Encouraging Computer Engineering Students to Take the Fundamentals of Engineering (FE) Examination

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ABSTRACT

We describe the experience of pursuing EIT registration and in particular sitting for the FE examination from two perspectives; that from a recent computer engineering graduate who successfully passed the examination, and from the viewpoint of educators in encouraging students to take the examination in their senior year. Strategies for passing the test with a typical computer engineering undergraduate background are suggested as are strategies for encouraging computer engineering students to pursue registration.

1. Introduction

Many senior-year computer engineering majors never imagine that it is to their advantage to take the *fundamentals of engineering* (FE) exam to become registered as an *Engineer-in-training* (EIT) in their state. Many of these students believe that this first step to professional licensure is for other disciplines and that computer engineering students cannot pass the examination. While it may be true that in some curriculums computer engineers have not taken many of the courses covered under the FE examination and must choose between taking the general afternoon examination or the electrical engineering examination, to a true engineer these facts serve more as challenges than deterrents. The number one deterrent for computer engineering seniors to take the FE examination is not the fact they believe they cannot pass but rather because they do not see the benefits of becoming a registered EIT.

An increasing number of students have aspirations not to use their degrees to gain employment within industry, but to start their own company or go into private practice. Whether these goals are realistic or not, most of these future entrepreneurs do not realize that without obtaining Professional Engineering (PE) registration, they cannot legally offer engineering services to the public or even refer to themselves as engineers in most jurisdictions. Other advantages that many of these students fail to appreciate are that in addition to being able to legally offer engineering services to the public, they can also miss out on other possible opportunities for consulting work. Also, being a professional engineer might cause their resumes to stand out even for jobs for which it is not required (under the industrial exemption).

The low number of computer engineers taking the FE exam is a concern for the entire engineering community. Currently, a whole engineering specialty exists that is for all practical purposes unchecked by the professional engineering society. Other professions such as medicine and law do not let this happen. Public recognition of credentials such as RN and CPA are far more common than PE and, as a profession, we should strive to achieve similar recognition. As engineers, we should understand quality assurance as well as or better than other professionals.

The remainder of this paper is focused on what computer engineering students can and should do to prepare themselves for FE registration at different stages of their academic experience and how they can be encouraged to do so. Students should be reminded that it is

never too late to start preparation for registration and that the earlier that one starts this process, the better their chances for success.

2. Early Academic Experience

One of the biggest challenges facing advisors is to convince students to not just enroll in the easiest course that meets elective requirements and instead to take courses that will help them the most in their future career. Many students struggle with the idea of taking relevant technical courses versus others that may require less effort to pass (or at least are perceived to require less effort). Instead of taking additional advanced courses beyond required sciences, many students elect to take introductory courses in other non-required science courses. While we are not discouraging students to pursue greater breadth in their studies, the benefit of taking all electives as introductory courses over a diverse set of knowledge areas is questionable.

At this point in a computer engineering student's eduscation, the most important thing an advisor can do is to convince the student to take required basic physical science requirements such as University Physics and University Chemistry seriously. Also it is important to convince students to be equally concerned with what they are learning as with the final grade achieved in the course. This is by no means an easy task, but stressing the relationship with achieving EIT registration during this part of a computer engineer's education can help.

3. Middle Academic Experience

The middle portion of a student's undergraduate academic experience typically starts around the second semester of the sophomore year and ends around the final semester of the junior year. This time period of the academic experience may be the most critical in a student's undergraduate studies. This is when he or she will choose their elective courses. Just as important as the selection of math and science electives is the choice of how to use one's free elective hours. Many universities allow students to take 3 or more hours of free electives. Some students use these hours to take courses such as jogging or bowling while others use these hours for co-op opportunities. Very rare is the student that uses these hours to take an additional math, science, or engineering class. Many computer engineering graduates talk about how they would have treated their selection of electives differently as well as their entire approach to classes in hindsight. However, even students surrounded by such graduates tend to ignore them and follow their friends' lead.

The subjects that are covered by the FE examination are as follows: Algebra, Trigonometry, Geometry, Properties of Areas and Solids, Probability, Statistics, Calculus, Differential Equations, Engineering Economics, Ethics, Inorganic and Organic Chemistry, Statics, Kinematics, Kinetics, Energy, Work, Power, Fluid Statics, Fluid Dynamics, Thermodynamic Properties, Transport Phenomena, Thermodynaics, Cycles, Combustion, Heat Transfer, Materials Science, Material Testing, Stress and Strain, Beams and Columns, Electrostatics, DC and AC Circuits, Electronics, Computers, Measurement, and Controls. The typical computer engineer is prepared to answer questions in the areas of Algebra, Trigonometry, Geometry, Properties of Areas and Solids, Probability, Statistics, Calculus, Differential Equations, Engineering Economics, Ethics, Inorganic and Organic Chemistry, Energy, Work, Power, Electrostatics, DC and AC Circuits, and Electronics. This leaves 15 subjects that the typical computer engineering student may not have studied at all. Any elective course that will allow the student to reduce the numbered of uncovered subjects is a good elective.

4. Late Academic Experience

If students have not spent the previous years of college preparing for the FE, it is important to reassure them that it is never too late to start. They should also be advised that they may have to work a little harder and longer than those students who have been preparing themselves previously. All students, whether they have been preparing for the exam or not, are encouraged to take a review course for the FE examination. No matter how much attention is given in courses taken 3 years ago, students will still be rusty and need a refresher. SMU has a very good review course that meets once a week with a different instructor at each meeting. Each instructor is either currently teaching the course over the subject that is covered that week or has taught the course the last time it was offered.

5. Study Groups

While students tend to be more comfortable in study groups with people they know, usually students know more people in their own engineering field than students in other fields. When assembling a study group, the best make up is to have one student from each engineering field so that students can help others in their own different areas of expertise. These groups tend to form naturally as students trade help in one subject for help in another. Since most engineering students have taken computer classes and used computers in other engineering classes, many are already prepared for the computer related portions of the exam. Therefore, computer engineering students may need to be able to help other engineering students in subject areas such as mathematics, physics and chemistry in order to receive help in subjects such as materials or thermodynamics. A good way to meet people in other disciplines in order to form these groups is through attending FE examination review courses.

6. Preparation during the semester of the exam

One of the hardest parts of preparing for the FE examination for most students is that it is the first time that they have to truly work independently. There is homework to do but no one is collecting or grading it. No grade is given in the review course so it does not affect their GPA's. Another important decision that must be made is whether to take the general engineering or electrical and computer engineering exam in the afternoon. Unless a computer engineering student has taken several electrical engineering courses during his/her undergraduate studies, the best option may be to choose the general engineering exam. The following study plan is suggested to help students maximize their possibility of passing the Fundamentals of Engineering examination:

> Step 1: Sign up for a review course and buy a FE study guide. Also, purchase the FE Supplied-Reference Handbook from the *National Council of Examiners for Engineering and Surveying* (NCEES) and familiarize yourself with it's content as this will be the only reference material available during the examination. Familiarize yourself with the format and logistics of the examination by reading through the NCEES webpage [2].
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> Step 2: Take 1 sample test before beginning to study. Then use the sample test to identify strengths and weakness. In addition to sample examination problems available from independent publishers, the NCEES also offers a sample examination for the FE examination.

Step 3: Identify subjects that you have little hope of mastering before the exam and spend little time in these areas.

Step 4: Spend only a small amount of time on your area of strengths, possibly only listening to the lecture on the subject and skimming through notes.

Step 5: In the areas that you are very rusty or feel you have the background to master in the time before the test, carefully read the review manual chapter and attempt to work the problems at the end of the chapter before the lecture. During the lectures on these subjects pay close attention and ask lots of questions. After the lecture, read the chapter again and find someone that can help you in that subject if you are still having trouble with some of the content.

Step 6: Approximately one week before sitting for the FE examination, take another practice exam. This time only identify areas that need just a little more work.

Step 7: Work only on the areas identified in step 6.

Step 8: Do not stay up all night cramming before the exam. Get 8 full hours of sleep. About hour before going to sleep, stop studying and use this hour to clear your mind and relax.

7. Strategies for Encouraging Students to Achieve EIT Registration

Due in part to the lack of public awareness of professional registration of engineers and the large majority of working (computer) engineers that are employed under the industrial exemption clause, many undergraduate computer engineering students are totally unaware of the process for achieving licensure. Even those who have heard of PE licensure often believe that it is not relevant for computer engineering, or even worse, have been counseled by others that they do not need licensure. For these reasons, it is important to mention licensure as early as possible and in as many different classroom settings as possible. Spending one lecture per semester going over state regulations is probably not an effective way to encourage students to start down the licensure path. Rather, interjecting anecdotal stories at appropriate times during the semester is more interesting to students and is probably a better way to motivate them to seek licensure.

As an example, during a basic digital logic course, which is typically a second-year computer engineering requirement, there is usually a discussion of how to avoid hazards or glitches in digital circuits that manifest themselves as momentary transient pulses. A good example is to point out what would happen if this glitch were to appear at the reset input of another digital circuit – a reset could occur when it was not intended. Then the conversation could proceed by assuming that the circuit that was mistakenly reset was the control circuit for an elevator controller or perhaps the electronic braking control system for an automobile. Clearly, these are issues of public safety and this is exactly the purpose of professional licensure; to protect the public. This can lead to interesting classroom interaction and helps students to understand that licensure makes as much sense for computer engineers as it does for structural engineers who design bridges.

A common misconception among students when considering the licensure process is that the examinations are in place to test the academic prowess of the candidate. This is natural since

students exist in an academic environment where they are constantly being assessed and graded to determine their depth of knowledge. It should be re-iterated that the purpose of licensure is not to determine the degree of their mastery of a particular subject matter, but rather to demonstrate achievement of minimal competence such that public safety can be assured. Understanding that the licensure examinations are designed to measure minimal competence can give students with average GPAs confidence that they can pass the examination and that it is not only for the superstars in the classroom.

Students like to hear about real-world experiences and this is a great way to promote licensure. Many engineering professors are Professional Engineers and perform consulting services or have previous significant experience in the private sector. Describing experiences in the industrial or consulting arena not only give students information about the "real world" but also can serve as a good way to talk about professional licensure in general.

A final and more pragmatic reason for encouraging students to sit for the FE examination in their senior year is to point out that, even if they do not plan for private practice immediately, they may wish to do so in the future. After several years of engineering experience in a practice field have been obtained, it is more difficult to pass the FE examination than if it were taken during the senior year when coursework pertaining to the fundamentals is more recent. In this sense, taking the FE examination now rather than later is a good insurance policy should the student decide to pursue professional licensing later in their career.

8. Conclusion

The low number of computer engineering students taking the FE examination is a concern that we must address in order to preserve the quality of profession. However, we must not wait until the last semester of their education to start telling them the importance of passing the FE examination. It must be something that they are aware of early in their undergraduate studies so they will know that the longer they wait to prepare themselves, the harder they will have to work to do so in later years. Only by increasing the number of students taking the FE and achieving EIT registration can we hope to eventually institute a computer engineering depth module in the afternoon portion of the FE examination.

References

[1] M. Lindeburg, *FE Review Manual*, Professional Publications INC, 2002.
[2] Fundamentals Exams web page, National Council of Examiners for Engineering and Surveying (NCEES), **http://www.ncees.org/exams/fundamentals/**.