

## **AC 2008-1145: PREPARING MINORITY ENGINEERING STUDENTS TO PASS THE FUNDAMENTALS OF ENGINEERING EXAMINATION**

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# **Preparing Minority Engineering Students to Pass the Fundamentals of Engineering Examination**

## **Abstract**

The Fundamentals of Engineering (FE) examination is the first of two (2) examinations engineers must pass in order to be certified as a Professional Engineer. Once they pass the FE exam, they are classified as an intern, also known as an Engineering Intern (EI) or an Engineer-in-Training (EIT). This exam is offered twice yearly, in April and October, by the National Council of Examiners of Engineering and Surveying (NCEES) and it has jurisdictions in each state.

Our engineering program is an ABET accredited program. One of our educational objectives is to produce graduates who are competent enough to pass the FE exam, leading to professional registration. To be able to assess this objective, the program requires students to take the FE exam prior to graduation, preferably after all relevant technical courses have been taken and while the information they have studied is still fresh in their minds. In reality, some students attend the FE exam without any preparation, taking the exam just to satisfy the requirement and lacking the determination to pass the exam since the program does not require the student to do so.

To correct this misconception among the students and to stimulate their awareness of the importance of engineering licensure in their profession, the faculty of the department has been undertaking a series of actions that could help students prepare for the FE exam and could improve the pass rate of the FE exam in the future. In this paper, the authors would like to share their experiences and outline the processes that could help minority engineering students pass the FE exam.

## **1. Fundamentals of Engineering Examination Background**

The Fundamentals of Engineering (FE) examination is the first of two (2) examinations engineers must pass in order to be licensed as a Professional Engineer. The FE exam is often viewed as a measure of minimum competency to enter the profession. This exam is offered in April and October every year by the National Council of Examiners of Engineering and Surveying (NCEES) and the licensure board for engineers in each state.

Those who pass the exam are designated Engineers In Training (EIT) or given an equivalent designation, such as Engineer Intern (EI), by their state's licensure board for engineers, and are partway through the certification process. After completing an apprenticeship (the length of which is set by state law and based on the type of degree received) an EIT or EI may qualify to take the Professional Engineer (PE) exam. Licensure is awarded upon successful completion of the PE exam. The standard time of apprenticeship under a Professional Engineer for graduates of an ABET accredited engineering program is four (4) years of work experience.

The FE exam was developed to evaluate fundamental knowledge of mathematics, applied science, and engineering principles. The exam specifications were developed from a survey of accredited engineering programs and licensed practitioners. The content of the exam is based on those specifications and is prepared by a group of volunteers consisting of both engineering educators and practitioners.

In recent years, the FE exam is more frequently being used nationwide by engineering colleges to assess minimum technical competencies of their programs. Many colleges and universities encourage students to take the FE exam and use it as an outcome assessment tool upon completion of the coursework.

## **2. Weakness in Preparing Students to Pass the FE Exam**

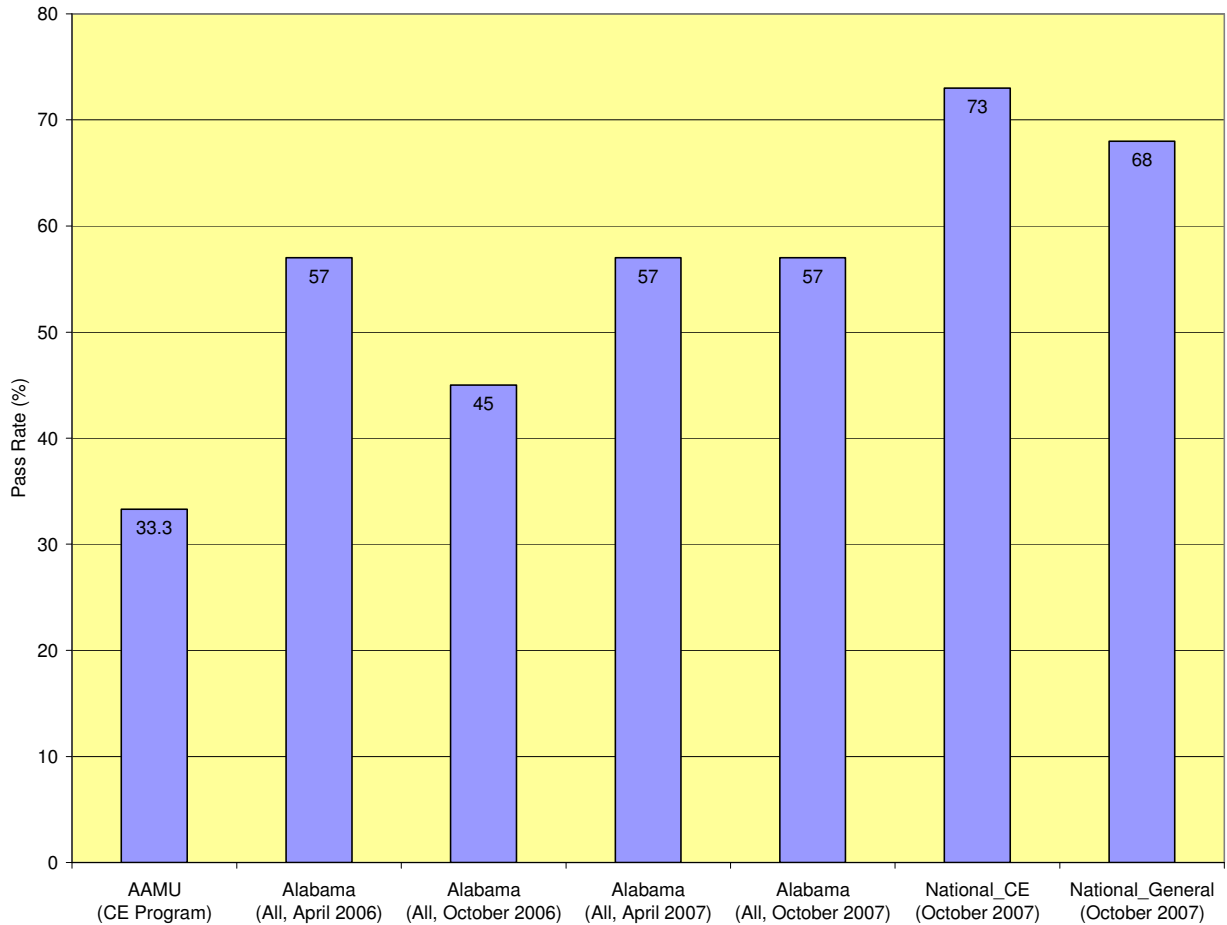
Our civil engineering program at Alabama A&M University is an ABET accredited program and has an enrollment of approximately one hundred (100) undergraduate students. Alabama A&M University is a land-grant historical black university located in Huntsville, Alabama, a major city in North Alabama whose main industry revolves around space, military defense, and high-technology research and development.

One of our educational objectives is to produce graduates who are competent enough to pass the Fundamentals of Engineering (FE) examination, leading to professional registration. In order to be able to assess this objective, the program requires that students take the FE exam prior to graduation, preferably after all of the relevant technical courses have been taken and while the information they have studied is still fresh in their minds.

In reality, some students attend the FE exam without any preparation, taking the exam just for the matter of satisfying the requirement and lacking the determination to pass the exam since the program does not require them to do so. Based on data provided by the Department, 33% of the students who took the FE exam during the period from October 2004 to April 2007 passed the test. A comparison of the program's FE pass rate versus the National and the State of Alabama's pass rates can be found in Figure 1. Our results for the years reported in the chart have been below the national and regional norms, as well as below our own expectations.

According to the published FE results from the October 2007 exam shown on the NCEES website<sup>1</sup>, the national average pass rate for first-time takers from an EAC / ABET accredited civil engineering program who chose the Civil Engineering (CE) Module during the afternoon session was 73%, while the examinees who elected to take the General Engineering Module had a pass rate of 68%.

The State of Alabama does not break down pass rate results for each of the available afternoon sessions, however the overall FE pass rates for first-time takers from an EAC / ABET accredited engineering program was lower than the national average. This is shown in Figure 1 where it can be noted that the pass rate for three of the last four FE exams was only 57%, with the other even lower at 45%. The summary of this subset of examination results can be found on the Alabama State Board of Licensure for Professional Engineers and Land Surveyors<sup>2</sup> website.



**Figure 1: A Comparison of AAMU, Alabama, and National FE Exam Pass Rates**

An impact of the low pass rate of the FE exam is the depiction of poor performance by our students. It not only affects their career development but also compromises the program's credibility. The consequence of this weakness was reflected during our most recent ABET evaluation. As a result, finding ways to improve the pass rate has become a major issue.

### 3. Actions Taken

To correct any misconceptions amongst our students and to stimulate their awareness of the importance of engineering licensure in their profession, the faculty of the department has been undertaking a series of actions that are expected to help students prepare for the FE exam, and thereby improve the pass rate of the exam in the future.

Basically, four major actions were identified as ways of promoting the significance of and passing the FE exam:

- Stimulate students' awareness of the importance of engineering licensure in their profession;
- Help students understand the process of engineering licensure and the content of the FE exam;

- Help students become familiar with the FE style exam by giving similarly structured homework assignments and exams during regular classes; and
- Conduct FE Review Sessions using voluntary faculty and practitioners.

The following subsections outline the actions that have been administrated within the department. The information regarding the FE exam is adopted from the official website of the National Council of Examiners of Engineering and Surveying<sup>1</sup> (NCEES).

### **3.1 Awareness of the Importance of Engineering Licensure**

It is the responsibility of the advisors and engineering faculty to inform students of the importance of engineering licensure. The CE Department urges all instructors to emphasize the importance of engineering licensure, and provide information regarding the FE exam in each class, especially in the entry level classes. Some topics that should be mentioned in the discussion are:

- What is licensure and why is it important?
- How do engineers get licensed?
- Why bother with licensure?
- What is the FE exam?
- When and where do engineering students take the FE exam?

Other points that can be highlighted may include:

- Future employment opportunities with regard to how employers hiring recent engineering graduates often look to see if the applicant has successfully passed the FE exam.
- Passing the FE exam demonstrates how serious the student is about his or her engineering career.
- The potential earning power of a professional engineer versus a non-licensed engineer.

### **3.2 Understanding the Process of Engineering Licensure and Content of the FE Exam**

The typical process of obtaining and maintaining engineering licensure and content of the FE exam is initially discussed in the Introduction of Civil Engineering class and is then mentioned repeatedly throughout the engineering curriculum. In general, there is a four-step process to obtain an engineering license in this country.

First, graduation from an ABET accredited engineering program at a college or university is typically required. Second, the student must pass the FE exam, the first of two (2) examinations, which is offered twice yearly, in April and October. Most students take the exam right before graduation while the information is still fresh in their minds. Once the student passes the exam, he or she is classified as an intern, also known as an Engineering Intern (EI) or an Engineer in Training (EIT).

Third, the EI / EIT must gain experience, usually by an apprenticeship. Many states have specific requirements about the type of experience he or she needs to gain. Most also require that the EI / EIT gain this experience under the supervision of someone who is already licensed

and that it involve projects with increasing levels of responsibility. The standard time of apprenticeship under a Professional Engineer is four (4) years of work experience for graduates of an ABET accredited engineering program.

The last step involves taking the second exam, the Principles and Practice of Engineering (PE), which is usually taken once the experience requirements of the licensing board have been satisfied. After passing the PE exam and satisfying the requirements of the local board, the engineer is certified and can use the distinguished Professional Engineer (PE) designation.

Our program requires that students take the FE exam prior to graduation, preferably after all of the relevant technical courses have been taken and while the information they have studied is still fresh in their minds. Students are aware that the current version of the FE exam is broken up into two (2) sections, each lasting four (4) hours. The morning session is common to all examinees and covers various topics within the general engineering coursework. In the afternoon session, students have a choice between two exam formats, a general exam and a discipline-specific exam.

### **3.3 Familiarization with the FE Exam and FE Review Session(s)**

Based on the results of discussions in departmental meetings and input from past and current students, the department has implemented a requirement that faculty include FE style exam problems in the quizzes and exams in all courses. This will allow students to become accustomed to the wording and format of the FE exam problems.

There are many resources available to help students prepare for the FE exam. The NCEES offers sample examinations and diagnostic tools prepared by engineering professionals, which are reviewed annually and revised as needed. Other commercial FE review books and software packages are available for students, such as those provided by the National Society of Professional Engineers<sup>3</sup> (NSPE), Professional Publishers, Inc.<sup>4</sup>, EIT Exam online source for FE exam preparation<sup>5</sup>, and Kaplan AEC Education<sup>6</sup>.

Students are strongly encouraged to obtain and familiarize themselves with the materials in the FE Reference Handbook supplied by NCEES. The Reference Handbook contains many important reference formulas and tables in each topic and is very useful in problem solving.

In the Fall Semester of 2007, during the months of September and October, an eight-week FE Review session was held on Tuesdays and Thursdays. Originally, the review sessions were scheduled from 5:00 PM to 6:30 PM. A majority of our students could not attend at the allotted time, so to help alleviate conflicts in scheduling it was moved to early afternoon from 12:30 PM to 2:00 PM. The review sessions were divided into fourteen (14) topics, with each topic conducted voluntarily by a specialized faculty member within or outside the CE Department. This included a practitioner from our Industry Advisory Board who specializes in construction management. The number of attendance for the various topics fluctuated due to different priorities of the individual student. During this past semester, ten (10) students signed up while the peak attendance was eight (8).

One of the highlights of the review session was a scheduled mock FE exam, which was given on Saturday, October 20, 2007, one week before the official FE exam was to take place. This was a “live” practice test monitored by faculty members to help the students get used to the pressure that they would actually experience. Six (6) students showed up early that morning to take the rigorous eight (8) hour FE exam. The morning general engineering session consisted of one hundred and twenty (120) problems and the afternoon session consisted of sixty (60) problems, taking either the discipline-specific exam or the general exam option. It can be very difficult for students to work out a large number of problems during a limited time period. During the mock exam, they experienced the mental stress and the emotional frustrations that they would during the actual exam, helping them learn what they will need to do to manage their time and control their feelings. The mock exam received very positive reactions from the students who participated.

#### **4. Future Plan**

The department is actively seeking ways to improve our FE Review Session so that it can help our students pass the FE exam and achieve our educational goals. One of the ways is to offer FE review sessions free of charge on a regular basis which the department is committed to. Past review sessions have been conducted by our voluntary faculty and practitioners in the area including members from our Industry Advisory Board.

The lack of student commitment in passing the FE exam has been a major hurdle with our students. Although the low enrollment rate in the FE review session was primarily due to schedule conflicts, it also is an indicator of low student commitment. The review sessions are voluntary so it is not possible to enforce attendance at the sessions.

Strategically, in order to circumvent this lack of student commitment the department has decided to modify its curriculum to increase the lecture hours in one of the senior level required courses each semester and integrate an FE review session into this regular course. By embedding review topics into a mandatory course, students would essentially be compelled to attend the whole FE review session without any conflict whatsoever.

In the future, perhaps in the next three to five years, the authors would be willing to share any further experience and findings with other engineering programs with regards to preparing minority engineering students to pass the FE exam. The authors also welcome any suggestions and feedback from others that may help improve our program.

#### **Bibliography**

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