University of California, Berkeley **Department of Mechanical Engineering**

ME 285A: Foundations of the Theory of Continuous Media

Syllabus

1. Introduction. The nonlinear field theories. Mathematical preliminaries. Tensors. Fréchet derivative and differential.

2. Kinematics of Deformable Continua. Bodies. Deformations. Polar decomposition theorem. Derivatives of stretch and rotation tensors. Velocity and vorticity fields. Pull-back and push-forward operations. Lie derivative. Material transport of fields. Internal constraints. Relative deformation gradient. Rivlin-Ericksen tensors.

3. Balance Laws. Conservation of mass. Balance of linear and angular momenta for continua. Stress tensors. Balance of energy. A remark on the second law of thermodynamics.

4. General Constitutive Relations (Purely Mechanical Theory). Relationship between stress and history of deformation. Invariance requirements. Simple materials. Symmetry considerations. Cauchy-elastic and Green-elastic (or hyperelastic) materials. Internally constrained elastic materials. Viscous fluids. Materials with memory. Viscoelastic fluids and solids. Reiner-Rivlin fluids. Rivlin-Ericksen fluids. Materials with fading memory. Linear viscoelasticity. Pseudo-Rigid materials.

5. Thermoelastic Materials. Ideal gas. Entropy and Helmholtz free energy functions. Clausius-Duhem inequality. Thermoelasticity. Approach of Coleman and Noll. Approach of Rivlin: construction of entropy function. Internally constrained thermoelatic materials. Linear thermoelasticity.

6. Thermoelastic Materials with Viscosity. Construction of the entropy function for thermoelastic materials with viscosity, and subject to internal constraints.

7. Thermodynamics of Materials with Memory. Materials with fading memory. Instantaneous elasticity. Open questions.

8. Selected Topics. Mixture theory, nonlocal continua.

Grading scheme: Homework (~40%), Midterm (~20%), Final Project (~40%).