SabanciUniversity
Faculty of Engineering and Natural Sciences

Introduction to the Finite Element Method

Instructor: GüllüKızıltaş Şendur
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Lecture Hour: M: 11:40-12:30, FENS L055, T: 10:40-12:30 FENS L055

Textbooks:

1.Thomas J. R. Hughes, *The Finite Element Method: Linear Static and Dynamic Finite Element Analysis*, 1987(Primary TextbookTA347.F5 H84 2000).

2.Moaveni, S., Finite Element Analysis Theory and Applications with ANSYS, 3rd ed. Prentice Hall, 2007.

TA and Office Hour TBA

References:

1.O. C. Zienkiewicz and R. L. Taylor*, The Finite Element Method,* Volume 1-3 Butterworth-Heinemann, 2001
2. B. Szabo and I.Babuska, *Finite Element Analysis*, New York: Wiley, 1991
3.J. N. Reddy, *An Introduction to the Finite-Element Method*, 2nd edition, McGraw-Hill
4. R. D. Cook, D. S. Malkus, M. E. Plesha, andR. J. Witt, *Concepts and Applications of Finite Element Analysis*, 4rd edition, Wiley
5. Klaus J. Bathe, *Finite Element Procedures*, Prentice-Hall, 1996(TA347.F5 B38 1996).
In addition, class handouts will be provided

Course Objectives:

The objective of the course is to teach the basic fundamentals of finite element method with emphasis on the underlying theory, assumptions, and modeling issues as well as providing hands on experience using finite element software to model, analyze and design systems of relevance to engineers.

At the end of the course, students should understand, be able to explain, use and develop further the key elements of the numerical analysis of the Finite Element Method. In particular, they should be familiar with the weak and strong form of PDEs, their discretization using conforming finite element methods, the construction of finite elements, error analysis in appropriate function spaces, and implementation issues. They will have knowledge of a range of applications including structures, heat transfer and fluid flow. If time permits and depending on the interest of students, there will be some emphasis on advanced topics.

Course Contents:

The course emphasizes the fundamental concepts in finite element analysis, and practical implementation of a working program. The course is divided into two halves. The first half is concentrated on the basic theoretical fundamentals of the finite element method. The second half will be focused on issues concerning the implementation. Advanced topics will be discussed if time permits.

The methods studied in this course are practical procedures that are employed extensively in the mechanical, civil, ocean, aeronautical and electrical industries. Increasingly, the methods are used in computer-aided design.

Prerequisites:

Familiarity with fundamental concepts of mechanics of materials and elementary matrix algebra and proficiency in numerical programming is highly recommended.

Course Work:

Graded homework is the essential part of this course. There will be 3 homework sets, each set is worth equal grade. Also there will be 1 midterm exam during the semester and a final project worth 25% and 30 % of the total grade, respectively. Weighting may change during the semester.

Homework	*45%*
MIDTERM	*25%*
Take Home Project	*30%*

The basic philosophy of this course is that in-depth understanding of the Finite Element Method is best obtained by actual implementation of the concepts in software. Therefore, the course emphasizes underlying principles with concurrent implementation in computer code via homework problems and the final take home project. The objective of the final is for each student to obtain hands-on experience in solving analysis problems using a typical finite element code in COMSOL or any other commercial software. The final exam will address a problem solution in one of alternative fields such as solids and structures, fluid flows, heat transfer, etc.

Syllabus Overview: An approximate allocation of topics throughout the semester is as follows.

Week 1-2 Introduction to FEM, Review of Basic Concepts in Math and Mechanics/Elasticity
Week 3-4 Formulation of the FEM-1D-Elastostatics-FDM, FEM Global Approach
Week 5-6-7 Formulation of the FEM-1D-Elastostatics, FEM Local Approach
Week 8-9 Formulation of the FEM-2D-Heat Conduction
Weeks 10-11 Formulation of the FEM-2D-Heat Conduction
Weeks 12-13 Formulation of the FEM-2D and 3D Elasticity