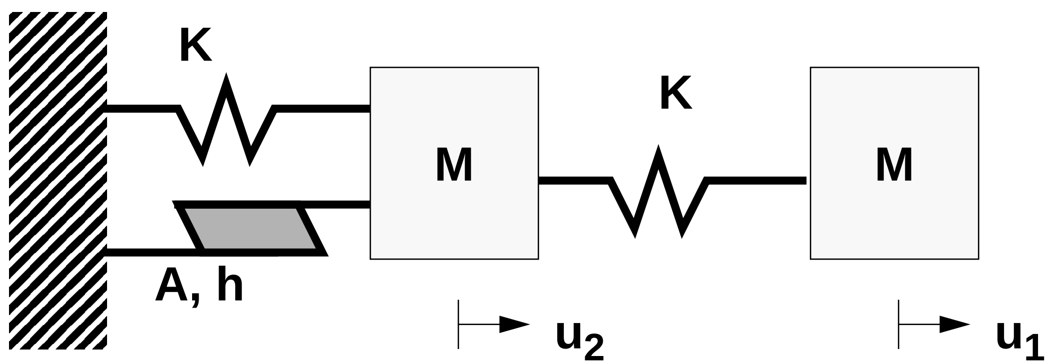
Take Home Final Exam
A Damping Problem

You may use any references, but do not ask anyone for help.

Please put you finished exams in an envelope and place that in my mail slot no later than noon Wednesday 16 December 1998.

We consider a structure such as that shown below



We have two masses, two springs, and a shear damper.The cross sectional area of the damper is A and the thickness of the damping material is h. The damping material is that discussed earlier. For $M = 300$ kg; $K = 1.0\times10^8$ N/m; $A = 0.01$ m^2, and $h = 0.01$ m

Problem

Use Matlab in any parts of the following that you wish

1. **Solving the governing equation in frequency space, plot the magnitude of the driving point frequency response function versus frequency.**

2. **From the above, calculate the fraction of critical damping for each mode using half-power points.**

3. **Using the modal strain energy method, calculate the fraction of critical damping for each mode. These should be similar to the values calculated above.**

4. **Find the elastic eigenmodes and frequencies. You may ignore the slider for this, but you must tell me why.**

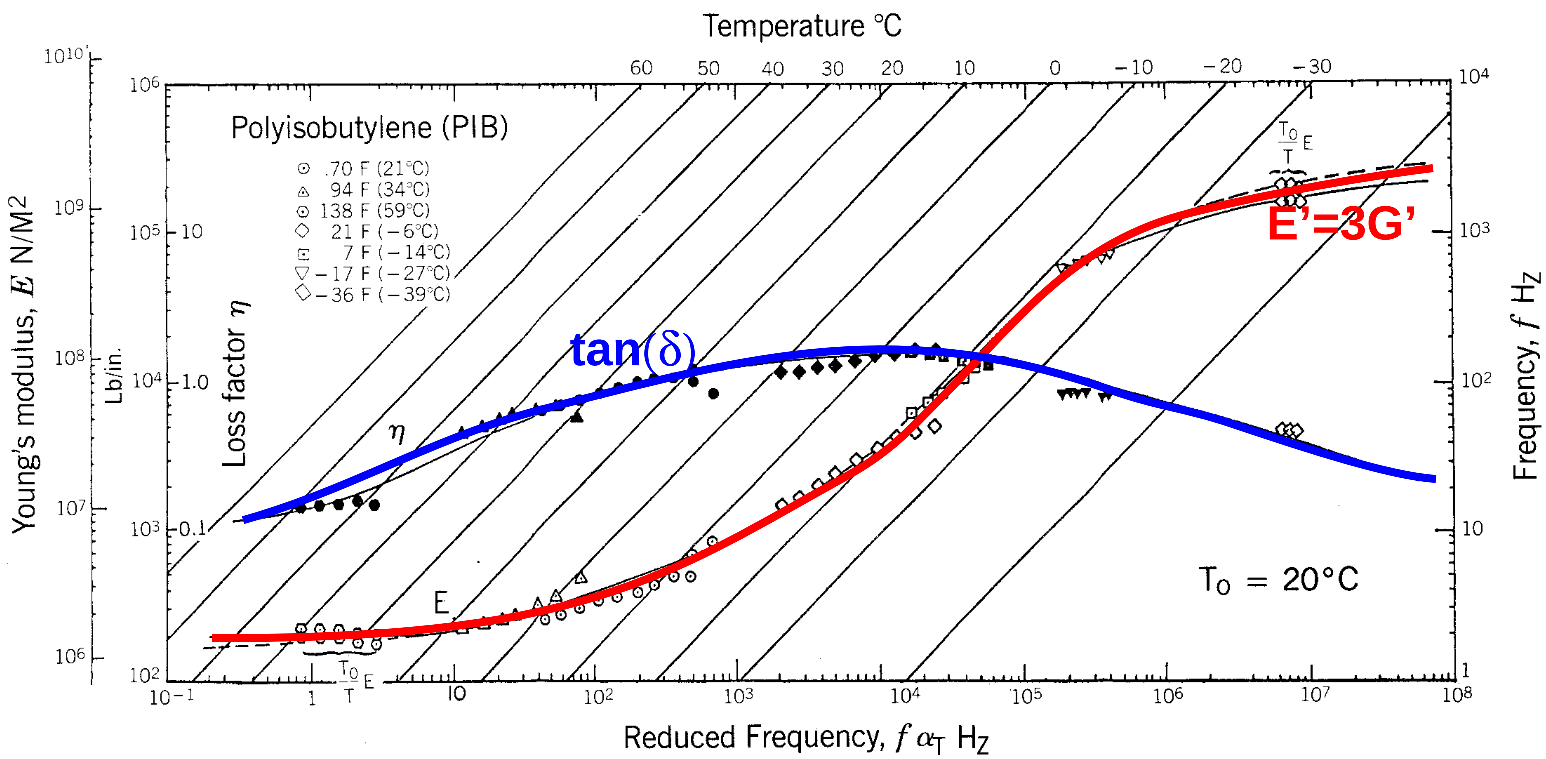
5. **Assuming modal damping, solve the problem for the following initial conditions:**

   $$u_1(0) = 0, u_2(0) = 0, \dot{u}_1(0) = 1, u_2(0) = 0,$$

   and plot $\dot{u}_1(t)$ and $\dot{u}_2(t)$ for several cycles of the lower frequency.

The Damping Material

The following plot for polyisobutylene is taken from “Vibration Damping” by Nashif et. al.



011C. Nomogram.

Interpolating Functions

We can fit the above plots reasonably well in $0.1 < \frac{\omega}{2\pi} < 10^5$ **by**

$$Log(3G'(\omega)) = Log(E'(\omega)) = 6.2 + 0.0112\left(Log\left(\frac{\omega}{2\pi}\right)\right)^{3.3}$$ **or**

$$G'(\omega) = 10^{5.72 + 0.0112\left(Log\left(\frac{\omega}{2\pi}\right)\right)^{3.3}}$$ **and**

$$Log(\tan\delta(\omega)) = -1 + 0.56Log\left(\frac{\omega}{2\pi}\right) - 0.069\left(Log\left(\frac{\omega}{2\pi}\right)\right)^{2}$$ **so**

$$G''(\omega) = G'(\omega)\tan\delta(\omega)$$

$$= 10^{4.72 + 0.56Log\left(\frac{\omega}{2\pi}\right) - 0.069\left(Log\left(\frac{\omega}{2\pi}\right)\right)^{2} + 0.0112\left(Log\left(\frac{\omega}{2\pi}\right)\right)^{3.3}}$$