

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 what is posted on the web site.

1. What does a dashpot (damper) do with energy? Where does the energy go (give two examples). (15 points)
2. Exposure to 18 g (18 times gravity) acceleration causes permanent brain damage. At 1000 Hz, what displacement amplitude is this? (15 points)
3. Sketch the free response of an underdamped system, labeling T and the equation for the decay envelope. (10 points)
4. Sketch the forced response of an underdamped system to a sinusoidal excitation for:
 - (a) A driving frequency close to the natural frequency. (10 points)
 - (b) A driving frequency equal to the natural frequency. (10 points)

Label each figure clearly, and explain how they relate to one another.

5. Derive the equation of motion of the system shown below for large angles. The spring is unstretched at the vertical position. The mass slides freely from left to right without friction. Hint: Pythagorean. (25 points)
6. *Grad student/bonus* Determine the natural frequencies and mode shapes for a clamped-spring bar. The equation of motion of a bar is $\left(\frac{E}{\rho}\right) \frac{\partial^2 w(x,t)}{\partial x^2} = \frac{\partial^2 w(x,t)}{\partial t^2}$. (20% of other points)