ME 460/660, Mechanical Vibration Final Exam, Fall 2007

Closed book, closed notes. Use one $8\frac{1}{2} \times 11$ formula sheet (brought by student) and turn in with exam. Test books will be provided. All problems are to be done in the test book.

Short answers (2 points each). **Answer in blue book only**.

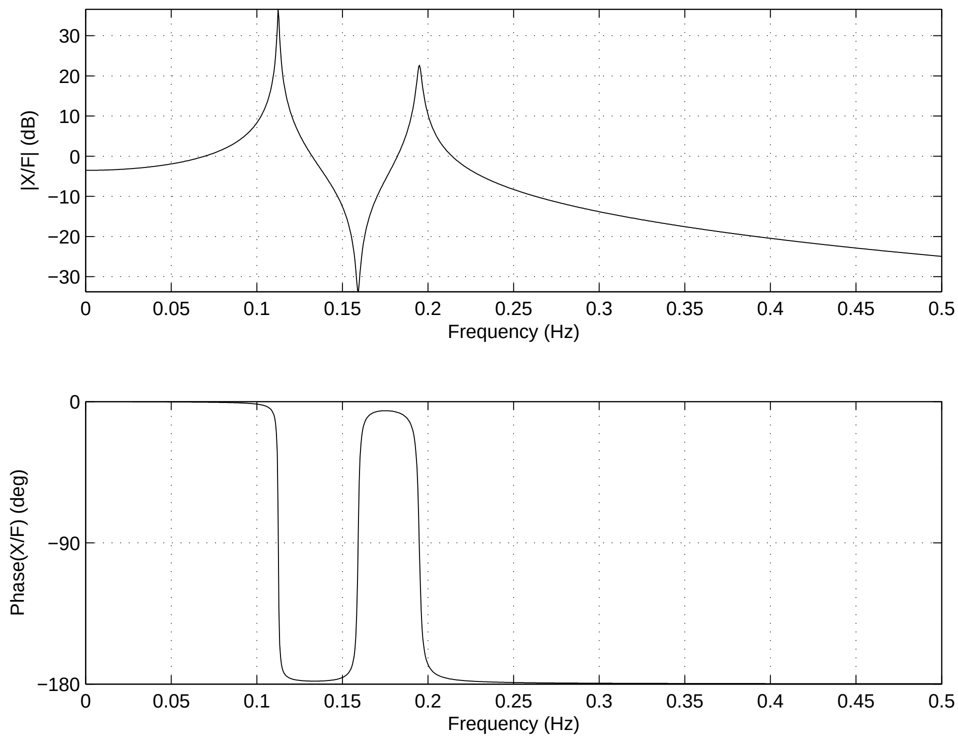
1. The type of material (or the effect) that generated voltages from stresses in load cells and accelerometers is:
2. What advantage does a seismometer have over piezoceramic type accelerometer when used as an accelerometer?
3. Which of the following parameter(s) has(ve) *no* effect on the steady-state frequency of response to harmonic excitation for a linear system: mass, damping, natural frequency, driving frequency.
4. The impulse response of system is

$$x(t) = 10e^{-.01t}\sin(.9t)$$

   write the homogeneous (unforced) equation of motion.
5. Why should you use Lagrange's equations instead of the Energy Method to derive equations of motion? (no more than two sentences)
6. Are mode shapes orthogonal to one another? If so, how?
7. The modal summation method takes advantage of **what property** of **what items** to significantly reduce computational effort.
8. In practice, what method is used in place of the convolution integral for solving for system responses.

Long problems. 10 points each.

1. A linear system has the Frequency Response Function shown in the following figure.

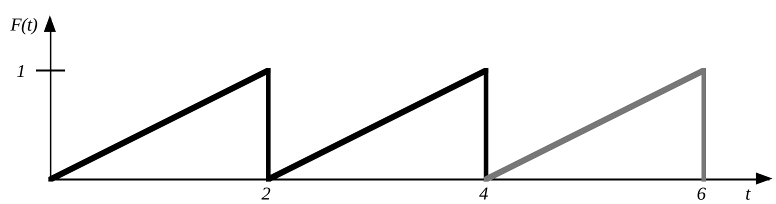


(a) Fill in the following table:

F (m)	f_{dr} (Hz)	$\lvert X \rvert$	$\measuredangle X$ (deg)
10	0.1		
2	0.15		
1	0.2		

(b) For $F(t) = 10\sin(0.2\pi t + .3)$, write $x(t)$.

2. Find the Fourier series of $F(t)$ shown below



3. Find the natural frequencies and mode shapes for the MDOF system with

$$M = \begin{bmatrix} 100 & 0 \\ 0 & 200 \end{bmatrix} \qquad \text{and} \qquad K = \begin{bmatrix} 3000 & -1000 \\ -1000 & 4000 \end{bmatrix}$$

The mode shapes need not be mass normalized!

4. A MDOF system is released from rest has modes of

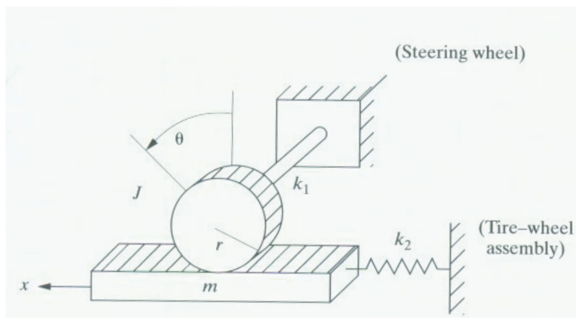
$$S = \frac{1}{\sqrt{2}} \begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}$$

no damping, and natural frequencies of 3 rad/sec and 10 rad/sec. It has initial conditions of

$$\mathbf{x}(0) = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$$

Find $\mathbf{x}(t)$.

5. Obtain the equations of motion the following system.



6. Graduate Students/Undergraduate Bonus (20%): Solve for the steady-state (particular) response of the following system if the boundary conditions are presumed to be fixed-fixed ($0 < x < l$) where $c = \sqrt{\tau/\rho}$.

$$w_{tt}(x,t) - c^2 w_{xx}(x,t) = 100\delta(x - \frac{l}{2}) \sin(3t)$$

Recall that the integral of a Dirac delta function times another function is equal to the "another function" evaluated when the argument of the argument of the Dirac delta function is zero.

BONUS: What is $h(t)$ called? What is $H(j\omega)$ called? What is the relationship between them? (4 points)