

Advanced Computational Solid Mechanics

MAE5007

Spring Semester 2023

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References:

- The Finite Element Method: linear static and dynamic finite element analysis, Thomas J.R. Hughes, Dover 2000.
- Computational Inelasticity, J.C. Simo and T.J.R. Hughes, Springer, 2000.
- Nonlinear Finite Elements for Continua and Structures, W.K. Liu, B. Moran, T. Belytschko, and K. Elkhodary, Wiley, 2014.
- Computational Methods for Plasticity: Theory and Applications, E.A. de Souza Neto, D. Peric, and D.R.J. Owen, John Wiley & Sons, 2008.
- Nonlinear Solid Mechanics: a continuum approach for engineering, G.A. Holzapfel, John Wiley & Sons, 2000.
- Methods of Applied Mathematics, T. Arbogast and J.L. Bona, 2008.

Goals: This course aims at providing students an in-depth understanding of the finite element method with a focus on nonlinear and inelastic problems. Theoretical foundation as well as the implementation of the finite element method will be covered with applications primarily in the static and dynamic analysis of solids and structures.

Prerequisites: Differential calculus, Linear algebra, and MATLAB programming.

Grading:	Homework assignment	75%
	Midterm exam	15%
	Final presentation.	7%
	Class participation	3%

Schedule:

Class	Topic
Week 1	Review of linear elasticity, weak-form problem, and Galerkin formulation
Week 2	Review of the finite element implementation

Week 3	Review of elastodynamics and time stepping algorithms
Week 4	Solution method of nonlinear systems: Newton-Raphson method
Week 5	Solution method of nonlinear systems: line search, BFGS, and arc-length
Week 6	Formulation of small-strain nonlinear heat conduction and elastostatics
Week 7	Finite deformation hyper-elastostatics: kinematics
Week 8	Finite deformation hyper-elastostatics: balance equations and consistent linearization
Week 9	Finite deformation hyper-elastostatics: material models and implementation details
Week 10	Finite deformation hyper-elastodynamics: Newmark- β and generalized- α method
Week 11	Finite deformation hyper-elastodynamics: Energy-momentum scheme
Week 12	Viscoelasticity: linear theory and integration algorithms
Week 13	Viscoelasticity: nonlinear model
Week 14	Elastoplasticity: one-dimensional motivation and formulation
Week 15	Elastoplasticity: J2 flow theory and return mapping algorithm
Week 16	Contact and impact