The Fundamentals of Engineering Exam

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Professor of Civil Engineering
Outline

- The FE Exam in perspective
- Engineering registration requirements
- Overview of FE Exam
- Registering for the FE Exam
- Preparation for the FE Exam
  - Discipline specific or general afternoon exam?
  - Preparation tools
  - Mind
  - Body
- Summary
Fundamentals of Engineering exam?
Engineering

- Engineering is a profession like medicine, law, etc., which aspires to high standards of conduct, and recognizes its responsibility to the general public.

- To protect the public, we follow engineering design codes and have engineering registration:
  - Codes used to control the construction of various components and systems.
  - A register designer is required to acquire a level of competence through Education, Examinations and Experience before s/he is allowed to practice independently.
History of Licensing

- 1907, first licensing law was enacted in Wyoming?
- 1928, St. Francis dam collapsed – over 400 killed.
  - This resulted in California enacting a licensing law for civil engineers in 1929
  - 1931, licensing law amended to recognize structural engineering title
  - 1947 chemical, electrical, mechanical and petroleum engineering recognized
- 1947, 50th licensing law enacted in Montana
# of Engineers in the US

<table>
<thead>
<tr>
<th>Engineering Discipline</th>
<th>Approx. # Engineers</th>
<th>Approx. # Licensed</th>
<th>Percent Licensed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Civil</td>
<td>360,000</td>
<td>160,000</td>
<td>44</td>
</tr>
<tr>
<td>Mechanical</td>
<td>395,000</td>
<td>91,000</td>
<td>23</td>
</tr>
<tr>
<td>Electrical</td>
<td>803,000</td>
<td>73,000</td>
<td>9</td>
</tr>
<tr>
<td>Chemical</td>
<td>180,000</td>
<td>15,000</td>
<td>8</td>
</tr>
<tr>
<td>Industrial</td>
<td>133,000</td>
<td>11,000</td>
<td>8</td>
</tr>
<tr>
<td>Agricultural</td>
<td>40,000</td>
<td>5,000</td>
<td>13</td>
</tr>
<tr>
<td>Mining/Metals</td>
<td>30,000</td>
<td>5,000</td>
<td>17</td>
</tr>
<tr>
<td>Other</td>
<td>259,000</td>
<td>40,000</td>
<td>15</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2,200,000</strong></td>
<td><strong>400,000</strong></td>
<td><strong>18</strong></td>
</tr>
</tbody>
</table>
Labor Department statistics (~1.6 million jobs in engineering in 2008)

<table>
<thead>
<tr>
<th>Engineering Category</th>
<th>Employment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Civil engineers</td>
<td>278,400</td>
</tr>
<tr>
<td>Mechanical engineers</td>
<td>238,700</td>
</tr>
<tr>
<td>Industrial engineers</td>
<td>214,800</td>
</tr>
<tr>
<td>Electrical engineers</td>
<td>157,800</td>
</tr>
<tr>
<td>Electronics engineers, except computer</td>
<td>143,700</td>
</tr>
<tr>
<td>Computer hardware engineers</td>
<td>74,700</td>
</tr>
<tr>
<td>Aerospace engineers</td>
<td>71,600</td>
</tr>
<tr>
<td>Environmental engineers</td>
<td>54,300</td>
</tr>
<tr>
<td>Chemical engineers</td>
<td>31,700</td>
</tr>
<tr>
<td>Health and safety engineers, except mining safety engineers and inspectors</td>
<td>25,700</td>
</tr>
<tr>
<td>Materials engineers</td>
<td>24,400</td>
</tr>
<tr>
<td>Petroleum engineers</td>
<td>21,900</td>
</tr>
<tr>
<td>Nuclear engineers</td>
<td>16,900</td>
</tr>
<tr>
<td>Biomedical engineers</td>
<td>16,000</td>
</tr>
<tr>
<td>Marine engineers and naval architects</td>
<td>8,500</td>
</tr>
<tr>
<td>Mining and geological engineers, including mining safety engineers</td>
<td>7,100</td>
</tr>
<tr>
<td>Agricultural engineers</td>
<td>2,700</td>
</tr>
<tr>
<td>Engineers, all other</td>
<td>183,200</td>
</tr>
</tbody>
</table>

http://www.bls.gov/oco/ocos027.htm
Figure 1

Employed engineering graduates and U.S. engineers: 1999

NOTE: Engineering graduates have a bachelor’s or higher degree in engineering. A person whose principal occupation is engineer may or may not be an engineering graduate.

SOURCE: National Science Foundation/Division of Science Resources Statistics, SESTAT (Scientists and Engineers Statistical Data System), 1999.
Engineering Registration Requirements
Licensure Process

- Successfully complete the degree requirements of an EAC/ABET accredited program
- Take and pass the FE exam
- Then, practice under the supervision of a registered designer for several years – 2 to 4
- Finally, qualify for, take, & pass the Principles-and-Practices of Engineering (PE) exam
Recent developments in licensing

- votes to increase amount of education required for engineering licensure

**New Model Law language**

- Licensure by Examination:
  - The following individuals shall be admitted to an 8-hour written examination in the principles and practice of engineering:
    - “An engineer intern with a bachelor's degree, with an additional 30 credits of acceptable upper-level undergraduate or graduate-level coursework …”

Effective January 1, 2020
The argument for more education

Agogino, NAE
Overview of FE
Format

- **Morning (AM) part**
  - 120 questions in 4 hours → 2 minutes per question
  - General subjects covered in the lower division courses
- **Afternoon (PM) part**
  - 60 questions in 4 hours → 4 minutes per question
  - Choice of a number of disciplines, concepts covered in the upper division courses
  - General exam similar to the one in the morning
  - Must choose discipline when you register for exam!
<table>
<thead>
<tr>
<th>Subject</th>
<th># of questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics</td>
<td>19</td>
</tr>
<tr>
<td>Engineering Probability and Statistics</td>
<td>8</td>
</tr>
<tr>
<td>Chemistry</td>
<td>11</td>
</tr>
<tr>
<td>Computers</td>
<td>8</td>
</tr>
<tr>
<td>Ethics and Business Practices</td>
<td>8</td>
</tr>
<tr>
<td>Engineering Economics</td>
<td>10</td>
</tr>
<tr>
<td>Eng. Mechanics (Statics and Dynamics)</td>
<td>13</td>
</tr>
<tr>
<td>Strength of Materials</td>
<td>8</td>
</tr>
<tr>
<td>Materials Properties</td>
<td>8</td>
</tr>
<tr>
<td>Fluid Mechanics</td>
<td>8</td>
</tr>
<tr>
<td>Electricity and Magnetism</td>
<td>11</td>
</tr>
<tr>
<td>Thermodynamics</td>
<td>8</td>
</tr>
</tbody>
</table>
# PM part general (Other discipl)

<table>
<thead>
<tr>
<th>Subject</th>
<th># of questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced Engineering Mathematics</td>
<td>6</td>
</tr>
<tr>
<td>Engineering Probability and Statistics</td>
<td>5</td>
</tr>
<tr>
<td>Biology</td>
<td>3</td>
</tr>
<tr>
<td>Engineering Economics</td>
<td>6</td>
</tr>
<tr>
<td>Application of Engineering Mechanics</td>
<td>8</td>
</tr>
<tr>
<td>Engineering of Materials</td>
<td>7</td>
</tr>
<tr>
<td>Fluids</td>
<td>9</td>
</tr>
<tr>
<td>Electricity and Magnetism</td>
<td>7</td>
</tr>
<tr>
<td>Thermodynamics and Heat Transfer</td>
<td>9</td>
</tr>
</tbody>
</table>
## PM part CE discipline specific

<table>
<thead>
<tr>
<th>Subject</th>
<th># of questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surveying</td>
<td>7</td>
</tr>
<tr>
<td>Hydraulics and Hydrologic Systems</td>
<td>7</td>
</tr>
<tr>
<td>Soil Mechanics and Foundations</td>
<td>9</td>
</tr>
<tr>
<td>Environmental Engineering</td>
<td>7</td>
</tr>
<tr>
<td>Transportation</td>
<td>7</td>
</tr>
<tr>
<td>Structural Analysis</td>
<td>6</td>
</tr>
<tr>
<td>Structural Design</td>
<td>6</td>
</tr>
<tr>
<td>Construction Management</td>
<td>6</td>
</tr>
<tr>
<td>Materials</td>
<td>5</td>
</tr>
</tbody>
</table>
# PM part EE discipline specific

<table>
<thead>
<tr>
<th>Subject</th>
<th># of questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circuits</td>
<td>10</td>
</tr>
<tr>
<td>Power</td>
<td>8</td>
</tr>
<tr>
<td>Electromagnetics</td>
<td>4</td>
</tr>
<tr>
<td>Control Systems</td>
<td>6</td>
</tr>
<tr>
<td>Communications</td>
<td>5</td>
</tr>
<tr>
<td>Signal Processing</td>
<td>5</td>
</tr>
<tr>
<td>Electronics</td>
<td>9</td>
</tr>
<tr>
<td>Digital Systems</td>
<td>7</td>
</tr>
<tr>
<td>Computer Systems</td>
<td>6</td>
</tr>
</tbody>
</table>
Scoring

- Morning part – 1 point each question
- Afternoon part – 2 points each question
- Raw score is 240 points
- From exam history, a passing score is NOT 70% of the total 240 points, but you should try to get a minimum of 70%
- Raw passing score (total out of 240 pts) normalized to 70%
- Raw passing score in the past has been roughly 55-60%, but may be higher
Registering for the Exam
- Visit the California Board for Professional Engineers and Land Surveyors website for more information at:
  [http://www.pels.ca.gov/](http://www.pels.ca.gov/)

- Application information can be found at:

- The applications can be completed at:
Exam Qualifications

- Applicants must have completed:
  - **Three years of course work** in a Board-approved engineering curriculum (any curriculum approved by ABET)
  - **OR** three years or more of engineering-related work experience anywhere in the world
  - **AND** never have been convicted of a crime substantially related to the practice of engineering
Preparing for the FE exam
In the PM, Discipline Specific or General?

- Choose the one you are most comfortable with – either your discipline specific exam or the general exam

- General PM part
  - More complex questions than in the morning
    - One difference between the AM and PM problems is that the PM problems usually have a lot of extra information provided, which is NOT needed to solve the problem
  - Advantage of General PM part is that you will have reviewed the general subject for the AM part

- Discipline Specific Part
  - If you have taken most of your upper division courses, this may be more appropriate, and in many cases the questions are easier to solve that the General PM exam
Mind – Studying

Review

- **Attend all the review sessions**

- Before each class study the Lindeburg manual and sample problems. Work the FE style problems at the end of each chapter using the Reference Handbook

  
  Cost is $10 for 3 month access

- View free FE exam questions at [http://ncees.confex.com/creatinguser/register.html](http://ncees.confex.com/creatinguser/register.html)
Use the right tools to study

- Be familiar with the **ENGINEER-IN-TRAINING** and **LAND SURVEYOR-IN-TRAINING EXAMINEE INSTRUCTIONS** before test day

- Be familiar with one of the approved calculators
  - Hewlett Packard – HP 33s and HP 35s models
  - Casio – all FX-115 models
  - Texas Instruments – All TI-30X and TI-36X models

- Be very familiar with the NCEES Handbook
Reference Handbook

- Know it well
- Familiar with the sections you know best, statics, math, etc.
- Be familiar with the Table of Contents
- USE THE INDEX

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Body

- Train to gain stamina
  - Test will begin at 8:00am
  - Will last all day
  - Practice exam questions under exam conditions (get up early some days and solve problems)

- Just before the test
  - No exotic meals (or drinks) the night before
  - Hearty breakfast
  - EAT LUNCH THE DAY OF THE EXAM. Bring lunch from home, with a beverage! Don't rely on scrounging for food at the test site – you and 1000 others.
  - Bring snacks (quite ones)
  - Layered clothing (it may be hot or cold in the room)
Summary of Preparation

- Use the reference manual
- Use FE approved calculator to do everything
- Attend review sessions
- Focus on stuff you know
- Take sample tests
- Practice under test environment (time of day and duration)
- Organize everything in advance do not wait until the night before
  - Stay near the testing center the night before the exam; make reservations ahead of time
  - Get familiar with the test site; know where it is, where the parking lot is located, entrances, etc. It may be dark when you get there on test day.
  - Assemble your 'things to take' list.
    - Exam acceptance letter
    - Government issued picture ID (not UOP student ID card)
    - 2 calculators
    - Working watch for time keeping
    - Packed lunch & drink (don't count on having enough time to go someplace & get back in time)
    - Advil, allergy medicine, tissues
    - Quiet candy - ask monitors if you can have them
    - Seat cushion

- The night before:
  - Relax
  - No special food or drink
  - Most importantly, get a good night sleep
References

- FE information on the web:
  - www.ncees.org
    - Information about passing rates, calculator policy exam dates, learn more about professionalism, brief practice exam
  - www.ppi2pass.com
    - FE review manual, take practice examination learn about examination
  - www.eitexam.com
    - take practice exams for $10.
- FE Review Manual by Lindeburg
  - New cost about $50; We will loan you these
- FE Supplied-Reference Handbook
  - We will loan you these
- DS and General Sample Questions & Solutions – NCEES or PPI (Recommended)