ETH Zurich
Department of Mechanical and Process Engineering
Winter 06/07
Nonlinear Continuum Mechanics
Exercise 12

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1 Homework

1.1 Numerical computation of viscoelastic material

Compute the response of a General Standard Linear Solid with,

$$E_\infty = 1 \tag{1}$$
$$E_1 = 1 \tag{2}$$
$$\eta_1 = 10 \tag{3}$$
$$\tau = \frac{\eta_1}{E_1}\,. \tag{4}$$

Use the following numerical algorithm introduced in class.

Algorithm: Given σ^n_{neq} and ε^{n+1}, compute σ^n.

1. Compute σ^{n+1}_{eq}.

$$\sigma^{n+1}_{eq} = E_\infty \varepsilon^{n+1}$$

2. Compute σ^{n+1}_{neq}.

$$\sigma^{n+1}_{\text{neq}} = e^{\frac{-\Delta t}{\tau}} \sigma^n_{\text{neq}} + e^{\frac{-\Delta t}{2\tau}} \frac{E_1}{E_\infty} \left[\sigma^{n+1}_{\text{eq}} - \sigma^n_{\text{eq}}\right]$$

3. Compute σ^{n+1}.

$$\sigma^{n+1} = \sigma^{n+1}_{\text{neq}} + \sigma^{n+1}_{\text{eq}}$$

Compute the time history stress response for the following two cases.

1.1.1 Creep test

Apply a step strain,

$$\varepsilon(t) = \begin{cases} 0 & t < 0 \\ 1 & t \geq 0 \end{cases} \tag{5}$$

and compute the stress. Plot the stress time history response.

1.1.2 Frequency response

Apply a sinusoidal strain history,

$$\varepsilon(t) = \begin{cases} 0 & t < 0 \\ \sin(\omega t) & t \geq 0 \end{cases} \tag{6}$$

with varying frequencies, $\omega = 0.01,\ 0.1,\ 1.0$. Plot the stress time history response and stress-strain relationship for each frequency.