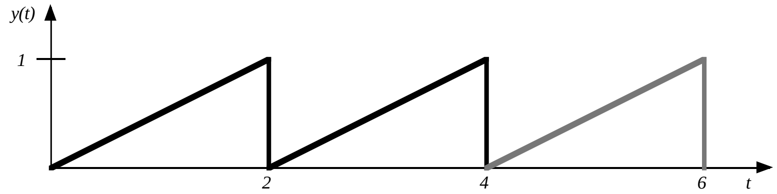
ME 460/660, Mechanical Vibration Exam 2, Fall 2010

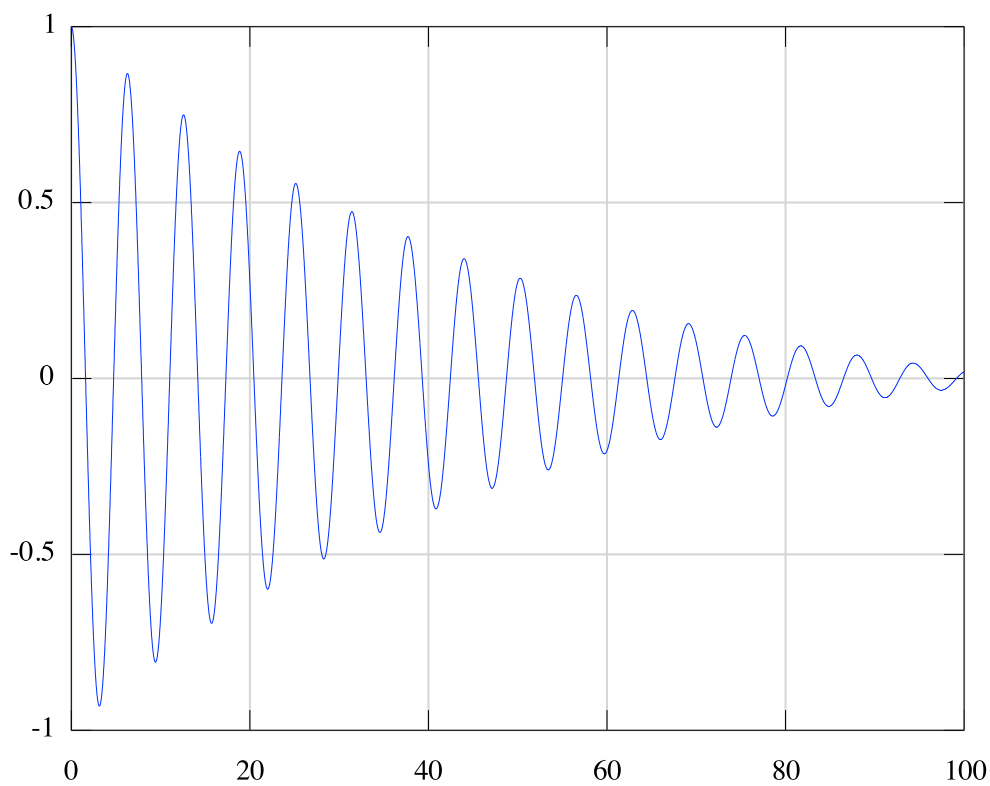
Closed book, closed notes. Use $8\frac{1}{2} \times 11$ formula sheet from web and turn in with exam (nothing else may be written on the formula sheet). Test books will be provided. Calculators allowed. Knowing how to use them well is highly recommended.

Problems are 10 points each. Problem 4 is required for graduate students, bonus for undergraduates (worth 6 points).

1. Determine the Fourier Series representation of the function shown below.



2. Given air damping, viscous damping, and Coulomb damping, determine which (may be one OR two) is apparent in the following response. **Prove it.** You answer will be graded on the merit of your explanation. No points will be given for a guess without sufficient explanation.



3. For the system defined by

$$M = \begin{bmatrix} 10 & 0 \\ 0 & 100 \end{bmatrix}, \qquad K = \begin{bmatrix} 10 & -10 \\ -10 & 100 \end{bmatrix} \tag{1}$$

(a) Find the mass normalized mode shapes

(b) Find the natural frequencies

(c) Prove or disprove that the mass normalized mode shapes are

$$S = \begin{bmatrix} 0.953 & 0.953 \\ 0.302 & -0.302 \end{bmatrix} \tag{2}$$

4. *Grad student/bonus* (20% of other points) Determine the first natural frequency and mode shape for a clamped-pinned beam. The equation of motion of a beam is $\left(\frac{EI}{\rho A}\right) \frac{\partial^4 w(x,t)}{\partial x^4} + \frac{\partial^2 w(x,t)}{\partial t^2} = 0$. Yes, you have to obtain all constants that can be obtained.