

## **2006-1730: "FE EXAM" - THE FIRST "REALITY SHOW" ENCOUNTER FOR ENGINEERING AND ENGINEERING TECHNOLOGY UNDERGRADUATES**

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# **“FE Exam” – The First “Reality Show” Encounter for Engineering and Engineering Technology Undergraduates**

## **Abstract**

The first “Reality Show” facing engineering and engineering technology undergraduates involves their ability to adequately demonstrate technical competence in the field of engineering. A nationally accepted measure for assessing a student’s broad base of technical knowledge of the engineering field is the Fundamentals of Engineering (FE) exam.

As with every “reality show” certain rules and guidelines apply that each person must follow if they are to “survive”. Many times unfamiliarity with the FE exam format can greatly impede the student’s chance of success simply because they have not encountered a similar format during their undergraduate studies.

This paper addresses a variety of simple in-class techniques for acquainting the students with the FE exam format itself and the references available to them when they take the exam. It also discusses the classroom tactics for implementing the use of the FE Reference Handbook<sup>1</sup> as a teaching tool. Student’s positive/negative reactions to the use of the FE Reference Handbook in the classroom will also be discussed.

## **Introduction**

During their junior year, engineering and engineering technology undergraduates must face a “Reality Show” that is the Fundamentals of Engineering (FE) exam. This important challenge to “survival” is for the student to adequately demonstrate technical competence in the field of engineering. A nationally accepted measure for assessing a student’s broad base of technical knowledge of the engineering field is the Fundamentals of Engineering exam.

Some colleges and universities go so far as to require students to successfully pass the FE exam prior to receiving their undergraduate degree. The professional FE certificate represents the first mandatory step towards professional registration which in some disciplines is essential to a successful engineering career.

During their undergraduate years, engineering and engineering technology students spend countless hours preparing for exams. A similar effort must be made for this critical “reality show” examination in order to enhance the student’s probability of passing it.

Incorporation of a few simple techniques into undergraduate classes can significantly assist students in understanding the FE exam format. As an example, students are not permitted to take their own reference materials into the FE exam. A copy of the Fundamentals of Engineering Reference Handbook is provided for use at that time. By requiring the students to use sections out of the FE Reference Handbook when preparing homework assignments and taking class exams, the professor ensures students are familiar with the content of the reference book.

In a second related example, different books often use varying notations for the same variable. This can create confusion for students taking the FE exam. They must be able to translate from the notation learned in class to the notation used in the FE Reference Handbook. Requiring the use of the relevant FE Reference Handbook sections, again forces students to learn and become familiar with various notations.

In summary, the “Reality Show” or FE exam facing engineering and engineering technology undergraduates necessitates their understanding of the rules and guidelines to successfully compete and not be “voted out” by the engineering profession “tribe” should they fail the exam.

### **Concept Development**

A secondary goal of most Engineering Technology professors is to aid in their students’ preparation of the Fundamentals of Engineering exam. The technique described in this paper is recommended for core courses whose material is included in the FE exam.

Today, students are not permitted to take their own reference materials into the FE exam. A clean copy of the Fundamentals of Engineering Reference Handbook is provided for use during the exam. All essential equations and conversions needed to complete the test are included in the handbook. Limiting the students to use only the reference material given has several drawbacks. First, since the FE exam is a timed exam, familiarity with the Handbook is essential. The student must “know his way around” the book. Unfortunately, all studies prior to the exam used different reference materials. The preparation time for the FE exam is often tight due to the demands of coursework and the student enters the exam lacking the necessary familiarity of the Reference Handbook to maneuver quickly and efficiently.

The second drawback that students have with the Reference Handbook is unfamiliarity with notation. Very often the texts used during their course studies use different notation from the FE Reference Handbook. Additional preparation time is required for the student to translate the notation and to become familiar and comfortable with the FE notation.

Third, the generality of the equations in the FE Reference Handbook may throw students off guard. Most courses today do not require students to derive even the simplest equation. Students become dependent on being given many variations of the same equation enabling them to simply “plug and chug” for the answers. The FE Reference Handbook supplies the students with general equations. It is assumed that, during the exam, the student can apply the general equation to various specific situations.

The strategy utilized in this paper is to provide the students with the relevant sections from the FE Reference Handbook for use during course work. This strategy addresses all three of the drawbacks stated above. By the end of the course the students will be familiar with the layout, notation and general equations of the relevant sections.

There are several considerations to be made when applying this strategy to a course. First, how will the reference material be used in the classroom? Second, if the Reference Handbook is to be

supplied to the students for use during course exams, how will the professor handle material and equations not included in the Reference Handbook? The FE Exam uses only the metric unit system; as such the Units and Conversions sections do not cover English units. Each of the issues raised will be discussed in context with the following case study.

### ***Case Study – Year 1***

#### **Initial Implementation**

This case study was conducted for the first time in the fall of 2003 at the University of Pittsburgh at Johnstown. Students in two sessions of Fluid Mechanics participated. One session was taught to junior status Mechanical Engineering Technology students the other to junior Civil Engineering Technology students. Students sat for the FE Exam in the spring of 2004.

The students were told the first day of classes that they would be permitted to use only the Units, Conversions, and Fluids sections from the FE Reference Handbook during exams. They were informed that, in addition to clean copies of the FE Reference sections, any equations additional equations that were needed would be provided on the exam. The exams would be utilizing metric units only but homework would use both metric and English units. A link from the class web page to the publisher was provided where the students could download the sections free of charge. It was recommended that the handbook sections be used when completing homework.

During lectures, the FE sections were referenced; differences between the book equations and approaches were noted. The methods and notation used in the text was used during in class problems. It was felt that while initially learning concepts it would be confusing to the students to have two sets of notation on the board.

#### **Intermediate Feedback – Year 1**

Class discussions about the FE reference material increased as the first exam approached. It was clear that anxiety was mounting. In order to ensure that the FE Reference would not hinder the performance of individuals, the rule was amended. It was agreed that the students would be allowed to bring their own copy of the FE Reference for use during the exam and that they would be permitted to write on them. The copies were collected with the exam for review by the professor.

The students were pleased with the compromise unfortunately, it undermined several of the objectives of the exercise. First, by allowing the students to write on the cards they were able to add detailed equations that they will not be privy to during the FE exam. Second, it was admitted by several students that they really did not try to use the FE reference for anything more than paper to write on. It should be noted that the students that simple added the books notation to the equations on the FE Reference performed, for the most part, better on exams than students that crammed the pages with equations.

Following the first exam, the class discussed the use of the FE Reference. It was clear that opinions varied. The students that used them, as intended, were strongly in favor of the stricter

program where a clean reference would be used for exams. Students that did not take advantage of them generally disregarded their potential. The opinion of the majority of the students fell between the two extremes. It was decided that the program would continue as it was for the remainder of the semester. Students would be expected to use the FE Reference but they were permitted to bring their own edited versions for exams.

### **Final Feedback – Year 1**

During last week of class, participants of the program filled out a questionnaire about the experience. The first question asked, “Do you feel there is potential value to using the FE cards for the course? Sixty six percent of the students answered yes while only 16.7% said no. Clearly, the students see the benefit. Additional comments were forthcoming to this question.

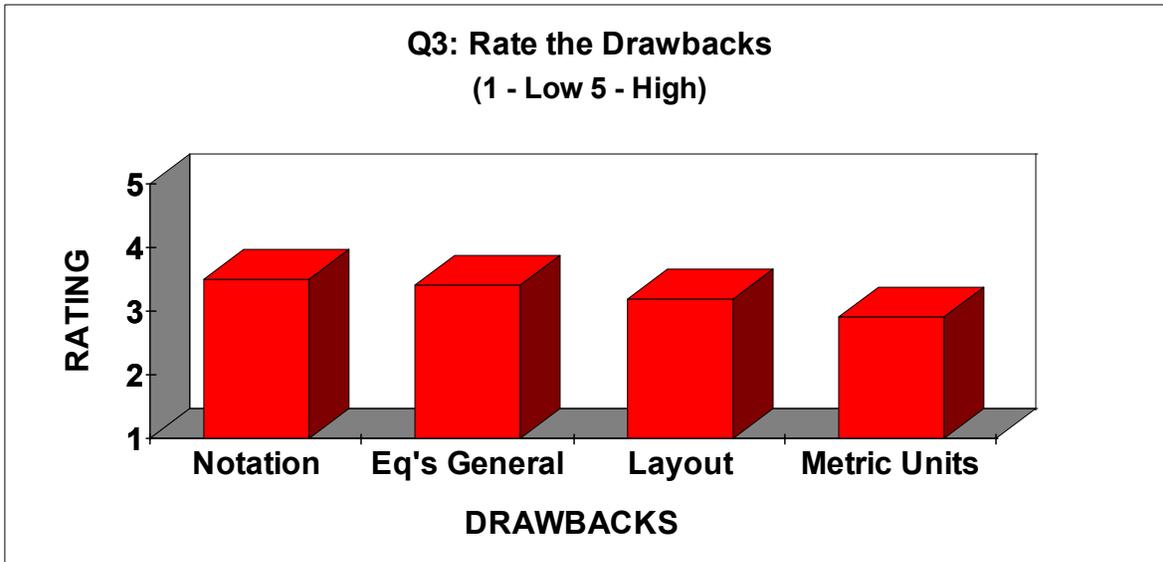
The second question on the survey asked, “Did you use the FE Reference cards when doing homework and during exams?” A disappointing 46.7% said that they did not use the cards. While the numbers sound discouraging it does mean that 53.3% of the nearly 60 students did use the FE References to some extent. Much of the feedback on this question relayed a missed opportunity. For example students said, “Looking back I should have made an effort to use the FE sheets for homework” and “I did not use them as much as I should have. I think it was a great idea and that it will definitely help on the EIT exam.”

The third question, asked the students to rate the potential drawbacks (1 low to 5 high). The data for this question indicates that students felt that the different notation was the greatest drawback to using the FE Reference. See the figure below. The average rate for notation was 3.5. Many comments were made about the notation. Some of their suggestions were: 1) “Use double notation in class” 2) “Use a text that has the same notation as the FE Reference.”

The generality of the FE section was the second greatest drawback as rated by the students at 3.4. The student suggestions included: 1) “The handout is too difficult to follow, not applicable to the class” 2) “Discuss in class which FE equations apply”.

The layout of the FE Reference was third with an average rate of 3.2. Many students seemed thrown by the FE Reference layout. A sampling of the comments follows: 1) “Handout is too difficult to follow.” 2) “The FE cards are too difficult to look at.” 3) “At first I didn’t realize that they had all the needed equations.”

The use of only metric units was the least prohibitive to the students with a rating of 2.9. Not one of the written comments received pertained to the units. It should be recognized that each of the four drawbacks stated had an average above the midrange, meaning that the students felt strongly about all four.



Many of the other written student comments were encouraging. It was clear that the students who used the FE Reference while doing homework were prepared to use it during exams and were the most supportive.

### *Case Study -Year2*

#### **Initial Implementation**

For the fall 2004 term at the University of Pittsburgh at Johnstown modifications were made to the implementation strategy. Again two sessions of Fluid Mechanics participated. Students sat for the FE Exam in the spring of 2005.

Students were informed during the first class that they would not be permitted to bring support materials into exams. The students were again instructed to print the relevant sections from the NCEES website. In addition, because the course had subject matter not included on the FE Exam, a supplementary equation sheet was provided at this time. By giving the students the supplementary equations on the first day of classes, they were able to see exactly what equations were available to them on exams. It was apparent that nerves were calmed by that fact over the previous year. Again, students were encouraged to use the reference materials when doing homework and to mark the textbook notation on their private copies.

The professor carefully constructed the supplementary equation sheets to include only subject matter not offered in the FE reference materials. The students were given the right to request additional equations for the supplementary sheets at any time. If it was found that the equation existed in another form in the FE reference cards, the request was rejected with a demonstration of the sameness of equations.

## **Course Implementation – Year 2**

During lectures, the FE sections were referenced; differences between the book equations and approaches were noted. The methods and notation used in the text was used during in class problems. However, dual notation was pointed out during lectures. Students were advised to mark the dual notation on their personal copy of the FE reference materials. It was believed that by seeing both together while doing class work they would be able to recognize the FE notation during exams.

Prior to the first exam students expressed concerns about a closed book exam that they were not able to have their own equation sheets for. The professor, while showing understanding for their anxiety, ensured them that, had they properly prepared using the reference materials for homework, the process would not affect their grades. Following the first exam two things happened. First, students that had not used the reference materials earlier for homework began doing so. And secondly, there was a calming about the use of the reference materials during exam time.

## **Feedback – Year 2**

During the last week of classes the students were surveyed. Ten percent of the students felt that the “forced” use of the FE reference materials was a negative experience in the course. Three percent felt that it was a positive experience; the remaining students were indifferent.

## **Final Feedback – Year 2**

The same students were again surveyed about their experience several months later while attending FE Review classes. With the student focus now on the FE examination rather than on a class grade, 100% of the students at the review class felt that using the FE equation resources was beneficial. When asked if the practice of using the FE review sections should continue to be used in fluids class, 100% of the students said, “Yes”. In addition, every student responded positively that the FE reference sections should be used in other classes and nearly 50% of the students said that they had taken it on themselves to print out the relevant sections for use in other classes. Many of the students that had not printed out sections for other classes said that it was something they wished they had done.

## **Conclusions and Comments**

In summary, the “Reality Show” or FE exam facing engineering and engineering technology undergraduates necessitates their understanding of the rules and guidelines to successfully compete and not be “voted out” by the engineering profession “tribe” should they fail the exam.

While modifications were implemented from the first year, the use of the FE References in the classroom was a success. While it does present initial anxiety for the students it is a practice that, in the long run, they appreciate. The practice of using the FE References as discussed above continues today at the University of Pittsburgh at Johnstown. It the hope of the author that more instructors implement this exercise and see the benefits provided to their students.

Experience has shown that anyone proposing to implement the use of the FE Reference materials in the classroom should include consideration of the following:

1. Rather than providing additional equations on the exams, create a supplementary formula card that will be given out the first day of class. Anxiety will be decreased by showing the students exactly what resources they will have in addition to the FE Reference.
2. Encourage students to use the FE Reference materials during homework and to add the text notation on their working copy.
3. Show examples in class of how to modify the general equations to meet the specific needs of the text.

## References

1. *Fundamentals of Engineering Supplied-Reference Handbook*, 6<sup>th</sup> Edition, National Council of Examiners of Engineering and Surveying, 2003