CEE 630 / ME 525
Nonlinear Finite Element Analysis
Spring 2017
Professor Guglielmo Scovazzi
Homework # 3
Due Tuesday, March 7 2017.

Consider the following system of nonlinear equations, containing two equations and two unknowns:

$$\mathbf{N}(\mathbf{d}(t)) = \mathbf{F}^{ext}$$

where $\mathbf{d}$ represents ths unknown solution vector (parameterized by t), and $\mathbf{F}^{ext}$ is prescribed by

$$\mathbf{F}^{ext} = \left\{ \begin{array}{c} t \\ t + 2t^2 + 2t^3 \end{array} \right\}$$

Take $\mathbf{N}$ to be a vector-valued nonlinear function of $\mathbf{d}$ as

$$\mathbf{N}(\mathbf{d}) = \left\{ \begin{array}{c} d_2 - d_1 \\ d_2 + d_2^2 - d_1^2 \end{array} \right\}$$

1. Write a Newton-Raphson solver for this problem, using an incremental loading procedure. Have the solver plot d_1 and d_2 as functions of the load parameter t, for $t \in [0, 1]$. Use 10 load steps. Submit (via email) your solver.

2. Modify your NR-solver to incorporate a line search. Compare the number of iterations required within each time step to that obtained without a line search. Is this a hardening or a softening system? Submit (via email) your solver.

3. Modify your NR-solver with line search to incorporate a BFGS update. Compare the number of iterations required within each step to that obtained in 1). Submit (via email) your solver.