

University Of California, Berkeley
Department of Mechanical Engineering

**ME C180: ENGINEERING ANALYSIS USING THE FINITE ELEMENT
METHOD [3 Units]**

Elective Course

Syllabus

CATALOG DESCRIPTION

This is an introductory course on the finite element method and is intended for seniors in engineering and applied science disciplines. The course covers the basic topics of finite element technology, including domain discretization, polynomial interpolation, application of boundary conditions, assembly of global arrays, and solution of the resulting algebraic systems. Finite element formulations for several important field equations are introduced using both direct and integral approaches. Particular emphasis is placed on computer simulation and analysis of realistic engineering problems from solid and fluid mechanics, heat transfer, and electromagnetism. The course uses FEMLAB, a multi-physics MATLAB-based finite element program which possesses a wide array of modeling capabilities and is ideally suited for instruction. Assignments will involve both paper- and computer-based exercises. Computer-based assignments will emphasize the practical aspects of finite element model construction and analysis.

COURSE PREREQUISITES

- E7 or CS61A
- Math 53 and Math 54
- Senior status in engineering or applied science
- Calculus, differential equations and linear algebra
- Computer programming using procedural constructs.
- Familiarity with elementary field theories of solid/fluid mechanics and/or thermal science.

TEXTBOOK(S) AND/OR OTHER REQUIRED MATERIAL

- Required text: The Finite Element Method for Engineers, by K. H. Huebner, D. L. Dewhirst, D. E. Smith and T. G. Byrom, 4th edition, Wiley, New York, 2001.
- Recommended text: Introduction to the Finite Element Method, by N. S. Ottosen and H. Petersson. Prentice-Hall, Englewood Cliffs, 1992.
- Class notes provided, as necessary.

COURSE OBJECTIVES

- Introduce basic aspects of finite element technology, including domain discretization, polynomial interpolation, application of boundary conditions, assembly of global arrays, and solution of the resulting algebraic systems.
- Discuss the use of finite element methods in engineering problem-solving drawing from applications in solid mechanics, fluid mechanics, heat transfer, and electromagnetism.
- Familiarize students with professional-level finite element software.

DESIRED COURSE OUTCOMES

Upon completion of the course, students shall be able to:

- Derive integral statements for linear partial differential equations, such as the Laplace/Poisson equation, the wave equation, and the elasticity equations.
- Use integral statement to deduce finite element approximations for the underlying linear partial differential equations.
- Write special-purpose finite element programs within a procedural programming computer environment, such as MATLAB.
- Use professional-level finite element software to solve engineering problems in solids mechanics, fluid mechanics, heat transfer and electromagnetism.
- Assess the accuracy and reliability of finite element solutions and troubleshoot problems arising from errors in a given finite element analysis.

TOPICS COVERED

- The history of the finite element method.
- Domain discretization in one, two and three dimensions.
- The Ritz method.
- The Galerkin method.
- Compatibility and completeness requirements.
- Computer program organization.
- Automated assembly of finite element arrays.
- Application to structural mechanics problems.
- Application to steady and unsteady heat conduction.
- Application to convection-diffusion problems.
- Application to compressible inviscid flow.
- Application to steady and unsteady linear viscous flow.
- Application to electromagnetic field problems.
- Design using the finite element method.
- Multiphysics problems.

CLASS/LABORATORY SCHEDULE

There are two 80-minute lecture and one 110-minute computer laboratory session per week.

CONTRIBUTION OF THE COURSE TO MEETING THE PROFESSIONAL COMPONENT

This course contributes primarily to the students' knowledge of engineering topics and does not provide hands-on design experience. However, aspects of computer-aided design are discussed in connection with the use of the finite element method. [*The following statement indicated which of the following considerations are included in this course: economic, environmental, ethical, political, societal, health and safety, manufacturability, sustainability*]

Economic issues are considered throughout the course as they apply to the topics addressed.

RELATIONSHIP OF THE COURSE TO ABET PROGRAM OUTCOMES

These are that our graduates have: An ability to apply knowledge of mathematics, science, and engineering; an ability to identify, formulate, and solve engineering problems; the broad education necessary to understand the impact of engineering solutions in a global and societal context; an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

ASSESSMENT OF STUDENT PROGRESS TOWARD COURSE OBJECTIVES

- Homework assignments on a weekly basis.
- Midterm examination.
- Final examination.

PERSON(S) WHO PREPARED THIS DESCRIPTION: [P. Papadopoulos](#) Feb. 26, 2006

ABBREVIATED TRANSCRIPT TITLE (19 SPACES MAXIMUM): ENG ANALYFINITE
MTH

TIE CODE: LECS

GRADING: Letter

SEMESTER OFFERED: Spring

COURSES THAT WILL RESTRICT CREDIT: NONE

INSTRUCTORS: Profs. Papadopoulos, Govindjee

DURATION OF COURSE: 14 Weeks

EST. TOTAL NUMBER OF REQUIRED HRS OF STUDENT WORK PER WEEK: 9

IS COURSE REPEATABLE FOR CREDIT? No

CROSSLIST: Yes