Syllabus for
ME 447—Finite Element Method
3 Credit Hours
Fall 2006

I.   COURSE DESCRIPTION

This course presents an introduction to the theory, programming and application of the finite element method that is used to solve problems in engineering analysis and design. Furthermore, finite element analysis of two and three-dimensional models is conducted using the computer.
Prerequisite: ME 321
Course fee: $35.

II.   COURSE GOALS

The purpose of this course is to enable the student to develop an understanding of the theoretical basis of finite element approximations and provide the student with knowledge and experience in the finite element method and analysis.

III.   STUDENT LEARNING OUTCOMES FOR THIS COURSE

As a result of successfully completing this course, the student will be able to do the following:

A.   Explain and discuss the theory behind the finite element method.

B.   Solve problems by application of the finite element method using MATLAB.

C.   Discuss analysis and design techniques utilizing Finite Element Analysis (FEA) software. Utilize a state of the art FEA software package (Algor) for static stress analysis.

IV.   TEXTBOOKS AND OTHER LEARNING RESOURCES

A.   Required Materials

        Textbook
        Thompson, Erik G., <u>Introduction to the Finite Element Method</u>, Wiley, 2005.
        Zecher, J., <u>Finite Element Analysis</u>, SDC Publications, 2003

B.   Optional Materials
        Other
        1.   Calculator
        2.   Computer

V.   POLICIES AND PROCEDURES

    A. University Policies and Procedures
            1.   Attendance at each class or laboratory is mandatory at Oral Roberts University. Excessive absences can reduce a student's grade or deny credit for the course.

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2. Students taking a late exam because of an unauthorized absence are charged a late exam fee.
3. Students and faculty at Oral Roberts University must adhere to all laws addressing the ethical use of others' materials, whether it is in the form of print, video, multimedia, or computer software. By submitting an assignment in any form, the student gives permission for the assignment to be checked for plagiarism, either by submitting the work for electronic verification or by other means.
4. Final exams cannot be given before their scheduled times. Students need to check the final exam schedule before planning return flights or other events at the end of the semester.
5. Students are to be in compliance with University, school, and departmental policies regarding ePortfolio requirements. Students should consult the ePortfolio handbooks for requirements regarding general education and the students' majors.
   a. The penalty for not submitting electronically or for incorrectly submitting an ePortfolio artifact is a zero for that assignment.
   b. By submitting an assignment, the student gives permission for the assignment to be assessed electronically.

B. Course Policies and Procedures
1. Evaluation Procedures

Homework	20%
Exam 1	20%
Exam 2	20%
Exam 3	20%
Final Exam	20%

2. Assignments are to be turned in at the beginning of class on the date they are due.
3. Normally, no points are awarded for assignments that are turned in late.
4. The first three absences will not result in a grade reduction. Each absence thereafter will result in a 1% grade reduction in the final score (100% maximum), which determines the grade. The absences allowed prior to grade reduction are designed to accommodate emergencies and illnesses and are not designed for indiscriminate use. The final score will be increased by 1% for perfect attendance.
5. Students are expected to be prompt for class. They will incur one absence for every two times they are late.
6. ePortfolio Requirements
   None.

VI. COURSE CALENDAR

Week	Topic	Reading Due
1	Introduction	None
1	Governing equation	1.1 – 1.2 (Thompson)
2	Finite Element Approximations	1.3 – 1.4
2	Calculus of Variations	Chapter 2
3	Shape Functions and Element Stiffness	3.1 – 3.3
3	Global Stiffness Matrix	3.4 – 3.7
3	Linear Second-Order Ordinary Differential Equations	4.1 – 4.3
4	Linear Second-Order Ordinary Differential Equations	4.4 – 4.7
4	Finite Element Function for two dimensions	Chapter 5
4	Poisson's equation: FEM approximation	Chapter 6
5	Review for Exam I	None
5	**EXAM I: Chapters 1-6 (Thompson)**	None
5	Applications of Poisson's equation	7.1 – 7.3
6	Applications of Poisson's equation	7.4 – 7.6
6	Higher Order Elements: Continuity	8.1 – 8.2
6	Higher Order Elements: The K Matrix	8.3 – 8.4
7	Higher Order Elements: Additional Elements	8.5 – 8.7
7	FEM for 2-D Boundary Value Problems	9.1 – 9.2
7	FEM for 2-D Boundary Value Problems	9.3 – 9.5
8	Analysis of Transient Behavior	10.1 – 10.3
8	Analysis of Transient Behavior	10.4 – 10.7
8	Elasticity	11.1 – 11.3
9	Elasticity	11.4 – 11.7
9	Higher Order Equations	12.1 – 12.2
9	Higher Order Equations	12.3 – 12.5
10	Review for Exam II	None
10	**EXAM II: Chapters 7-12 (Thompson)**	None
10	Introduction	Chapter 1(Zecher)
11	**SPRING BREAK (No Class)**	None
12	Stiffness Matrices	Chapter 2
12	Using Superdraw	Chapter 3
12	Preparing Finite Element Data with Algor	Chapter 4
13	Modeling Techniques	Chapter 5
13	Plane Stress/Strain Modeling Techniques	Chapter 6
13	Axi-symmetric Element Modeling Techniques	Chapter 7
14	Review for Exam III	None
14	**EXAM III: Chapters 1-7 (Zecher)**	None
14	Truss Element Modeling Techniques	Chapter 8
15	Beam Element Modeling Techniques	Chapter 9
15	Plate/Shell Element Modeling Techniques	Chapter 10
15	3D Solid Element Modeling Techniques	Chapter 11
16	Using Boundary Elements	Chapter 13
16	Heat Transfer	Chapter 14
16	Review for Final Exam	None

Course Inventory for ORU's Student Learning Outcomes

ME 447– Finite Element Method
Spring 2006

This course contributes to the ORU student learning outcomes as indicated below:
Significant Contribution – Addresses the outcome directly and includes targeted assessment.
Moderate Contribution – Addresses the outcome directly or indirectly and includes some assessment.
Minimal Contribution – Addresses the outcome indirectly and includes little or no assessment.
No Contribution – Does not address the outcome.

The Student Learning Glossary at http://ir.oru.edu/doc/glossary.pdf defines each outcome and each of the proficiencies/capacities.

OUTCOMES & Proficiencies/Capacities	Significant Contribution	Moderate Contribution	Minimal Contribution	No Contribution
1 **Outcome #1 – Spiritually Alive** Proficiencies/Capacities				
1A Biblical knowledge				√
1B Sensitivity to the Holy Spirit				√
1C Evangelistic capability				√
1D Ethical behavior			√	
2 **Outcome #2 – Intellectually Alert** Proficiencies/Capacities				
2A Critical thinking	√			
2B Information literacy			√	
2C Global & historical perspectives			√	
2D Aesthetic appreciation				√
2E Intellectual creativity	√			
3 **Outcome #3 – Physically Disciplined** Proficiencies/Capacities				
3A Healthy lifestyle				√
3B Physically disciplined lifestyle				√
4 **Outcome #4 – Socially Adept** Proficiencies/Capacities				
4A Communication skills		√		
4B Interpersonal skills			√	
4C Appreciation of cultural & linguistic differences				√
4D Responsible citizenship				√
4E Leadership capacity			√	