

**‘Don’t Fear the FE Exam, use FEER’ –
Developing FE Review Sessions for Students
in a New Engineering Program**

Monika Bubacz and Kevin Skenes

The Citadel, Charleston, SC

Abstract

The Citadel School of Engineering has initiated a Bachelor’s of Science in Mechanical Engineering program in the fall of 2014. Various classes have been offered to freshmen, sophomores and juniors during the first semester, and the first mechanical engineering graduates are expected in May 2016. The authors of this paper anticipate that the first ME seniors will consider taking the Fundamentals of Engineering (FE) examination in the academic year 14/15. The FE exam is also being considered as a mandatory exit exam for all ME students in the future. The authors propose a review program, called FEER – FE Exam Review – that will be offered to students during the fall semester of their senior year and will consist of refresher lectures in various delivery methods, solving problems critical to the FE exam, and workshops on successful test taking.

Keywords

FE exam, course review, new engineering program

Fundamentals of Engineering Examination

Most professions, including engineering, law, and medicine, have procedures for licensing of practitioners.¹ The procedure for aspiring engineers is known as “registration” or “professional registration.” It is a legal process, governed by the states in the USA. Many countries around the world have similar processes, and other countries are developing procedures to ensure public safety through mandatory registration for engineers. The licensing process is designed to protect the health, safety and welfare of the public from fraudulent and unethical practitioners.

Registration is a two-step process in all U.S. states. The first step is to take and pass the Fundamentals of Engineering (FE) examination, also known as the Engineer-in-Training (EIT) examination. The second step is to take and pass the Principles and Practice (P&P) examination, or PE, in a specialized field (such as Electrical, Civil, Mechanical, etc.). It is important to apply for and receive one's EIT certificate, because issuance of the EIT certificate starts the clock on the minimum period of experience required before one can apply to take the PE Examination.

On January 1, 2014, the National Council of Examiners for Engineering and Surveying (NCEES) transitioned the FE and Fundamentals of Surveying (FS) exams to computer-based testing (CBT).² These exams are now administered exclusively at approved Pearson VUE test centers. NCEES made this move because they felt that computer-based testing provided advantages for both examinees and the NCEES. For example, the move to computer-based testing allows

examinees to schedule their exam at a time and location that work best for them and to receive their results within 7 to 10 days. With computer-based testing, the NCEES gains enhanced security and better uniformity in testing conditions.

The new Mechanical FE computer-based test consists of 110 multiple-choice questions which the examinee will have 6 hours to complete. The Mechanical FE exam covers topics such as:

- Mathematics
- Probability and Statistics
- Engineering Economics
- Statics
- Dynamics, Kinematics, and Vibrations
- Mechanics of Materials
- Fluid Mechanics
- Thermodynamics
- Heat Transfer

The New Mechanical Engineering Program at The Citadel

The Citadel School of Engineering has had a proud record of significant contributions at The Citadel since its inception in 1842.³ The Civil and Environmental Engineering Department was established in 1912 and became accredited in 1936. The Electrical and Computer Engineering Department was established in 1941 and became accredited in 1976. The Mechanical Engineering Program was added in 2014 with the first mechanical engineering courses (MECH) offered in the fall. The School of Engineering will apply for ABET accreditation of the new Mechanical program as soon as the first mechanical engineering students graduate, which is expected in May 2016.

The new Mechanical Engineering Program of Study offers focused tracks in Power and Energy, Manufacturing, Aeronautical Systems, Materials (Composites), and Mechatronics. It is available to the cadet population as well as to evening students transferring from Trident Technical College (2+2 programs). The full-time evening Mechanical Engineering program mirrors the current full-time evening 2+2 programs in Civil and Electrical Engineering.

The Citadel School of Engineering encourages all engineers to work toward professional registration/licensure. Licensure as a Professional Engineer (PE) indicates that the individual has met the testing and experience standards of their state registration board. There are many reasons to become a registered PE, including: the legal authority to sign engineering drawings, personal satisfaction and recognition, being permitted to offer engineering services to the public, and raising the overall level of engineering professionalism.

The first and best time for a registration applicant to take the FE examination is during the last term before graduation with a B.S. Both juniors and seniors are eligible to take the exam, though it may be easier for seniors since they have more experience. So far only the Civil Engineering Department provided voluntary FE review sessions to their students, 1.5 to 2 hour long lectures were scheduled every Wednesday for six to eight weeks at the beginning of Fall semester. Electrical Engineering faculty were invited to teach some of the topics related to their

specializations. Currently, due to the new computer-based test, the Civil Engineering Department is considering adding flexibility to the schedule of offered review sessions, possibly providing on-line lectures, and changing the scope of review. Also, each graduating Civil Engineering student is required to sit to the FE Exam and provide documentation to the department head.

The FEER – FE Exam Review

The Mechanical Engineering Program faculty members propose to offer review sessions to all mechanical engineering seniors in order to improve student confidence and scores. The FE preparation sessions will be taught by multiple instructors using proven study strategies in their respective fields of expertise. The authors will select topics for review, assign appropriate time for their coverage, prepare workshops and problem solving sessions, and report on the progress, shortfalls, strengths, and implemented changes before the review program is introduced to students. The authors' goal is to ensure that ME undergraduates who wish to take the exam are well-prepared and confident in their ability to do well.

The main goal of FEER is to help ME seniors to prepare for FE exam by:

- focusing on important/high-probability topics that will appear in the examination,
- preparing essential problem-solving skills needed to pass the FE Exam,
- covering topics in a logical, progressive manner.

The following topics will also be covered:

- Ethics,
- Computational Tools,
- Material Science,
- Electricity and Magnetism,
- Material Properties and Processing,
- Advanced Fluid Mechanics,
- Mechanical Design and Analysis,
- Measurements, Instrumentation & Controls.

An initial review session schedule is based on weekly meetings during a semester, see Table 1. The topic coverage is based on NCEES FE Mechanical CBT Specifications⁴. The authors anticipate starting FEER in the fall semester of 2015. The instructors will cover course materials, provide handouts and solve example problems. The FE Reference Handbook⁵ will be heavily utilized in order to familiarize students with the resources available during the test. The Mechanical Engineering faculty are also considering making the review mandatory by offering it as a part of a designated senior level course. The course has not been selected yet and there also exist a possibility of creating a new one credit hour course exclusively for FE review and preparation for graduation.

2015 ASEE Southeast Section Conference

Table 1. FEER weekly schedule.

Week	Knowledge	# of questions	Week	Knowledge	# of questions
1	Mathematics Analytic geometry; Calculus; Linear algebra; Vector analysis; Differential equations; Numerical methods	6-9	7	Mechanics of Materials Shear and moment diagrams; Stress types (axial, bending, torsion, shear); Stress transformations; Mohr's circle; Stress and strain caused by axial loads; Stress and strain caused by bending loads; Stress and strain caused by torsion; Stress and strain caused by shear; Combined loading; Deformations; Columns	8-12
2	Probability and Statistics Probability distributions; Regression and curve fitting Computational Tools Spreadsheets; Flow charts	7-11	8	Material Properties and Processing Properties, including chemical, electrical, mechanical, physical, and thermal; Stress-strain diagrams; Engineered materials; Ferrous metals; Nonferrous metals; Manufacturing processes; Phase diagrams; Phase transformation, equilibrium, and heat treating; Materials selection; Surface conditions; Corrosion mechanisms and control; Thermal failure; Ductile or brittle behavior; Fatigue; Crack propagation	8-12
3	Ethics and Professional Practice Codes of ethics; Agreements and contracts; Ethical and legal considerations; Professional liability; Public health, safety, and welfare Engineering Economics Time value of money; Cost, including incremental, average, sunk, and estimating; Economic analyses; Depreciation	6-10	9	Fluid Mechanics Fluid properties; Fluid statics; Energy, impulse, and momentum; Internal flow; External flow; Incompressible flow; Compressible flow; Power and efficiency; Performance curves; Scaling laws for fans, pumps, and compressors	9-14
4	Electricity and Magnetism Charge, current, voltage, power, and energy; Current and voltage laws (Kirchhoff, Ohm); Equivalent circuits (series, parallel); AC circuits; Motors and generators Measurements, Instrumentation, and Controls Sensors; Block diagrams; System response; Measurement uncertainty	8-13	10	Thermodynamics Properties of ideal gases and pure substances; Energy transfers; Laws of thermodynamics; Processes; Performance of components; Power cycles, thermal efficiency, and enhancements; Refrigeration and heat pump cycles and coefficients of performance; Nonreacting mixtures of gases; Psychrometrics; Heating, ventilating, and air-conditioning (HVAC) processes; Combustion and combustion products	13-20
5	Statics Resultants of force systems; Concurrent force systems; Equilibrium of rigid bodies; Frames and trusses; Centroids; Moments of inertia; Static friction	8-12	11	Heat Transfer Conduction; Convection; Radiation; Thermal resistance; Transient processes; Heat exchangers; Boiling and condensation	9-14
6	Dynamics, Kinematics, and Vibrations Kinematics of particles; Kinetic friction; Newton's second law for particles; Work-energy of particles; Impulse-momentum of particles; Kinematics of rigid bodies; Kinematics of mechanisms; Newton's second law for rigid bodies; Work-energy of rigid bodies; Impulse-momentum of rigid bodies; Free and forced vibrations	9-14	12	Mechanical Design and Analysis Stress analysis of machine elements; Failure theories and analysis; Deformation and stiffness; Springs; Pressure vessels; Beams; Piping; Bearings; Power screws; Power transmission; Joining methods; Manufacturability; Quality and reliability; Hydraulic components; Pneumatic components; Electromechanical components	9-14

As a preparation for the FE review for students the authors anticipate offering the review sessions to future FEER instructors. Mechanical Engineering faculty members who do not have the PE license will be encouraged to attend and take the FE exam. The authors of the paper are not licensed in the state of South Carolina and will be taking the FE exam before the program is offered to the students and faculty.

The FEER review sessions will be assessed as soon as first ME students take their FE exam. The authors will evaluate test scores and adjust the review sessions content as needed.

Conclusions

The FEER review sessions will be offered to ME seniors in order to improve student confidence and scores on FE exam. The FE preparation sessions will be taught by multiple instructors using proven study strategies in their respective fields of expertise. The authors have selected topics for review and will prepare workshops and problem solving sessions, and report on the progress, shortfalls, strengths, and implemented changes. The authors' goal is to ensure that ME undergraduates who wish to take the exam are well-prepared and confident in their ability to do well. The results of FEER will be evaluated as soon as first ME students take their FE exam.

References

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Monika Bubacz

Dr. Monika Bubacz is an Associate Professor in the Department of Engineering Leadership and Program Management at The Citadel. She received both her B.S. and M.S. in Mechanical Engineering from Poznan University of Technology in Poland, and the Ph.D. in Engineering and Applied Science from the University of New Orleans. Before her current appointment she has worked for Mercer University, Center for NanoComposites and Multifunctional Materials in Pittsburg, Kansas and Metal Forming Institute in Poznan, Poland. Her teaching and research interest areas include materials science, polymers and composites for aerospace applications, nanotechnology, and environmental sustainability.

Kevin Skenes

Kevin Skenes is an Assistant Professor in the Department of Engineering Leadership and Program Management at The Citadel. He received his B.S. and M.S. in Mechanical Engineering from the Georgia Institute of Technology, and successfully defended his Ph.D. in Mechanical Engineering in October at Georgia Tech. His teaching and research interests include

manufacturing, non-destructive evaluation, causes and effects of residual stress, and solar energy.