MEGN 517A Inelastic Constitutive Relations

Homework 4

Due: 4/7/2016

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1. Implement a 1D macroscopic model for superelastic stress-strain response in shape memory alloys (SMA) using the algorithm discussed in the class. Assume uniaxial tension. You can use the following material parameters.

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E = 110e3; % Young's modulus (MPa)
theta_as = 253; % Transformation temperatures (K)
theta_ms = 173;
theta_t = (theta_ms + theta_as)/2.0; % A-M equilibrium temperature
theta = 323; % Test temperature (K) must be > theta_as
L = 80; % Latent heat (MJ/m^3)
lambda_dot_0 = 20; % Kinetic coefficient in the martensite volume evolution equation
d_lambda_crit  = L*(theta_as - theta_ms)/(theta_as + theta_ms); % Critical driving force for phase transformation
```

   a. In addition to the material parameters, you will define simulation parameters like total number of increments, stress, strain, maximum strain, time, timestep, transformation strain (ε_m) etc.
   b. The transformation temperature θ_{T} (theta_t) is typically calculated in terms of two other temperatures that characterize the phase transformation θ_{AS} and θ_{MS} (theta_as, theta_ms). Always $\theta_{\mathrm{AS}} > \theta_{\mathrm{MS}}$.
   c. Clearly specify the assumptions that you made when implementing this model and submit the source code.

2. Calibrate the material parameters in the model to fit the following stress-strain curve for NiTi SMA. (Plot from P. Thamburaja, L. Anand, Polycrystalline shape-memory materials: Effect of crystallographic texture, Journal of the Mechanics and Physics of Solids. 49 (2001) 709–737.)