Assignment 3 ME 562 Inelastic Continuum Mechanics Spring/2015

(25 points) Due Mar. 31

The purpose of this assignment is to write a driver program for evaluating constitutive equation subroutines and to write constitutive equation subroutines for orthotropic elasticity. Assume total strain increments are given. The object is to provide all components of stress and strain for each step. The logic and details are open but you must be able to show that your program works.

Set up a matrix of variables to include (at least) columns consisting of load step and/or time, stress components, strain components, volumetric strain, P and other variables such as q_1 and q_2. Be sure you have the capability to plot any one column against any other with appropriate headings. Use such plots to demonstrate your program is working for the following problems. Because elasticity is linear only one step is required for each leg of a loading path. However, use 10 steps to show your algorithm is working correctly because other constitutive equations are nonlinear and 10 to 100 steps will be required for each leg. To terminate a leg, allow for specifying the total number of steps, a limiting value for strain, or a limiting value of stress. Use simple but illustrative plots to demonstrate that your program is working correctly.

1. First write the driver program and an elastic constitutive equation subroutine based on anisotropic elasticity with the assumption of orthotropic symmetry. Read in material data as Young's moduli, shear moduli and Poisson's ratios and obtain the components of the elasticity matrix.

Show that your driver program is able to handle uniaxial strain and plane strain by prescribing zeros for particular components of increments in strain. Since the constitutive equation is linear and rate independent, you can verify that the end points of your plots (your choice) agree with your analytical solutions.

2. Show that you can do cyclic paths by doing the following:

2.1 Provide a cycle in uniaxial strain, e_{11}, with upper and lower values of σ_{11}.

2.2 Provide one rectangular cycle in e_{11} - e_{12} strain space. Plot the corresponding path in σ_{11} - σ_{12} stress space

(Such cycles would be performed hundreds of times to simulate fatigue tests.)

3. Add appropriate constraint options within your constitutive equation subroutine and show that you can obtain stress and strain for uniaxial stress, hydrostatic stress, triaxial compression and triaxial extension. Provide sufficient plots to indicate your algorithms are working correctly. Show that you can do one cycle of uniaxial stress with prescribed maximum (positive) and minimum (negative) values of stress.