Time to return your clickers

Take them to your lab instructors
• Take the College of Engineering Climate Survey – Extra Credit

• Start studying for Engr 10 final exam
The Engineering Profession

E10 - Introduction to Engineering

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College of Engineering

Spring 2014
What do we mean by a Profession?¹

1. Requires specialized & highly skilled knowledge
2. Requires academic training
3. Regulated by professional bodies
4. Requires examination of competence
5. Function of professional work is vital to society
6. Perform under a standard of professional behavior that requires adherence to the highest principles of legal and ethical conduct²
7. Requires continuing education to keep current with rapidly changing technology
8. Professionals enjoy higher social status
9. Higher compensation
The Engineering Profession
Training, Qualifications, Advancements, Licensure

- BS required for all entry level engineering jobs

- Engineers trained in one field, may also work in a related field of engineering:

  Civil ...................... Chem E.
  ME ......................... BME
  Aero E ..................... ME
  EE ......................... Comp. E
  Chem E. .................... Materials E

All 50 states require licensure for engineers who offer their services directly to the public\(^2\)
BS Degree

Engineer in Training (EIT) (FE Exam)

Professional Engineer (PE)
Training, Qualifications, Advancements, Licensure

A. Engineer In Training (EIT)
   • Fundamentals of Engineering (FE) Exam
   • Senior in or graduate of ABET accredited program

B. Professional Engineer (PE)
   • BS-ABET
   • Passed FE, or be waived of the FE
   • 4-Years work experience
   • Exam by NCEES (National Council of Examiners for Engineering and Surveying)
     1. Principles and Practice of Engineering
Being a licensed engineer

- The **PE license** allows you to call yourself a professional engineer
- Can have legal authority for engineering work (e.g. sign/stamp drawings, bid for government contracts, own company, serve as expert witness, etc.)
- Some states require at least one licensed engineer in a company.
What Engineers Do? (a review)

“Apply the principles of science and mathematics to develop economical solutions to technical problems”

1. **Design** products
2. **Build** and **test** these products
3. **Design** plants in which those products are made
4. **Design** systems that ensure the quality and efficiency of the manufacturing process
5. **Analyze** systems to evaluate their performance
6. **Develop** software to control systems
7. **Innovate** to improve performance of existing systems
Engineering Work Done in E10


Design:   – Turbine blades, support structure (CE, ME, Aero)  
           - Robot SWR and HDR (EE, Comp E, ME, SWR E)

Build Parts (Mfg):   – Blades (z-printer), IR Board

Assembly:   – Support structure, Motor installation. (CE, ME)  
            – IRB, Robot car (EE, ME)

Test:      – Blade performance. (Aero, EE, Excel )  
            – Structure stiffness (EE, CE, ME)  
            – IRB, Robot HDR/SWR

Communication:  – Technical presentation and report
What kind of a pattern do we see on the last two slides?
The Engineering Process

- Design
- Develop
- Manufacture
- Assemble
- Test/Evaluate
- Communicate
- Analyze
Where do you see your self 10 years from now

Profession, Professional Level, Environment, Location, ……
Engineering Education Timeline

Fr. | So | Jr | Sr | What Next?

Time (years)

grad school

work

???
### Earnings distribution by engineering specialty, 2009

<table>
<thead>
<tr>
<th>Specialty</th>
<th>25th Percentile</th>
<th>Median</th>
<th>75th Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerospace engineers</td>
<td>$60,000</td>
<td>$87,000</td>
<td>$115,000</td>
</tr>
<tr>
<td>Biomedical engineers</td>
<td>50,000</td>
<td>68,000</td>
<td>100,000</td>
</tr>
<tr>
<td>Chemical engineers</td>
<td>60,000</td>
<td>86,000</td>
<td>120,000</td>
</tr>
<tr>
<td>Civil engineers</td>
<td>57,000</td>
<td>78,000</td>
<td>103,000</td>
</tr>
<tr>
<td>Computer hardware engineers</td>
<td>69,500</td>
<td>88,470</td>
<td>111,030</td>
</tr>
<tr>
<td>Electrical engineers</td>
<td>60,000</td>
<td>85,000</td>
<td>110,000</td>
</tr>
<tr>
<td>Environmental engineers</td>
<td>51,000</td>
<td>70,000</td>
<td>93,000</td>
</tr>
<tr>
<td>Industrial engineers</td>
<td>55,000</td>
<td>75,000</td>
<td>101,000</td>
</tr>
<tr>
<td>Materials engineers</td>
<td>48,000</td>
<td>69,000</td>
<td>96,000</td>
</tr>
<tr>
<td>Mechanical engineers</td>
<td>59,000</td>
<td>80,000</td>
<td>105,000</td>
</tr>
<tr>
<td>Petroleum engineers</td>
<td>82,000</td>
<td>120,000</td>
<td>189,000</td>
</tr>
<tr>
<td>Engineering as a whole</td>
<td>53,000</td>
<td>75,000</td>
<td>102,000</td>
</tr>
</tbody>
</table>

Another source is the Bureau of Labor Statistics
From Student to Professional Engineer
Step 1

BS/MS

Majors
ME, EE, CE
ISE, SWR.E,
Comp.E ...

Specialization

Great web site for learning about each type of engineering
http://whatcanidowiththismajor.com/major/
Aero

- Aerodynamics
- Propulsion
- Flight Dynamics
- Structure & Materials
Fluid Dynamics  
Thermo-dynamics  
Mechanical Design  
Mechatronics
Mechatronics
Mechanical, Electronic, Control & Computing systems
EE

- Power Generation
- Communication Systems
- LSI
- Electronics
Computer OR Software E

Hardware Design
Software Design
Networks
Databases
Chem. E

- Biochemical
- Polymers Plastics
- Food Processing
Mat. E

- Semiconductors
- Microelectronics
- Ceramics
Industrial & Systems Eng.

Enterprise Operations

Safety/Ergonomics

Quality Control
What are employers looking for in new graduates?

- Fast learners
- Team players

This is a major employer’s checklist of desired attributes of engineering graduates.
Group A: Good Understanding of:

1. Engineering science fundamentals:
   a. Physical and life science
   b. Information technology
   c. Math (including statistics)

2. The design and manufacturing process
   (fundamentals of engineering)

3. Good communication skills:
   a. Written
   b. Verbal
   c. Graphic
   d. Listening
Group B: Basic understanding of:

1. The context in which engineering is practiced, including:
   - Economics/business practice
   - History
   - The environment
   - Customer and social needs

2. A multidisciplinary systems perspective.

3. The importance of teamwork.

4. Ethical standards
1. Curiosity and a LifeLong desire to Learn. (LLL)

2. Ability to think critically and creatively as well as independently and cooperatively.

3. Flexibility – the ability and the self-confidence to adapt.
From Student to Professional
Step 2

BS/MS

Majors

Specialization

Functional (Job) Classification
Typical Product Cycle

- Idea/Concept
- Design/Modeling
- Feasibility study $$$
- Development/Prototyping
- Testing
- Product Documentation Specifications
- To MFG
- Facilities
- Training
- Packaging
- Tooling/Automation
- Production
- To Customer/Consumer
- Shipping
<table>
<thead>
<tr>
<th></th>
<th>Functional Classification - All majors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Research</td>
</tr>
<tr>
<td>2.</td>
<td>Experimental</td>
</tr>
<tr>
<td>3.</td>
<td>Analytical</td>
</tr>
<tr>
<td>4.</td>
<td>Design</td>
</tr>
<tr>
<td>5.</td>
<td>Development</td>
</tr>
<tr>
<td>6.</td>
<td>Testing</td>
</tr>
<tr>
<td>7.</td>
<td>Production</td>
</tr>
<tr>
<td>8.</td>
<td>Operations</td>
</tr>
<tr>
<td>9.</td>
<td>Sales/Marketing</td>
</tr>
<tr>
<td>10.</td>
<td>Customer (large systems)</td>
</tr>
<tr>
<td>11.</td>
<td>Management</td>
</tr>
<tr>
<td>12.</td>
<td>Consulting</td>
</tr>
<tr>
<td>13.</td>
<td>Construction</td>
</tr>
<tr>
<td>14.</td>
<td>Safety</td>
</tr>
<tr>
<td>Title</td>
<td>Function</td>
</tr>
<tr>
<td>---------------</td>
<td>--------------------------------------------------------------------------</td>
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</tbody>
</table>
| Research E.   | -Solve new problems
               -Obtain new data
               -Devise new methods of calculation
               -Gain new knowledge            | Perceptiveness
                                      Patience
                                      Self-Confidence                  |
| Analytical E. | Model physical problems using math to predict performance
                   Perform failure analysis        | Math, physics, engineering,
                                      science, applications
                                      software                         |
| Development E.| -Develop products, processes, or systems
                   -Use well-known principles and employ existing processes or machines to perform a new function
                   -Concerned mostly with a prototype or model | Ingenuity
                                      Creativity
                                      Astute Judgment                   |
<table>
<thead>
<tr>
<th>Title</th>
<th>Function</th>
<th>SKILLS/Knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Design E.</strong></td>
<td>- Convert concepts &amp; information into detailed plans &amp; specs from which the finished product can be manufactured&lt;br&gt;- Restricted by the state of the art</td>
<td><strong>Creativity</strong>&lt;br&gt;&lt;br&gt;<strong>Innovation</strong>&lt;br&gt;&lt;br&gt;<strong>Fundamental knowledge of many disciplines</strong>&lt;br&gt;&lt;br&gt;<strong>Understanding of economics and people</strong></td>
</tr>
<tr>
<td><strong>Production E.</strong></td>
<td>- Devise a schedule to efficiently coordinate materials and personnel&lt;br&gt;- Order raw materials at optimum times&lt;br&gt;- Set up the assembly line&lt;br&gt;- Handle and ship finished product</td>
<td>- <strong>Knowledge of design, economics &amp; psychology</strong>&lt;br&gt;- <strong>Ability to visualize the overall operation of a project</strong>&lt;br&gt;- <strong>Knowledge of each step of the production effort</strong></td>
</tr>
</tbody>
</table>
**Test E.**
- Develop & conduct tests to verify that a new product meets design specs
- Test products for structural integrity, performance, & reliability
- Testing is performed under all expected environmental conditions

**SKILLS/Knowledge**
- Knowledge of statistics, product & process specifications
- Measurement techniques
- Fundamental engineering aspects of the design

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**Operations or Plant E.**
- Select sites for facilities
- Specify layout for all facets of the operation
- Select fixed equipment for climate control, lighting, and communication
- Responsible for maintenance and modifications

**SKILLS/Knowledge**
- Industrial engineering, economics and law
From Student to Professional Engineer
Step 3

BS/MS

Majors

Specialization

Functional (Job) Classification

Company Levels
Company Levels (Publicly owned)

Corporate Management

COB
Board of Directors
CEO
CFO
COO
CTO

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V.P. of Marketing
V.P. of Engineering
V.P. of MFG
V.P. of ............

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Director of ....
Director of ....

Management

Plant Mgt.
Functional Mgt.*
Project Mgt.
Line Mgt.
......

Engineering

Fellow*
Senior E.
Project E.
or Lead E.
Advisory*
Staff*
Sr. Associate E.*
Engineer
or “Entry Level”

* Large Co.
Bachelor of Science in Engineering: The Key to "Maaaaaany" Doors
Directions After BS “Engineering”

- **Advanced Degrees-Academic Institutions** (Teaching, researching, publishing, community involvement)
- **Engineering Management** (MSE/MBA)
- **Law** (Patent law: 45 units of engr/science w/Lab., Corporate Law)
- **Medicine** (bioengineering, prosthetics, “Bionic man/Women”)
- **Government, Defense, CalTrans**
- **Engineering Consultant**
- **Your Own Business**
- **007 ???**
Could 007 Have Been an Engineer?

BS Engineering

CIA
Engineering Careers at CIA

- College Students – Scientists & Engineers
  - Electrical Engineer
  - Materials Engineer
  - Mechanical Engineer
  - Program Management Engineer
  - Research Scientist
  - Science, Technology, and Weapons Analyst
  - Systems Engineer
  - Technical Operations Officer

(www.cia.gov/careers/jobs/view-all-jobs/index.html)
Thank you
References

1. Fledderman, C. *Engineering Ethics*
2. www.nspe.org
5. www.abet.org
6. www.wetfeet.com
8. Prism (?)