ME 460/660, Mechanical Vibration — Exam 2, Spring 2009

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.

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

1. A system governed by the differential equation $10\ddot{x} + 1\dot{x} + 8.8826 \times 10^4 x = f(t)$ is excited by the force $f(t) = \sum_{n=1}^{\infty} a_n \cos \frac{2\pi n}{T} t$ where $a_n = \begin{cases} 0 & \text{n odd} \\ \frac{-8}{n^2\pi^2} & \text{n even} \end{cases}$ and $T = 0.2$. Find the terms in the series approximation for $x(t)$ corresponding to $n = 3$ and $n = 4$.

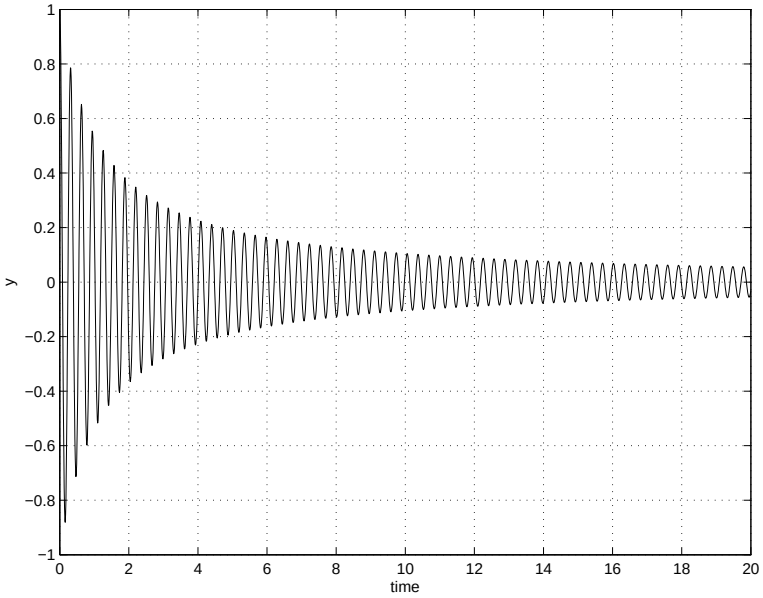
2. Find the pulse response of an undamped system defined by

$$\ddot{x} + 4\pi^2 x = f(t)$$

to a force defined by

$$f(t) = \begin{cases} 1 & 0 < t < 1 \\ 0 & 1 < t < \infty \end{cases}$$

3. Given air damping, viscous damping, and Coulomb damping, determine which is (there is only 1) 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.



4. *Grad student/bonus*
Determine the natural frequencies and mode shapes for simply supported beam. The equation of motion of a bar is $\left(\frac{EI}{\rho A}\right) \frac{\partial^4 w(x,t)}{\partial x^4} + \frac{\partial^2 w(x,t)}{\partial t^2} = 0$. (20% of other points)