University of California at Berkeley
Department of Civil and Environmental Engineering

SPRING 2017
MW 1-2 pm

Syllabus: CE 130N - Mechanics of Structures

Instructor: Shaofan Li; Classroom: 390 Hearst Mining; MW 1-2 pm
Office: 783 Davis Hall; Email: li@ce.berkeley.edu, Tel: (510)-642-5362

Lab One: GSI: Qingsong Tu; Classroom: 345 DAVIS HALL; M 2:00-5:00 pm;
Office Hour (504 Davis Hall): MW: 11:00 am -12:30 pm 504 Davis Hall,
Email: howietu@berkeley.edu

Lab Two: GSI: Benjamin Worsforld Butler; Classroom: 345 DAVIS HALL; Friday 2-5pm
Office Hour: : Wednesday: 2:00am-3:30pm & F: 10:30 am 12:00 pm (504 Davis Hall),
Email: benjamin_worsfold@berkeley.edu

Lab Three: GSI: Jes Parker; Classroom: 345 DAVIS HALL; Thursday 2:00-5:00 pm
Office Hour: Tu: 11:00am-12:30pm & Thu: 12:00 pm-1:30pm (504 Davis Hall),
Email: jmparker@berkeley.edu

Reader: Mr. Yuxi Xie; Email: yuxi_xie@berkeley.edu

Grading: HW 25 %, Lab Report 30 % Midterm 20 % Final Project 25%

My Office Hour: TuTh. 1:00pm-4:00 pm (783 Davis Hall)

Homework will be assigned on each Friday, and due on the following Friday. Assignments will be paper and pencil and computer-based. Lab assignments will mostly be required to be completed in the lab but some may extend over a longer period and be part of the weekly homework.

Lab: Mandatory M 2-5, Tu. 2-5, Thu. 2-5 in 345 Davis Hall. If you do not already have access to the computer lab. Please follow the instructions on the department website. Note, there will be no labs the rst week of the semester. Labs will begin January 26. You must go to your assigned lab section.

Software: MATLAB is used extensively in the course so it is recommended that you have you have a copy on your own computer. You can obtain a free license from the campus; see *https:/software.berkeley.edu/matlab*

Web Page: Please see bCourses. bCourses will be used extensively for the course. You can download the course reader there, the syllabus, assignments, here.

Prerequisites: CE30/ME85 and (CE60 or E45)
Description: Elastic deformation analysis of bars, shafts, beams, and columns using energy and variational methods and their generalization to related areas of engineering science; stability analysis of structures;

computer-aided mathematical techniques for solution of engineering problems and modular computer programming methods.
Textbook: The text for the course can be downloaded from bCourses: Govindjee, S. (2015). A First Course on Variational Methods in Structural Mechanics and Engineering.

There will be one midterm exams and a final project. The in-class midterm exam are scheduled for March 15th (Wednesday). The final project presentation will be held on Tuesday, May 14, 2017, 8am-11am.

Limited collaboration is permitted on homework assignments. You may discuss the homework with each other but may not show your written work or computer code to others. Similarly, the use of solution keys or solution sets of any type is expressly forbidden. All cases of misconduct on homework will be reported to the Student Conduct Office in addition to the assignment of a zero for the entire homework portion of the course grade. Misconduct on examinations will likewise be reported to the Student Conduct Office and result in a failing grade for the course.

Topic Outline

1. Review of one dimensional models for basic elastic structural elements, tension-compression bars, torsion bars, beams
(a) Differential equation representations,
(b) Static indeterminacy.

2. One dimensional elements in two and three spatial dimensions
(a) Direct assembly of truss systems, determinate and indeterminate systems.

3. Energy methods
(a) Review of conservation of energy, conservative forces, conservative systems,
(b) Potential energy of a system,
(c) Stationary potential energy and Castigliano's 1st Theorem,
(d) Trusses revisited using stationary potential energy,
(e) Approximate energy solutions: Ritz,
(f) Buckling and potential energy.

4. Variational Methods
(a) Method of virtual displacements

5. Multi-Dimensional Problems
(a) Two dimensional mechanical systems: membranes
(b) Applications to other fields: Darcy's flow and seepage
(c) Applications to other fields: Heat conduction

Detailed lecture-by-lecture topics and lab scheduling

1. Week 1
(a) Introduction, overview, recall 1-D bar from CE C30;
(b) Review: Tension-Compression bar as a second order differential equation.
No Lab

2. Week 2
(a) Review: Torsion of a circular bar as a second order differential equation;
(b) Review: Beam bending as a fourth order differential equation.
(Lab 1) BVP4c in Matlab applied to tension-compression bars.

3. Week 3
(a) Equilibrium of Trusses: Introduction;
(b) Equilibrium matrix & Compatibility matrix.
(Lab 2) BVP4c in Matlab applied to beams

4. Week 4
(a) Truss Stiffness Matrix;
(b) Energy Definitions: Power, Work, Conservative Forces, Conservative Systems.
(Lab 3) Construction of compatibility matrix for truss program.

5. Week 5
(a) Energy conservation: trusses and expressions for torsion and bending;
(b) Energy conservation: examples.
(Lab 4) Static condensation and solution for nodal displacements.

6. Week 6
(a) Energy conservation example; Potential Energy;
(b) Potential energy example, potential energy truss.
(Lab 5) Utilization of truss program from Lab 4 to analyze a truss.
(Monday lab is out of phase due to holiday).

7. Week 7
(a) Potential energy truss, Approximate potential energy;
(b) Approximate potential energy, the method of Ritz.
Monday lab meets; no labs TuThFr

8. Week 8
(a) Midterm Exam (b) Approximate potential energy, the method of Ritz worked example with program.
(Lab 6) Visualization lab for potential energy in 1 and 2 degree of freedom systems.

9. Week 9
(a) Revisit rigid buckling with potential energy;
(b) Revisit beam buckling with potential energy;
(Lab 7) Potential energy solution with hat functions: mini- FEA code

Spring Break Week: No lectures or labs

10. Week 10
(a) Buckling with supports and distributed loads;
(b) Response of beams with axial compression; intro to virtual work (bars).
(Lab 8) Buckling lab with rigid bars.

11. Week 11
Bars Virtual Work; Principle of V.W.; approximate V.W.
(a) Virtual Work expressions for torsion and bending.
(Lab 9) Buckling of beams using polynomial and trigonometric expansions with potential energy approximations

12. Week 12
(a) Introduction to multidimensional problems;
(b) Example two dimensional mechanical system.
(Lab 10) Virtual work solutions of beam problems using Hermite polynomials: mini-FEA code

13. Week 13
(a) Example application to membrane problems;
(b) Example application to heat conduction;
(Lab 11) Finite element solution for 2D heat conduction.

14. Week 14
(a) Anti-plane problem and the Saint-Venant torsion problem;
(b) Review, final exam discussion, evaluations.
No labs