engr. Applications

EE Core

- Intro to Electronics
- Fields and Waves I
- Microelectronics Technology

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Electrical Engineering

Concentration

- Automatic Controls
- Comm & Info Proc
- Computer Hardware
- Electromagnetics
- Electronic Circuits
- Power Electronics
- Electric Power
- Manufacturing or Entrepreneurship
- Microelectronics
- Individualized

Specified Electives

- Lab Elective
  - Adv Manufacturing
  - VLSI Design
  - Electric Power
  - Experimental Networking
  - Computer Applications
  - Computer Hardware

- Design Elective
  - Will soon be ECSE Design for All EE & CSE Students

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Electrical Engineering

- Any ECSE or EPOW
- Used to satisfy concentration
- Can also include one ENGR course

- Any course at all
- Usually used up for dual degrees
- Most students take additional technical courses
ECSE Electives

- 296x: Sensing and Imaging
- 4040: Digital Electronics
- 4060: Communication Circuits
- 4080: Semiconductor Power Electronics
- 4160: Fields & Waves II
- 4250: IC Processes and Design
- 4290: Electronic Packaging
- 4320: Plasma Engineering
ECSE Electives

- 4440: Control Systems Engineering
- 4490: Fundamentals of Robotics
- 4510: Discrete Time Systems
- 4520: Communication Systems
- 4630: Lasers and Optical Systems
- 4640: Optical Communications & Integrated Optics
- 4670: Computer Communications Networks
- 4710: Interactive Computer Aided Design
ECSE Electives

- 4720: Solid State Physics
- 4540: Voice & Image Processing
- 4750: Computer Graphics (CSE Software Elective)
- 496x: Advanced Electronic Circuits
- 496x: Subsurface Imaging
- 496x: Digital Comm. Engineering
- 496x: Distributed Systems & Sensors
- 496x: Integrated Sensors
ECSE Electives

- 496x: Mixed Signal Circuit Design
- 496x: VLSI Architectures for Signal Processing and Communications
- 6770: Software Engineering I
Computer and Systems Engineering

Science, Math, H&SS Core

Engineering Core

CSE Core

ECSE Core

Restricted Electives

Concentration

Free Electives

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Computer and Systems Engineering

Courses Not Generally Taken by Other Majors: Computer Science I &II, Discrete Structures, Data Structures & Algorithms, Multidisciplinary Elective (Materials Science for Engineers, Engineering Dynamics, Thermal Fluids I, Strength of Materials – all of which are parts of other programs).

- Chem Princ for Engr
- Calculus I&II
- Differential Eqns.
- Physics I&II
- **CS I&II (1st Year)**
- **Data Structures & Alg. (2nd Year)**
- H&SS (5) + PD II
- **Discrete Structures (1st Year)**
- IEA
- IEE
- EG&CAD
- IED
- Embedded Control
- PD I&III
- **Multidisciplinary Elective (3rd Year)**
Computer and Systems Engineering

ECSE Core

- Electric Circuits
- Computer Components and Operations
- Signals & Systems
- Probability for Engr. Applications

CSE Core

- Computer Architecture, Networks and Operating Systems
- Software Engineering Elective
Computer and Systems Engineering

Concentration

- Automatic Controls
- Comm & Info Proc
- Computer Hardware
- Computer Systems
- Manufacturing or Entrepreneurship
- Individualized

Specified Electives

- Software Engineering Elective
  - Experimental Networking
  - Computer Graphics
  - Software Eng. I or Software Design & Doc
  - Intro. Graphical Interfaces
- Design Elective
  - Now ECSE Design for all EE & CSE Majors

Electrical Engineering
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Computer and Systems Engineering

- Any ECSE or CSCI
- Used to satisfy concentration
- Can also include one ENGR course

- Any course at all
- Usually used up for dual degrees
- Most students take additional technical courses
Electric Power Engineering

Science, Math, H&SS Core

Engineering Core

EPE Core

ECSE Core

Restricted Electives

Concentration

Free Electives

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Electric Power Engineering

Science, Math, H&SS Core

- Chem Princ for Engr
- Materials Sci for Engr
- Calculus I&II
- Differential Eqns
- Physics I&II
- C Prog. For Engineers
- H&SS (5) + PD II

Engineering Core

- IEA
- Engr. Proc. Or IEE
- EG&CAD
- IED
- MAU
- Modeling & Control of Dynamic Systems
- Embedded Control
- PD I&III
- Thermal & Fluids Engr I

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Electric Power Engineering

ECSE Core
- Electric Circuits
- Fields & Waves I
- Signals & Systems
- Intro to Electronics

EPE Core
- Power Engineering Fundamentals
- Electromechanics
- Semiconductor Power Electronics
- EPE Lab
- EPE Design

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Electric Power Engineering

- Not required for EPE degree
- Optional Concentration in Power Electronics Systems -- Includes courses from EPOW, ECSE, & MANE

- Technical Electives – any 2 courses in Engineering or Science above the 2000 level
Electric Power Engineering

- Any course at all
- Usually used up for dual degrees
- Most students take additional technical courses
- See undergrad handbook
Dual Degrees

- EE/CSE – Includes only the CSE concentrations (137 credits)
- CSE/CSYS – Includes all CSE concentrations (137 credits)
- EE/EPE – Includes only the Power Electronics concentration (131 credits)
- EE/Applied Physics – Includes only the Microelectronics concentration (132 credits)
ECSE Studios

- ECSE Courses make extensive use of studio facilities
  - Circuit Studio (eg Circuits)
  - Instrumentation Studio (eg Sensing & Imaging, Fields & Waves I)
  - Embedded Control (LITEC) Studio (eg Circuits)
  - Control Studio
  - Computer Studio (eg VLSI Design)
Should we change the classroom?

Studio Classrooms

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Current Lab Instrumentation Set

- Scope
- Power Supply
- Function Generator
- Multimeter
- CPU

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So what if … ?

We could enable students to perform experiments *anyplace at anytime*…

- Dormitory room
- Student Union
- Library
- Campus meeting rooms
- Etc.
Look to Devices Like the iPod for Inspiration in How to Bring the Power of Electrical & Computer Engineering to Education

Information from How Stuff Works – An Amazing Website Created by Marshall Brain who has an EE Degree from RPI
Most Exciting New Products Have Embedded Intelligence (Computers)

Why not use embedded intelligence to enhance the educational experience of EE, CSE, & EPE students?
The Mobile Studio was born...

Instrumentation Card Designed Here to Augment Student Laptops with a Full Set of Instruments

Work Supported by

NSF

ANALOG DEVICES

HP

Early Version

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New Instrumentation Hardware

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Current Board Specifications

- 8 A/D inputs, which can be configured as:
  - 2 channel scope
  - DVM
- 4 D/A outputs
- 16 Digital outputs/inputs (software configurable)
- +/-2.5v, 3.3v, 5v Power supplies (capable of delivering ~ 500mA)
- 2 Independent Function Generators

Version 3 … Faster Version 4 in Production

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The design of this system, like most electronics these days, is a combination of analog & digital circuitry and programmable components (in this case a microcontroller, in the case of version 4 a DSP chip. Thus, this project is as much software as hardware.
### Average Starting Salary for 2005 Graduates*

School of Engineering

<table>
<thead>
<tr>
<th>BS in Engineering</th>
<th>2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aeronautical</td>
<td>$53,290</td>
</tr>
<tr>
<td>Biomedical</td>
<td>56,500</td>
</tr>
<tr>
<td>Chemical</td>
<td>55,542</td>
</tr>
<tr>
<td>Civil</td>
<td>47,284</td>
</tr>
<tr>
<td>Computer and Systems</td>
<td>56,248</td>
</tr>
<tr>
<td>Environmental</td>
<td>Not Available</td>
</tr>
<tr>
<td>Electrical/Electric Power</td>
<td>56,243</td>
</tr>
<tr>
<td>Industrial and Management</td>
<td>51,636</td>
</tr>
<tr>
<td>Mechanical</td>
<td>50,905</td>
</tr>
<tr>
<td>Materials</td>
<td>51,150</td>
</tr>
<tr>
<td>Nuclear/Eng Phys</td>
<td>56,988</td>
</tr>
</tbody>
</table>

*Career Development Center Data

As of July, 2005
National Averages for Starting Salaries

- BSEE $53.6k ($56k at top schools)
- MSEE $66.5k ($70k at top schools)
- PhDEE $69.1k ($80k at top schools)

Note that an MS degree is worth from $13-14k per year, on the average and takes 1-2 years to complete (usually about 1.5 years & less than one year with significant advanced placement or summer school). Thus, the MS degree produces the greatest improvement in salary per dollar invested.
Job Info from NACE Link

- 2005 Top Demand: BS
  - Accounting
  - Electrical engineering
  - Mechanical engineering
  - Business administration/management
  - Economics/finance
  - Computer science
  - Computer engineering
  - Marketing/marketing management
  - Chemical engineering
  - Information sciences and systems

- 2006 Top Demand: BS
  - Mechanical engineering
  - Electrical engineering
  - Accounting
  - Business administration/management
  - Economics/finance
  - Computer science
  - Information sciences and systems
  - Marketing/marketing management
  - Computer engineering
  - Chemical engineering
Masters Degree Demand 2006

- M.B.A.
- Electrical Engineering
- Mechanical Engineering
- Accounting
- Computer Engineering
Top 5 Undergrad Majors Targeted by Region

- Northeast
  - Electrical Engineering
  - Mechanical Engineering
  - Accounting
  - Information Sciences Systems
  - Chemical Engineering

- West
  - Electrical Engineering
  - Computer Science
  - Mechanical Engineering
  - Computer Engineering
  - Accounting
Top 5 Undergrad Majors Targeted by Region

- **Midwest**
  - Accounting
  - Mechanical Engineering
  - **Electrical Engineering**
  - Economics/Finance (incl. banking)
  - Marketing/Marketing Management

- **South**
  - **Business Administration/Management**
  - Accounting
  - Mechanical Engineering
  - **Electrical Engineering**
  - Economics/Finance (incl. banking)
## US IT Jobs 1999/2003 (BLS)

<table>
<thead>
<tr>
<th>Job Category</th>
<th>1999</th>
<th>2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>Programmers</td>
<td>529</td>
<td>403</td>
</tr>
<tr>
<td>SE applications</td>
<td>289</td>
<td>410</td>
</tr>
<tr>
<td>SE systems</td>
<td>209</td>
<td>293</td>
</tr>
<tr>
<td>Computer support</td>
<td>463</td>
<td>481</td>
</tr>
<tr>
<td>Computer systems analysts</td>
<td>428</td>
<td>486</td>
</tr>
<tr>
<td>Database administrators</td>
<td>101</td>
<td>97</td>
</tr>
<tr>
<td>Network and systems admin</td>
<td>205</td>
<td>245</td>
</tr>
<tr>
<td>Network &amp; data communications analysts</td>
<td>98</td>
<td>156</td>
</tr>
<tr>
<td>Computer systems managers</td>
<td>281</td>
<td>257</td>
</tr>
<tr>
<td>Hardware engineers</td>
<td>60</td>
<td>70</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2688</strong></td>
<td><strong>2922</strong></td>
</tr>
</tbody>
</table>
Additional Information on History, the Profession, Etc.


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Career Information

- IEEE
  [http://www.ieee.org/organizations/eab/studentcareers_text.htm](http://www.ieee.org/organizations/eab/studentcareers_text.htm)
- ESCAPE (Purdue)
- About Electrical and Computer Engineering (Discover Engineering Online)
- IEEE Spectrum Careers
More Career Information

• National Society of Professional Engineers
  http://www/nspe.org/students/
• National Action Council for Minorities in Engineering
  http://guidemenacme.org/
• Society of Women Engineers
  http://www.swe.org/
• National Society of Black Engineers
  http://www.nsbe.org
• Society of Hispanic Professional Engineers
  http://www.shpe.org/
Job Descriptions from Company Websites

- Intel
- Texas Instruments
- Motorola
- Maxim
Additional Information

How Stuff Works – Started by ECSE grad Marshal Brain [http://www.howstuffworks.com/]
How Things Work from the University of Virginia [http://howthingswork.virginia.edu/]
The Straight Dope [http://www.straightdope.com]
Contact Information

- connor@rpi.edu
- http://www.rpi.edu/~connor

All of the link information is also available on my webpage.