ME 460/660, Mechanical Vibration
Exam 1, Fall 1998

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? (10 points)

   (a) Spring

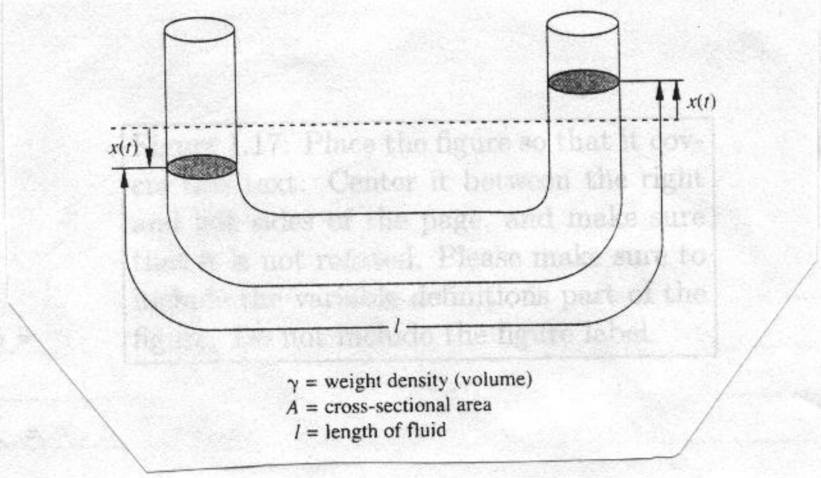
   (b) Dashpot

   (c) Mass

3. An unforced undamped system is set to vibrate with an amplitude of 10 mm. The maximum velocity is 95.5 mm/s. Then, a mass of 2 kg is added to the system. Now when the amplitude of vibration is 10 mm, the maximum velocity is 76.4 mm/s. Determine the effective mass and stiffness of the original system. (20 points)

4. An airplane wing vibrates wildly when the piston engine passes through a speed of 6,000 RPM. Tests reveal that when the engine stalls (stops running suddenly), it takes 1 second for the amplitude of the motion to drop to 50% of its original amplitude. What is the damping ratio of the wing? (20 points)

5. Determine the equation of motion of the following device. (20 points)



ME 460/660 Soln to Exam, Fall '98

1) a) Conservation of Mechanical Energy
b) Only when there is no energy dissipation and no external force
c) No

2) a) Store potential energy
b) dissipate energy
c) Store Kinetic energy

3) $V_{max_1} = 95.5$ mm/s , $X_{max_1} = 10$ mm/s

$\omega_1 = 9.55$ rad/s

$V_{max_2} = 76.4$ mm/s , $X_{max} = 10$ mm/s

$\omega_2 = 7.64$ rad/s

$\omega_1 = \sqrt{\frac{K}{m}}$ $\omega_2 = \sqrt{\frac{K}{m+2}}$

$K = m \, 9.55^2$ $K = (m+2)\, 7.64^2$

$9.55^2 m = 7.64^2 m + 2 \cdot 7.64^2$

$m = \frac{2 \cdot 7.64^2}{9.55^2 - 7.64^2} = \underline{3.556 \text{ Kg}}$

$K = \underline{324.3 \text{ N/m}}$

4) $\omega_p = 6000 \text{ rpm} = 100 \text{ Hz} = 200\pi \text{ rad/s}$

$$e^{-\zeta\omega t} = .5 \quad @ \quad t = 1$$

$$-\zeta\omega = \ln .5$$

$$\zeta = \frac{-\ln .5}{\omega} = \underline{1.1\times10^{-3}}$$

5) $$T = \frac{1}{2} m \dot{x}^2$$
$$= \frac{1}{2}\frac{\gamma}{g} A l \dot{x}^2$$

$$U = m g h$$
$$= \left(\frac{\gamma}{g} A x\right) g x$$
$$= \gamma A x^2$$

$$\frac{d}{dt}\left(\frac{\partial T}{\partial \dot{x}}\right) + \frac{\partial U}{\partial x} = 0$$

$$\frac{\gamma}{g} A l \ddot{x} + 2\gamma A x = 0$$ done

$$\frac{l}{g}\ddot{x} + 2x = 0$$

$$\omega = \sqrt{\frac{2g}{l}}$$