MECH 6350
Advanced Solid Mechanics

Spring 2014

Instructor: Prof. Xin-Lin Gao
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Classroom: ATC 2.101 **Time**: TR 2:30-3:45 pm

Prerequisites: MECH 6306 (Continuum Mechanics) or equivalent

Textbook:
- Martin H. Sadd, *Elasticity: Theory, Applications, and Numerics*, 2nd edition, Elsevier, 2009

Reference Books:
- S. P. Timoshenko and J. N. Goodier, *Theory of Elasticity*, 3rd edition, McGraw-Hill, New York, 1970
- W. S. Slaughter, *The Linearized Theory of Elasticity*, Birkhäuser, Boston, 2002
- R. W. Little, *Elasticity*, Prentice-Hall, Englewood Cliffs, New Jersey, 1973
- P. C. Chou and N. J. Pagano, *Elasticity: Tensor, Dyadic, and Engineering Approaches*, D. Van Nostrand, Princeton, New Jersey, 1967
- A. P. Boresi and K. P. Chong, *Elasticity in Engineering Mechanics*, 2nd edition, Wiley, New York, 2000
- R. W. Ogden, *Non-Linear Elastic Deformations*, Ellis Harwood, Chichester, England, 1984

Grading:

Homework	10%
Exams (2×45%)	90%

Office Hours: TR 4:00-5:00 pm

Course Objectives:
- To learn the concepts of stress, strain and energy and the stress and displacement formulation methods
- To derive equilibrium, constitutive, kinematic and compatibility equations using different approaches
- To study the generalized Hooke's law for anisotropic solids
- To find approximate solutions of two- and three-dimensional engineering mechanics problems by using suitable assumptions
- To understand the nature of the approximations and their effects on the accuracy of the resulting elasticity solutions
- To apply the elasticity theory to analyze deformation problems common in engineering design

Course Outline*

1. **Tensor Analysis:** index notation, tensor algebra, tensor calculus (**2 weeks**) (*Chapter 1*)
2. **Kinematics:** deformation, displacements, strain tensors, strain-displacement relations, compatibility equations (**1 week**) (*Chapter 2*)
3. **Kinetics:** traction vector, stress tensors, principle stresses, equations of motion, equilibrium (**1 week**) (*Chapter 3*)
4. **Constitutive Equations:** anisotropic/orthotropic/transversely isotropic/isotropic materials, generalized Hooke's law, linearized elasticity (**1 week**) (*Chapters 4 & 11*)
5. **Basic Principles:** stress and displacement formulations, superposition, St. Venant's principle, boundary conditions (**1 week**) (*Chapter 5*)
6. **Variational Methods:** strain energy, uniqueness, complementary energy, potential energy, virtual work principle, minimum total potential/complementary energy principle, approximate solutions (**1.5 weeks**) (*Chapter 6*)
7. **Two-Dimensional (2-D) Theory:** plane stress and plane strain, anti-plane shear, Airy's stress function, inverse method, complex variable method, displacement solution (**1 week**) (*Chapters 7 & 10*)
8. **2-D Problems:** beam bending, plate with a hole, curved beams, pressurized cylinders, wedges, Flamant problem, rotating disks (**1.5 weeks**) (*Chapters 8 & 10*)
9. **Torsion:** St. Venant torsion theory, Prandtl stress function, membrane analogy (**1 week**) (*Chapter 9*)
10. **3-D Theory and Problems:** Helmholtz theorem**,** Galerkin vector, elastic potentials, Kevin solution, Boussinesq problem, thick-walled spheres (**2 weeks**) (*Chapter 13*)
11. **Other Topics:** dislocation problems, higher-order elasticity theories, thermoelasticity (**1 week**) (*Chapters 12 & 15*)

Other Relevant Information:

- Solving problem is essential in learning the course materials. Several sets of homework problems will be assigned and graded.
- The instructor is available for additional help with appointments.
- The class notes are intended to be self-consistent, but more examples can be found in the textbook and references suggested.

* The topics listed here are tentative and subject to change.

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