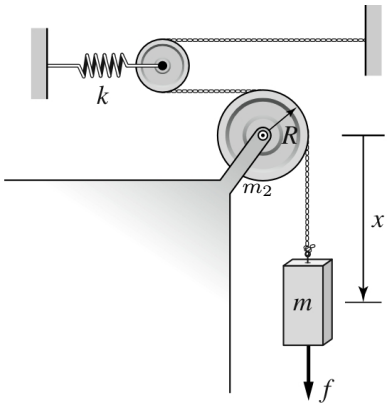
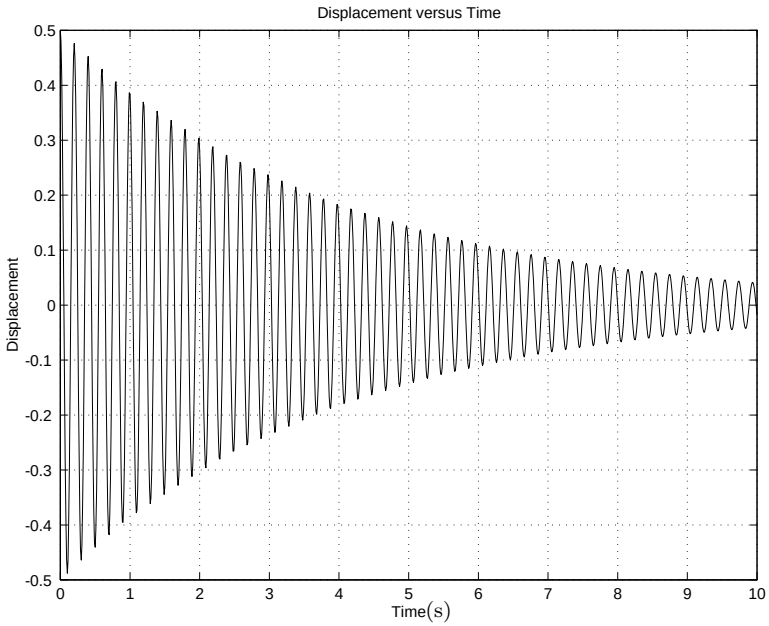
ME 460/660, Mechanical Vibration — Midterm, Spring 2009

Closed book, closed notes. Test booklets will be provided. Formula sheet must be turned in with the exam. Formula sheet must be exactly the same as that posted on the web site. Calculators allowed. Problem 4 is required for graduate students.

1. For the SDOF forced system modeled by $10\ddot{x} + 5\dot{x} + 1000x = 1\dot{y}$:
   (a) Find natural frequency
   (b) Find the damped natural frequency
   (c) For $y(t) = 10\sin(10t)$, find $x(t)$
   (d) For $y(t) = 10\sin(100t)$, find $x(t)$
   (e) For $y(t) = 10\sin(10t)$, find the amplitude of the force in the spring
2. Obtain the equations of motion for the system below to the left. Include the effect of gravity. Presume:
   (a) the pulley at the end of the spring is massless
   (b) the pulley with the radius R has a uniform mass distribution and mass m_2.



Problem 2



Problem 3

3. Estimate the damping ratio, natural frequency, stiffness, and damping coefficient of the system whose response is plotted above to the right. The mass is 10kg.
4. *Grad student/bonus:* Determine the natural frequencies and mode shapes for a free-clamped (at $x = l$) circular cross section torsion rod. The equation of motion of a torsion rod is $\left(\frac{G}{\rho}\right)\frac{\partial^2 w(x,t)}{\partial x^2} = \frac{\partial^2 w(x,t)}{\partial t^2}$. (20% of other points)