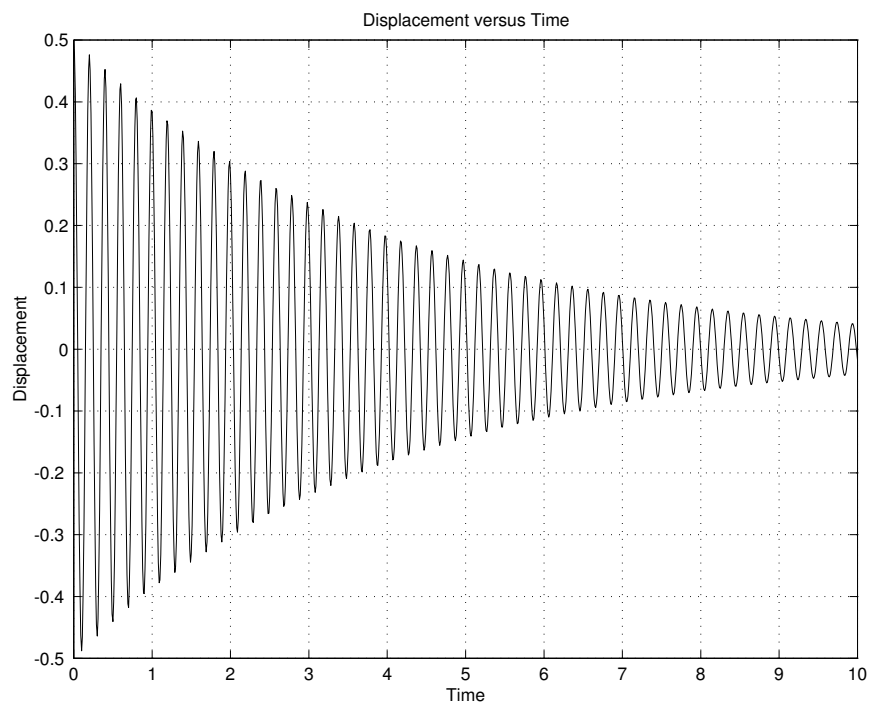


Closed book, closed notes. Use one $8\frac{1}{2} \times 11$ formula sheet, front and back. Test books will be provided.

1. On what law is the energy method based and when is it valid to apply the energy method? Does the same restriction apply to Lagrange's equation? (10 points)
2. What are the functions of the following devices in a vibrating system? (15 points)
 - (a) Spring
 - (b) Dashpot
 - (c) Mass
3. A machine oscillates in simple harmonic motion and appears to be well modeled by an undamped SDOF model. Its acceleration is measured to be $10,000 \text{ mm/s}^2$ at 8 Hz. What is its maximum displacement amplitude? (15 points)
4. Determine the stiffness k and damping coefficient c of the system for which a free response is shown below. The mass of the system is known to be 10 kg. (20 points)



5. An inverted pendulum with a mass m at the top is suspended between two springs with stiffness k . The rod can be assumed to be massless. Derive the equation of motion for

small motion (assume small θ). (20 points)

6. *Grad student/bonus* Determine the natural frequencies and mode shapes for a clamped-clamped bar. The equation of motion of a bar is $\left(\frac{E}{\rho}\right) \frac{\partial^2 w(x,t)}{\partial x^2} = \frac{\partial^2 w(x,t)}{\partial t^2}$. (16 points)