CE7620: Rheology of Civil Engineering Materials
Project – 1

Tasks: For the spring and dash pot arrangement assigned to your group:

A. Find the relation between the stress, stress rate, strain, and strain rate
B. Using an appropriate jump condition
   i. Find the stress response for an applied constant strain
   ii. Find the strain response for an applied constant stress
C. Find the response for oscillatory loading, $\sigma = \sigma_o \sin(\omega^c t)$
D. Find the response for oscillatory displacement, $\epsilon = \epsilon_o \sin(\omega^R t)$
E. Find the response for a simply supported beam subjected to constant uniformly distributed load.
F. Using the above results find the stress relaxation function, G and creep compliance function, J. Then verify the following:
   i. G(0)×J(0) = 1
   ii. G(∞)×J(∞) = 1
   iii. $1 = J(0) \times G(\tau) + \int_0^\tau G(\tau - s) \left.\frac{dJ}{dt}\right|_{t=s} ds$
G. Also compute the following:
   i. Apparent viscosity, $\eta = \int_0^\infty G(t)dt$
   ii. Characteristic creep times, $\tau_1^c = \frac{[J(\infty)-J(0)]}{\left.\frac{dJ}{dt}\right|_{t=0}}$, $\tau_2^c = \frac{\int_0^\infty s[J(\infty)-J(s)]ds}{\int_0^\infty [J(\infty)-J(s)]ds}$,
   iii. Characteristic relaxation times, $\tau_1^R = \frac{[G(0)-G(\infty)]}{\left.\frac{dG}{dt}\right|_{t=0}}$, $\tau_2^c = \frac{\int_0^\infty s[G(s)-G(\infty)]ds}{\int_0^\infty [G(s)-G(\infty)]ds}$
H. Comment on the obtained characteristic times and the apparent viscosity.
I. Compute the following for the oscillatory loading and oscillatory displacement:
   i. Phase lag between the stress and strain
   ii. Do a Fourier transform of the response and plot the amplitude versus frequency for the following: $\omega^j = \{\frac{1}{100}, \frac{1}{10}, 1, 10, 100\}\tau_1^j$, where j = C or R
J. Comment on the phase lag and the observed predominant frequencies in the response based on the results in part I.

CE21D750 & CE21D035 Spring and dashpot as arranged in the figure 1a in the next page.
CE20D069 & CE21D036 Spring and dashpot as arranged in the figure 1b in the next page.
CE20M041 & ME21S030 Spring and dashpot as arranged in the figure 1c in the next page.
CE20D031 & CE20D406 Spring and dashpot as arranged in the figure 1d in the next page.

Assume suitable values for the spring stiffness and viscosity for the dashpot. You can do a parametric study varying the model parameters also.

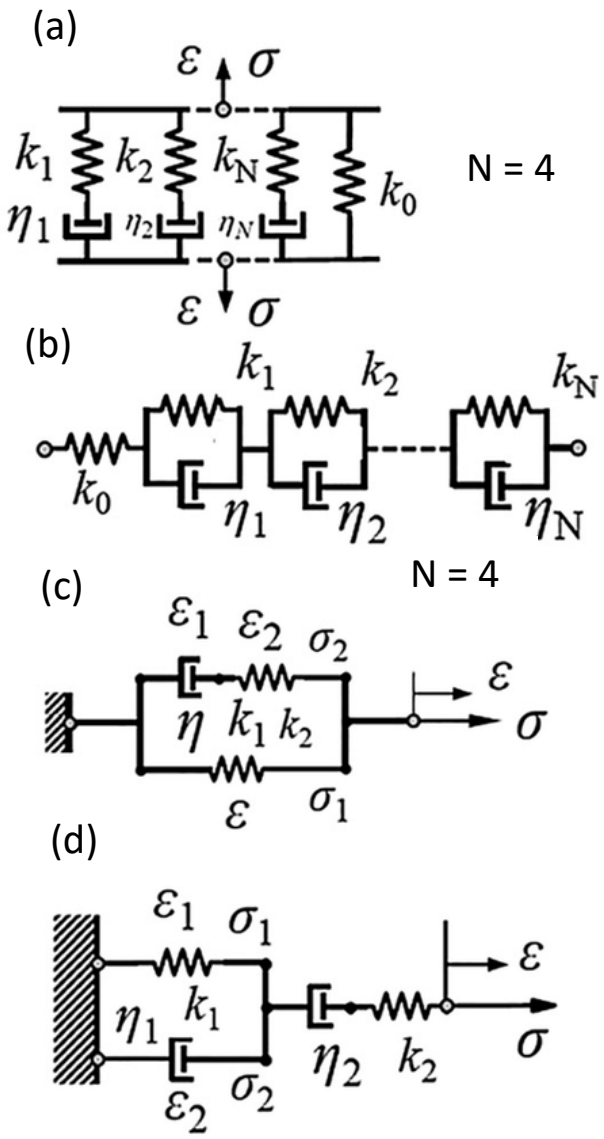

Figure 1: Various spring and dashpot arrangements