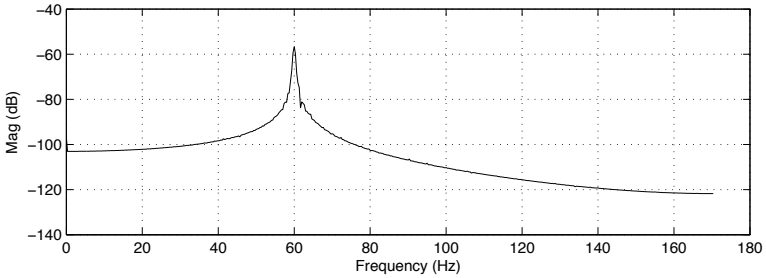
ME 460/660, Mechanical Vibration — Midterm, Fall 2008

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.

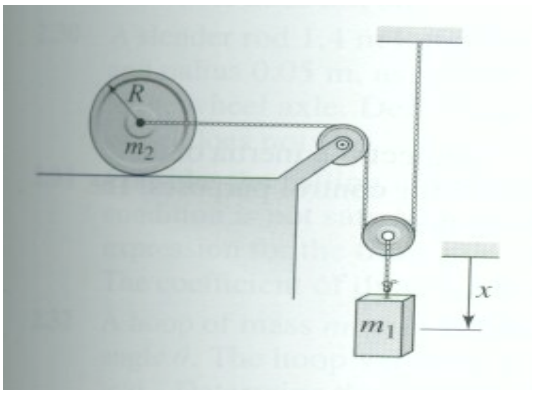
1. For the SDOF forced system (model of $m\ddot{x} + c\dot{x} + kx = f(t)$) with the frequency response function $\frac{X(j\omega)}{F(j\omega)}$ below, estimate a) The natural frequency, b) stiffness, c) mass, d) damping coefficient, and e) the amplitude of the *dashpot force* if the system is driven at 80 Hz.

   Note: Amplitude is plotted in dB, 20*log$_{10}$(X/F)



2. Solve $\ddot{x} + .1\dot{x} + 100x = 0$ for $x(t)$ given $x_0 = 0$ and $v_0 = 1$. Is the system underdamped, overdamped, or critically damped?

3. The following system isn't stable. If $m_1 = m_2 = 10$ kg and $R = .1$ m, what value of stiffness k would a horizontal spring connecting the center of the disk to a brace on the left would be needed to achieve a system natural frequency of 5 Hz?



4. *Grad student/bonus:* Determine the natural frequencies and mode shapes for a free-free 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)