University of Massachusetts - Amherst  
Department of Civil & Environmental Engineering  
CEE/MIE 630: Advanced Solid Mechanics

**Instructor:**  
Sanjay Arwade  
223 Marston Hall  
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**Office Hours:**  
T Th 3:45-4:45  
also by appointment

**Course web page:** http://www.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:**  

**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, plasticity, and problems in which some input or system parameters are uncertain. The focus is on analytical methods and introductions to numerical methods are also covered. 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.

**Sample 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

• **Special topics**: probabilistic mechanics.

**Class Schedule:**
Lectures, TuTh 2:30-3:45 See SPIRE for room assignment

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

• formulate and understand 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 whether a crack in an elastic solid will propagate,

• determine whether a solid will exceed the elastic limit and analyze the post-yield behavior

**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 25%
Midterm 35%
Final 40%

**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. **Homeworks which do not meet minimum standards of neatness will be returned ungraded.**

**Midterm exam:** The midterm examination will be held in the evening at 630 on the date shown in the syllabus. If you have a conflict with this time you must inform Prof. Arwade in writing during the first week of the semester. After the end of the first week the date and time of the midterm is considered fixed for all students.
<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
<th>U&amp;F</th>
<th>Timoshenko</th>
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| 1    | Introduction and course info  
   Definition of stress at a point | 1   | 2,3        |
| 2    | Principal stresses and transformation  
   Equilibrium, strain, compatibility | 2   |            |
| 3    | Strain transformation  
   Constitutive relations | 5   |            |
| 4    | Plane stress/strain  
   Plane stress/strain | 3   | 8          |
| 5    | Torsion | 6   |            |
| 6    | **No meeting, Monday schedule, Oct 14**  
   Concentrated loads | 3   |            |
| 7    | Concentrated loads  
   Contact stresses | 3   |            |
| 8    | **Review, Midterm exam evening, Oct. 27**  
   Energy, definitions | 2,10| 9          |
| 9    | Energy, definitions  
   Rayleigh-Ritz method |        |            |
| 10   | Failure theories  
   Elementary plasticity | 4   | 12         |
| 11   | Elementary plasticity  
   Elementary plasticity |        |            |
| 12   | Elementary fracture mechanics | 4   |            |
| 13   | **No meeting, Thanksgiving, Nov. 26**  
   Fatigue | 4   |            |
| 14   | Plate bending  
   Special topics | 13  | 11,13      |