ME280B - Finite Element Methods in Non-linear Continua

COURSE OUTLINE

Part 1: General developments

I. Brief review of continuum mechanics

1. Kinematics of deformation.
2. Basic physical principles (balance laws).
3. Invariance under superposed rigid-body motions.

II. Consistent linearization

1. Gâteux and Fréchet differentials.
2. Consistent linearization of kinematic variables and balance laws.

III. Incremental formulations

1. Weak forms of the balance laws.
2. Total- and updated-Lagrangian methods.
3. Co-rotational methods.
4. Arbitrary Lagrangian-Eulerian methods.
5. Eulerian methods.

IV. Solution of non-linear field equations

1. Generalities.
2. Newton's method and its variants.
3. Continuation methods.
4. Computational treatment of constraints.

Part 2: Selected applications

V. Constitutive modeling of deformable continua

1. Non-linear elasticity.
2. Elasto-plasticity at finite strains.
3. Physically coupled problems.

Part 3: Recent developments (select one)

VI. Continuum multiscale methods

1. The Hill-Mandel and Irving-Kirkwood homogenization approaches.
2. The FE^2 method for continuum-to-continuum modeling.
3. The quasicontinuum method for discrete-to-continuum modeling.

VII. Isogeometric finite element methods

1. Review of splines.
2. Isogeometric interpolation.
3. Isogeometric finite element formulations.

VIII. Particle-based methods

1. A brief survey of particle methods.
2. Volume- vs. particle-based methods.
3. State-based peridynamics.