STUDENT INTRODUCTION

Rather than diving right into technical material, it's helpful to give an introduction to help orient the students to the licensing process, the FE exam, and the course.

The Licensing Process

The process for obtaining an engineering license differs from state to state. Be familiar with the requirements of your state, but refer students to their state board of registration for the current requirements. The phone numbers for the state boards of registration are on PPI's web site, **www.ppi2pass.com/stateboards.html**.

> **FE/EIT**: In most states, passing the FE exam is enough for an EIT certificate. Some states have education or experience requirements to sit for the FE. Some colleges and universities make the FE exam a requirement for graduation.
>
> **PE**: For most states, the requirements for getting a license include earning an EIT certificate, having a requisite number of years of appropriate work experience, presenting some number of references, and passing the Principles and Practice of Engineering (PE) exam. The exact experience and reference requirements differ from state to state. Some states require continuing education to retain a license. The state charges fees for the exam and the license, as well as periodic renewal fees.

Reciprocity

All states have reciprocity for the licensing exams in that they accept the results regardless of where the exam was given. In general, states accept an EIT certificate from any other state (although there are exceptions). States sometimes do have different requirements for licensing (for example, in California, civil PE candidates must pass not only the PE exam but also two other state-specific exams on surveying and seismic principles.) A PE may be able to practice in a state other than the one he or she is licensed in on a limited basis, depending on the rules in that state.

Advantages of Having an Engineering License

There is a certain prestige and commanding of respect that goes with a PE License. Other professionals and the public will admire the fact you have done something that is difficult, shows competence, and takes commitment.

It looks good to employers on a résumé. They can be confident that a PE knows his or her subject. They can tell customers and potential customers that they have a PE on staff. The more PEs they employ, the better they look.

A PE can take pride in having done something that only a small fraction of the people in the country can do.

Certain work (usually involving structures or public safety) must be prepared by or supervised by a licensed engineer. A PE's seal and signature have the weight of the state behind them.

A PE license is required by most courts to act as an expert witness.

A PE license will certainly help to establish your credentials if you do consulting or private practice work. In many cases, a license is required by law to consult or practice privately.

A PE license is required for an increasing number of federal, state, and municipal government jobs and for some jobs in education.

When downsizing, employers are likely to retain a licensed engineer over an engineer without a license.

A PE license can help to establish an engineer's qualifications if he or she is working in a field different than his or her academic training. (To use a personal example, my bachelor's degree was in physics and my license is in electrical engineering.)

Lecture Preparation

Provide all reading assignments the first day of class.

Urge students to read FERM2 *before* attempting homework problems.

Most Effective Study Method

- Read the assigned FERM2 chapters
- Work all the problems, covering the answers
- Work on separate paper (show the instructor the paper for credit)
- Use *only* the NCEES Handbook to do homework
- Go to FERM2 chapters only when stuck on a problem.

Urge students to read the relevant parts of the NCEES Handbook thoroughly and to be able to find formulas they need *without searching*. The following sections of the NCEES Handbook are NOT relevant to the general version of the exam:

- *part of* Heat Transfer (the part not relevant is identified in the NCEES Handbook)
- Transport Phenomena
- Computers, Measurement, and Controls
- Chemical Engineering
- Civil Engineering
- Electrical and Computer Engineering
- Industrial Engineering
- Mechanical Engineering

Urge students to read the user's manual for their calculator *before* the exam. No reference material other than the NCEES Handbook is allowed in the exam room—including calculator manuals and calculator formula lists. Having a sophisticated, complicated calculator works to the student's detriment if he or she doesn't know how to use it well. All the problems on the FE exam can be solved with a basic scientific calculator.

What to Bring to the Exam

The items in boldface are essential. Without these items, the student might as well not bother to go. *Remind the student of these items on the last day of lecture.* Nothing else you tell them is any good if they don't remember these items. The other items not in bold are just suggestions.

- **Letter admitting student to the examination**
- **Photo identification**
- **Calculator that the student knows how to use (and ideally a backup calculator of the same model)**
- **Lots of sharp #2 pencils**
- **Lunch**
- Pencil sharpener
- Light jacket or sweater
- Seat cushion
- Ear plugs
- Straight edge
- Ruler
- Protractor

A word about the one-hour lunch break: Students should pack a nonperishable lunch for the day of the exam. They may not be allowed to go out to a restaurant for lunch. I've been told that at one site, students who didn't bring their own lunch had the choice of choking down a $3 hot dog that was hard to look at, much less enjoy, or going without.

Students can take a walk during the lunch break to clear their heads—but they should get back early enough to avoid the crowd checking in through the proctor security.

Exam Rules

- CAUTION! When time is called during the exam, drop that pencil! Warn the students that writing or even holding a pencil after time is called results in a *failed test*.

- Calculators must be silent and have no printer.
- Pagers must be silent, and may not be allowed at all in the exam room.
- Students should turn off any beepers on their watches.
- Any voluntary disruption may result in a failed test (you can sneeze but you may not hum).

Exam Strategy

Students should:

- NOT try to solve all the questions—they're only trying to get enough points to pass. Spend minimal time on areas of known weakness.
- NOT spend more than 5 minutes on any problem.
- decide before the exam what strategy they are going to use during the exam. Strategies include:
  - guessing on problems they can't solve and move on, **or**
  - leaving these problems unanswered and go back if time permits, **or**
  - skipping through the exam working problems in their specialty areas, **or**
  - some combination of these strategies.
    (When they skip problems, they run the risk of leaving them unanswered or getting confused and marking the wrong line on the answer sheet. Only the individual can judge if he or she is capable of dealing with these risks.)

Guessing: The exam has no penalty for wrong answers, so students should answer all problems even if they have no idea how to solve them. Inevitably, you will hear students say that they've heard one should guess all "As," or all "Cs," and they want to know which letter will give the best result. I tell students that if they choose one letter and guess on a significant number of problems, they will get around 25% right. If they guess randomly, it then becomes theoretically possible to guess right on all the problems they don't know, and it's also possible to get them all wrong.

Last two minutes: If the student is still working when the proctor calls the two-minute warning, the rest of the exam should be a coloring exercise. Urge students not to lose points they could have gotten by guessing. At that point, there's no use in struggling to solve one more problem they may or may not get right. Get to work filling in those bubbles!

Exam Schedule: Give the schedule for FE exam administration (and the PE exams, if appropriate) in your state for the next two or three years.

Exam Specs: Give the students copies of the exam specification. This enables students to know where they should concentrate their study to get the most points. Table 1 shows percentages of questions by subject in the morning and afternoon (general) sessions. Table 2 shows a typical subdivision of the major subjects.

Table 1. *FE Exam Specifications by Subject*

morning session		**afternoon (general) session**	
subject	**percentage of total questions (%)**	**subject**	**percentage of total questions (%)**
chemistry	9	advanced engineering mathematics	10
computers	7	engineering probability and statistics	9
electricity and magnetism	9	biology	5
engineering economics	8	engineering economics	10
engineering mechanics (statics and dynamics)	10	application of engineering mechanics	13
engineering probability and statistics	7	engineering materials	11
ethics and business practices	7	fluids	15
fluid mechanics	7	electricity and magnetism	12
materials properties	7	thermodynamics and heat transfer	15
mathematics	15		
strength of materials	7		
thermodynamics	7		

***Table 2**. Typical Subdivisions of Major Subjects*

MORNING SESSION (120 questions in 12 topic areas)

Topic Area	Approximate Percentage of Test Content
CHEMISTRY	9%
Nomenclature	
Oxidation and reduction	
Periodic table	
States of matter	
Acids and bases	
Equations (e.g., stoichiometry)	
Equilibrium	
Metals and nonmetals	
COMPUTERS	7%
Terminology (e.g., memory types, CPU, baud rates, Internet)	
Spreadsheets (e.g., addresses, interpretation, "what if," copying formulas)	
Structured programming (e.g., assignment statements, loops and branches, function calls)	
ELECTRICITY AND MAGNETISM	9%
Charge, energy, current, voltage, power	
Work done in moving a charge in an electric field (relationship between voltage and work)	
Force between charges	
Current and voltage laws (Kirchhoff, Ohm)	
Equivalent circuits (series, parallel)	
Capacitance and inductance	
Reactance and impedance, susceptance and admittance	
AC circuits	
Basic complex algebra	
ENGINEERING ECONOMICS	8%
Discounted cash flow (e.g., equivalence, PW, equivalent annual FW, rate of return)	
Cost (e.g., incremental, average, sunk, estimating)	
Analyses (e.g., breakeven, benefit-cost)	
Uncertainty (e.g., expected value and risk)	

Topic Area	Approximate Percentage of Test Content
ENGINEERING MECHANICS (Statics and Dynamics)	10%
Resultants of force systems	
Centroid of area	
Concurrent force systems	
Equilibrium of rigid bodies	
Frames and trusses	
Area moments of inertia	
Linear motion (e.g., force, mass, acceleration, momentum)	
Angular motion (e.g., torque, inertia, acceleration, momentum)	
Friction	
Mass moments of inertia	
Impulse and momentum	
Work, energy, and power	
ENGINEERING PROBABILITY AND STATISTICS	7%
Measures of central tendencies and dispersions (e.g., mean, mode, standard deviation)	
Probability distributions (e.g., discrete, continuous, normal, binomial)	
Conditional probabilities	
Estimation (e.g., point, confidence intervals) for a single mean	
Regression and curve fitting	
Expected value (weighted average) in decision making	
Hypothesis testing	
ETHICS AND BUSINESS PRACTICES	7%
Code of ethics (professional and technical societies)	
Agreements and contracts	
Ethical versus legal	
Professional liability	
Public protection issues (e.g., licensing boards)	
FLUID MECHANICS	7%
Flow measurement	
Fluid properties	
Fluid statics	
Energy, impulse, and momentum equations	
Pipe and other internal flow	

Topic Area	Approximate Percentage of Test Content
MATHEMATICS	15%
Analytic geometry	
Integral calculus	
Matrix operations	
Roots of equations	
Vector analysis	
Differential equations	
Differential calculus	
MATERIAL PROPERTIES	7%
Properties (chemical, electrical, mechanical, and physical)	
Corrosion mechanisms and control	
Materials (engineered materials, ferrous metals, and nonferrous metals)	
STRENGTH OF MATERIALS	7%
Shear and moment diagrams	
Stress types (e.g., normal, shear, bending, torsion)	
Stress strain	
Deformations (e.g., axial, bending, torsion)	
Combined stresses	
Columns	
Indeterminant analysis	
Plastic versus elastic deformation	
THERMODYNAMICS	7%
Thermodynamic laws (e.g., 1st law, 2nd law)	
Energy, heat, and work	
Availability and reversibility	
Cycles	
Ideal gases	
Mixture of gases	
Phase changes	
Heat transfer	
Properties of enthalpy and entropy	

About the Lectures

Describe how your course is organized and what subjects will be taught.

Use of SI Units: The course should be taught entirely in SI units. Tell the students that, where possible, they should work in SI units.

Asking "OK?": I ask "OK?" often during my lecture. For me, this is not a rhetorical question. I've told my students this is their time and if it is *not* OK, they need to speak up. If they don't understand or if they need more time to write notes, they need to stop the lecture.

Other Resources

You may want to mention PPI's web site at **www.ppi2pass.com**, on which students can find a wealth of information about the FE and PE exams, including test tips from previous examinees, exam facts, online resources for extra help, and state licensing board contacts.

Homework

Use FERM2 for homework assignments. There are over 1,100 practice problems in this book. You can also use problems from EIT8. Suggested homework assignments follow.

Give out the homework assignments for the entire course at the beginning of the course—or even before the course starts if possible. For homework, select the problems that you feel best reflect the questions on the exam, and make these problems required. Explain that the rest of the problems are optional. Identify any problems you feel are definitely not worth the student's time. The grading should be on the honor system, with students grading themselves using the solutions in FERM2. Be open to explaining a problem that a student doesn't understand, but don't take class time to do it—schedule time after class.

Have students show you their homework. Since you are not going to grade the homework, tell the students they shouldn't waste time making the homework legible. Return the homework after looking to see that it shows the student did some work. The down side to this system is that the students can cheat, but they are only cheating themselves. I had a student once who had marvelous penmanship. The homework looked almost like it had been typed. He turned in all the homework and there wasn't a single crossed-out formula, erasure, or any other imperfection. In other words, it sure looked like he had copied the solutions directly out of the book. But what could I say? I had to take him at his word no matter how improbable. He didn't pass the test. I tell my students this story as a warning. Urge students to work even problems that seem easy, instead of deciding that they know the subject and move on to the next subject. The easy problems will help them improve their speed in the exam environment.

If you choose to make up homework of your own, either grade it or pass out complete solutions after it is turned in.

Suggested Homework Assignments from the *FE Review Manual* (FERM2)

Note: There are two types of problems at the end of most chapters in FERM2, identified as "Sample" and "FE-Style."

Mathematics #1 Lesson
Diagnostic Exam III: 1, 2, 3, 10

Chapter 4	Sample: 1–5	FE-Style: 1–7
Chapter 5	Sample: 2	FE-Style: 1, 2, 10–13, 24–28

Mathematics #2 Lesson
Diagnostic Exam III: 4–8

Chapter 5	Sample: 1, 3, 4, 5, 6	FE-Style: 3–9, 14–23, 29–32
Chapter 6	Sample: 1–3	FE-Style: 1-21

Mathematics #3 Lesson
Diagnostic Exam III: 9, 11, 12, 13, 14, 15

Chapter 7	Sample: 1–5	FE-Style: 1–25
Chapter 8	Sample: 1–3	FE-Style: 1–20
Chapter 9		FE-Style: 1

Engineering Economics Lesson
Diagnostic Exam XVI: 1–15

Chapter 51	Sample: 1–6	FE-Style: 1–20
Chapter 52	Sample: 1–5	FE-Style: 1–18
Chapter 53	Sample: 1–6	FE-Style: 1–14

Ethics Lesson
Diagnostic Exam XVII: 1–15

Chapter 54	Sample: 1–11	FE-Style: 1–31

Biology Lesson
Diagnostic Exam XI: 1–15

Chapter 33	Sample: 1, 2	FE-Style: 1–9
Chapter 34	Sample: 1, 2	FE-Style: 1–6
Chapter 35	Sample: 1, 2	FE-Style: 1–5
Chapter 36	Sample: 1, 2	FE-Style: 1–6

Chemistry Lesson
Diagnostic Exam XII: 1–15

Chapter 37	Sample: 1–5	FE-Style: 1–24
Chapter 38	Sample: 1–9	FE-Style: 1–15
Chapter 39	Sample: 1–5	FE-Style: 1–14

Statics Lesson

Diagnostic Exam IV: 1–15

Chapter 10	Sample: 1–5	FE-Style: 1–23
Chapter 11	Sample: 1–4	FE-Style: 1–10
Chapter 12	Sample: 1–5	FE-Style: 1–12
Chapter 13	Sample: 1–6	FE-Style: 1–18

Dynamics Lesson

Diagnostic Exam V: 1–15

Chapter 14	Sample: 1–6	FE-Style: 1–16
Chapter 15	Sample: 1–7	FE-Style: 1–14
Chapter 16	Sample: 1–5	FE-Style: 1–17
Chapter 17	Sample: 1–7	FE-Style: 1–17

Fluid Mechanics Lesson

Diagnostic Exam VII: 1–15

Chapter 22	Sample: 1–2	FE-Style: 1–11
Chapter 23	Sample: 1–7	FE-Style: 1–10
Chapter 24	Sample: 1–5	FE-Style: 1–27
Chapter 25	Sample: 1–4	FE-Style: 1–22

Thermodynamics Lesson

Diagnostic Exam VIII: 1–15

Chapter 26	Sample: 1–5	FE-Style: 1–22
Chapter 27	Sample: 1–5	FE-Style: 1–19
Chapter 28	Sample: 1–5	FE-Style: 1–27
Chapter 29	Sample: 1–6	FE-Style: 1–14
Chapter 30	Sample: 1–2	FE-Style: 1–3

Heat Transfer Lesson

Chapter 31	Sample: 1–2	FE-Style: 1–13

Materials Science Lesson

Diagnostic Exam XIII: 1–15

Chapter 40	Sample: 1–3	FE-Style: 1–8
Chapter 41	Sample: 1–3	FE-Style: 1–11
Chapter 42	Sample: 1–3	FE-Style: 1–18

Mechanics of Materials Lesson

Diagnostic Exam VI: 1–15

Chapter 18	Sample: 1–5	FE-Style: 1–18
Chapter 19	Sample: 1–4	FE-Style: 1–18
Chapter 20	Sample: 1–5	FE-Style: 1–15
Chapter 21	Sample: 1–2	FE-Style: 1–10

DC Electricity Lesson
Diagnostic Exam XIV: 1–8
Chapter 43 Sample: 1–3 FE-Style: 1–5
Chapter 44 Sample: 1–7 FE-Style: 1–32

AC Electricity Lesson
Diagnostic Exam XIV: 9–14
Chapter 45 Sample: 1–5 FE-Style: 1–17

Electronics Lesson
Diagnostic Exam XIV: 15
Chapter 46 Sample: 4 FE-Style: 2–5

Computers Lesson
Diagnostic Exam XV: 1–8
Chapter 48 Sample: 4 FE-Style: 4–19, 27

Sample Exam: Work all problems

Suggested Homework Assignments from the *EIT Reference Manual*, 8th ed. (EIT8)

Another good source for homework problems (or problems to work in class) is EIT8. Solutions are found in the Solutions Manual.

Mathematics #1 Lesson

Chapter 3: 1 (a-d), 2 (a-d), 3 (a-d), 4 (a-d), 5 (a-d), 6 (a-d), 7 (a-d), 8 (a-d), 9 (a-c), 11 (a-d), 13, 14, 15, 16, 17 (a-j)
Chapter 6: 1(a-c), 2, 3, 8, 10 (a-c), 11, 12, 15 (a), 16, 17, 18
Chapter 7: 1–10, 17, 18, 19
Chapter 48: 1 (a-d), 2 (a-d), 3 (a-c)

Mathematics #2 Lesson

Chapter 3: 19 (a-d)
Chapter 4: 1, 2, 3 (a-c, e), 4 (a-i), 5, 6, 7, 9, 12 (a), 13, 15 (a-d), 18, 19, 20
Chapter 5: 1 (a-d), 2, 3
Chapter 11: 1, 2 (a-b), 3, 4 (a-b), 5 (a-c), 6 (a-d), 7, 9, 10, 11, 12 (a-c), 17, 18

Mathematics #3 Lesson

Chapter 3: 18 (a-d)
Chapter 8: 1 (a-e), 2 (a-c), 3 (a-d)
Chapter 9: 1 (a-b), 2 (a-c), 3, 4 (a-b), 5 (a-b)
Chapter 10: 1, 2, 5 (a-b), 6, 9, 11 (a-f), 14 (a-d), 15, 17, 18, 21, 22, 23

Engineering Economics Lesson
Chapter 13: 1–14, 15 (a-c), 16, 17, 18, 19 (a-b), 20, 21, 22, 23, 24, 25, 26 (a-b), 27 (a-b), 28, 30 (straight line only), 34, 36 (straight line only), 43, 44

Chemistry Lesson
Chapter 29: 3, 4, 5 (mole fraction), 6, 7, 8 (a-c), 14 (a-j), 15 (a-c), 16 (a-b), 20 (a-b), 21 (a-b), 22, 26, 27 (a-b), 30 (a-d), 31, 32, 33, 34, 39, 40, 41, 53 (a-b)
Chapter 30: 1 (a-p)

Statics Lesson
Chapter 32: 1, 2, 3, 5, 6, 7, 8, 9, 11, 12, 13, 14, 15
Chapter 39: 1–6

Dynamics Lesson
Chapter 20: 1–6
Chapter 42: 1–3
Chapter 43: 1–15
Chapter 44: 2, 3 (a-d), 4, 5, 6, 7, 8, 9, 10 (a-c), 11, 12, 13, 14, 15, 16, 19, 20, 21, 22 (a-d)

Fluid Mechanics Lesson
Chapter 14: 1, 2, 3 (a-b), 4, 5, 11, 12, 13, 16, 17
Chapter 15: 1, 2, 3, 4 (neglect atm, $\gamma = 10{,}050\ N/m^3$), 5, 6, 9 (a-b), 10 (neglect atm), 19, 20, 21, 22, 24
Chapter 16: 1, 2, 6 (a-c), 7, 8, 9, 10
Chapter 17: 1, 2, 3, 4, 5, 6, 7, 9, 16, 17, 18, 19, 26, 27

Thermodynamics Lesson
Chapter 21: 1 (a-c), 2 (a-e), 3, 5, 6, 9, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 29, 30
Chapter 22: 1, 2, 3, 4, 5, 6, 7, 10, 11, 12, 13, 14 (a-c), 21 (a-c)
Chapter 23: 1 (a-c), 2 (a-c)
Chapter 25: 4, 6, 7, 11
Chapter 26: 1 (a-b), 2 (a-b), 3
Chapter 27: 1 (b-c), 3, 5

Heat Transfer Lesson
Chapter 31: 1, 3, 4

Mechanics of Materials Lesson
Chapter 35: 1 (a-b), 3, 4 (a-c), 8 (a-c)
Chapter 36: 1, 2 (a-c), 3, 4
Chapter 37: 2 (a-b), 3
Chapter 40: 1, 3, 4, 6, 9, 10, 13, 15, 16, 17, 19, 20, 24
Chapter 61: 6, 8, 9

DC Electricity Lesson
Chapter 46: 1, 2 (a-b), 3 (a-b), 4, 5, 6, 7 (a-b), 8, 9, 10, 13
Chapter 47: 1, 2, 10, 11, 12, 13 (a-b), 14, 15, 17, 18, 19, 20, 21, 25, 26, 27, 28, 29

AC Electricity Lesson
Chapter 48: 4 (a-d), 5 (a-b), 6, 7, 8, 10, 11, 12 (a-b), 13, 14 (a-b), 15, 16 (a-d), 17 (a-b), 18 (a-c), 19, 21 (a-c), 23 (a-b)

Electronics Lesson
Chapter 51: 2, 4 (a-b), 13 (a-b), 14, 15, 16, 17

END OF STUDENT INTRODUCTION