University of Massachusetts - Amherst
Department of Civil & Environmental Engineering
CEE 630: Advanced Solid Mechanics (Fall 2009)

Instructor:
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Office Hours:
T Th 2:15-3:00
T 4-5
also by appointment

Course web page: http://www-unix.ecs.umass.edu/∼arwade/courses/cee630/

Catalog Description: Unified treatment of the analysis of solids. Consideration of continuity, mechanical energy, stress and strain. Application to elasticity, thermoelasticity, and plasticity. Same as M&I-ENG 630.

Prerequisites: Generally open to graduate students only. Exceptional undergraduates may be admitted by permission of instructor.

Text:
Required: Ugural and Fenster, *Advanced Strength and Applied Elasticity*. 4th ed. Prentice Hall, 2003.
Optional: Timoshenko, *History of Strength of Materials*. Dover, 1983.

Course Objectives: To solve problems in solid mechanics which cannot be satisfactorily addressed by the approaches of mechanics of materials. Examples of such problems include plane stress and strain problems, plate bending problems, beams supported on elastic foundations fracture problems, and problems in which some input or system parameters are uncertain. The tools developed for solution of these problems include the semi-inverse method using the Airy stress function, energy methods, and numerical methods such as the finite difference method. An objective also is to gain an understanding of the history of solid mechanics, the people who developed the solution methods we study, and the historical and modern application of these methods.

Topics Covered:

- **Elasticity:** stress; strain; equilibrium; compatibility; Hooke's law; Airy and Prandtl stress function; definition of energy.
- **Energy methods:** virtual displacements; virtual forces; Rayleigh-Ritz method; stability.

- **Failure, yield and fracture:** von Mises criteria etc.; elements of fracture mechanics.
- **Plasticity:** yield criteria, hardening rules, flow rules, cyclic loading.
- **Plates:** Governing equations of plate bending; rectangular and circular plates; finite difference and finite element solution
- **Stability:** Euler buckling of columns; energy methods in stability; approximate solutions; plate instability
- **Special topics:** micromechanics; probabilistic mechanics.

Class Schedule:
Lectures, TuTh 1:00-2:15 See SPIRE for room assignment

Course Outcomes: Students completing this course should be able to:

- solve the differential equations governing the behavior of two dimensional elastic solids,
- solve the differential equations governing the bending of plates,
- apply concepts of energy conservation to the solution of problems in solid mechanics,
- determine the load at which a structure becomes unstable,
- determine whether a crack in an elastic solid will propagate,
- develop idealizations to real world engineering systems that allow the use of the mathematical solutions presented in the course.

Assessment Methods: Students' performance in the class will be assessed through midterm and final examinations and weekly homework assignments. Assignments will be graded by the instructor. Solutions will only be distributed for selected problems. The final grade will be determined based on the following weighting:

Homework	15%
Midterm	35%
Final	50%

Homework policies:
Homework will be more or less weekly. You may help each other out on the homework, but you should feel comfortable claiming your own submission as your own work. On the front page of the submission, write the names of those students with whom you have collaborated. **Homeworks which do not meet minimum standards of neatness will be returned ungraded.**

Schedule of topics and reading assignments:

Date	Topic	U&F	Timoshenko
9/8	Introduction and course info		
9/10	Definition of stress at a point	Ch. 1	Chs. 1-2
9/15	Principal stresses and transformation		
9/17	Equilibrium, strain, compatibility	Ch. 2	
9/22	Strain transformation		Ch. 5
9/24	Constitutive relations		
9/29	Plane stress/strain		
10/1	Plane stress/strain		Ch. 8
10/6	2D elasticity problems	Ch. 3	
10/8	2D elasticity problems		
10/13	**No class, treated as Monday**		
10/15	2D elasticity problems		
10/20	Torsion	Ch. 6	
10/22	Energy, definitions		Ch. 9
10/27	**Midterm exam**		
10/29	Energy, definitions		
11/3	Rayleigh-Ritz method		
11/5	Finite difference methods	Ch. 7	
11/10	Finite difference methods and failure theories	Ch. 4	Ch. 12
11/12	Elementary plasticity		
11/17	Elementary plasticity		
11/19	Elementary plasticity		
11/24	Elementary fracture mechanics	Ch. 4	
11/26	**Thanksgiving Day**		
12/1	Fatigue		
12/3	Plate bending	Ch. 13	Chs. 11,13
12/8	Plate bending		
12/10	Plate bending		