UNIVERSITY OF CALIFORNIA BERKELEY | Structural Engineering,
Department of Civil Engineering | Mechanics and Materials
Spring 2019 | Professor: S. Govindjee

**CE C133/ME C180**
**Engineering Analysis Using the Finite Element Method**

**Instructor:**
Prof. Sanjay Govindjee, 779 Davis Hall. E-mail: s_g@berkeley.edu.
Office Hours: T 3:30-5, Th 11-12:30.

**GSIs:**
Mr. Linus Mettler, Location TBD. E-mail: linusmettler@berkeley.edu.
Office Hours: TBD.

**Lab:**
Mandatory W 4-6 or F 2-4 (you must go to your assigned section), Etcheverry 1171. The Etcheverry CAD Lab in 1171 Etcheverry Hall is open weekdays from 7am-7pm AND cardkey access is enabled 24x7, if cardkey access has been purchased at http://www.me.berkeley.edu/accounttool. The Cardkey fee is $5 per semester; it gives you cardkey access to Etcheverry Hall AND the 1171 Etcheverry CAD Lab. The charge will appear on your CARS account at the end of the semester.

**In order to use the computers in the lab you will need your CalID and password. Make sure this is working in the lab. Labs will start week 2 of the semester.**

**Web Page:**
bCourses will host the class website. To see material from prior years, see http://faculty.ce.berkeley.edu/sanjay/me180ce133 . Discussions for the class will be on Piazza: Signup Link:
http://piazza.com/berkeley/spring2019/ce133me180spring2019 .

**Prerequisites:**
Engineering 77 or Engineering 7 or Computer Science 61A; Mathematics 53 and 54; senior status in engineering or applied science. *Senior status*

*means you are a senior or have taken basically all of your junior year required courses. The more experience you have the easier the course will be.*

**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. The course uses Ansys, a multiphysics commercial finite element program that possesses a wide array of modeling capabilities. Assignments will involve both paper- and computer-based exercises. Computer-based assignments will emphasize the practical aspects of finite element model construction and analysis, as well as writing your own mini-FEA programs in either Matlab or Python depending on your preference.

**Textbook:**
The textbook we will use for the majority of the course is: *Introduction to the finite element method* by Niels Saabye Ottosen and Hans Petersson, Prentice-Hall, 1992. This book is in print but is not easy to find for sale at a reasonable price. For your convenience I have purchased the right to make an electronic version available to the students in the course — i.e. there will be a free PDF posted to bCourses. (The book is also on 2 hour reserve in the Engineering Library). Additionally, the following books may be of interest to some of you:

1. T.J.R. Hughes *The Finite Element Method*. This is a good graduate level text and well suited for those who are more mathematically inclined. Look for the inexpensive Dover edition (the library also has a e-version).

2. J.N. Reddy *An Introduction to the Finite Element Method,* 3rd Edition. This is a reasonably comprehensive book but is very expensive. Its level is between O&P and TJRH and covers fluids which are not covered in the first two books.

3. K.H. Huebner, D.L. Dewhirst, D.E. Smith, T.G. Byrom *The Finite Element Method for Engineers*. This is comprehensive book. Its level is similar to JNR and also covers fluids which are not covered in the O&P and TJRH.

Other books can be browsed near call number TA347.F5.

**Conduct of Course:**
Homework will be assigned weekly and due the following the week on Thursday in class. Assignments will be paper and pencil and computer-based. Lab assignments will be required to be completed in the lab.

**Midterm Exam:**
There will be **one** midterm examination and a final exam. Date of the midterm will be March 6, 6-8pm. The final exam will be Monday 5/13/19, 11:30–2:30 pm.

**Grades:**
The course grade is based on: Homework 15%, Lab 15%, Midterm 30%, Final 40%. Grades are assigned based on my judgement of your understanding of the course material A = excellent understanding, B = good understanding, C = fair understanding, D = poor understanding, F = failing understanding. In most years the cut-offs for the grades occur around A = 90%, B = 70%, C = 60%, D = 50%. The exact cut-offs and the assignment of pluses and minuses vary from year to year depending upon the difficulty of the actual assignments and exams.

**Rough Outline:**

1. Introduction
   (a) Modeling
   (b) Historical background
   (c) The central concept
2. Mathematical Preliminaries
   (a) Variational concepts
   (b) Calculus of variations
3. Second-order systems and their finite element models
   (a) Elastic rods
   (b) Heat transport
   (c) Diffusion
4. Fourth-order systems: Beams
5. Eigenvalue and time-dependent problems
   (a) Semi-discrete form
   (b) Heat conduction
   (c) Vibrations
   (d) Wave propagation
6. Multi-dimensional problems
   (a) Mathematical tools
   (b) Heat conduction
   (c) Elasticity
   (d) Fluid flow
7. Overview of element classes
8. Incompressible viscous flows
9. Coupled physics problems
10. Contemporary topics