UNIVERSITY OF CALIFORNIA BERKELEY — Structural Engineering,
Department of Civil Engineering — Mechanics and Materials
Spring 2016 — Professor: S. Govindjee

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

**Instructor:**
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Office Hours: Tue 11-12 and Wed 1-2:30.

**GSIs:**
Mr. Ahmed Bakhaty, 504 Davis Hall. E-mail: abakhaty@berkeley.edu.
Office Hours: Tu 5-6, W 4-5, Th 5-6.
Mr. Miquel Crusells-Girona, 504 Davis Hall. E-mail: miquel.crusells@berkeley.edu.
Office Hours: MWF 9:30-11:30.

**Lab:**
Mandatory W 2-4, W 4:30-6:30, or Th 5-7 (you must go to your assigned section), 10 Jacobs Hall. You will use your CalNet ID to logon. If you have problems logging in, "synchronize" your passphrase at http://calnet.berkeley.edu. There are 100 free printing pages per semester; if more are needed go to http://www.me.berkeley.edu/accounttool to add to your quota. A charge will appear on your CARS account at the end of the semester. Note Jacobs Hall is open from 8:30am to 7:00pm Monday-Friday. If you have a Jacobs Hall Maker Pass then you will also have cardkey enabled access during off hours: Weekdays off-hours (7pm-11pm), Saturday (12pm-7pm).

For additional hours access, 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://www.ce.berkeley.edu/~sanjay/me180ce133 .

**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 better.*

**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, as well as coupled problems. The course uses COMSOL, a multiphysics commercial finite element program that possesses a wide array of modeling capabilities. Throughout the course we will also make extensive use of MATLAB. 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 program.

**Textbook:**
You are required to have a finite element textbook to read but there is no single required book. You need to choose what you feel most suits your needs. Here is a list of 4 books from which I suggest you make your choice (these are all on 2 hour reserve in the Engineering Library):

1. Ottosen and Petersson *Introduction to the Finite Element Method*. This book is quite accessible and I think is probably a good book for most people in the course.

2. T.J.R. Hughes *The Finite Element Method*. This is a good graduate level text and well suited for those who are more mathematically in-

clined. Look for the inexpensive Dover edition (the library also has a e-version).

3. 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.

4. 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 covers fluids which are not covered in the first two books.

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

**Conduct of Course:**
Homework will be assigned weekly and due the following the week. 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 announced later. The final exam will be Monday 5/9/10 11:30am-2:30pm.

**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 assignments 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 conductions
   (c) Vibrations
   (d) Wave propagation
6. Multi-dimensional problems
   (a) Mathematical tools
   (b) Heat conductions
   (c) Elasticity
   (d) Fluid flow
7. Overview of element classes
8. Incompressible viscous flows
9. Coupled Thermo-elasticity
10. Applications to video-gaming