ME 460/660, Mechanical Vibration — Final Exam, Spring 2001

Closed book, closed notes. Use one provided $8\frac{1}{2} \times 11$ formula sheet and turn in with exam. Test books will be provided. **Do all work on the exam pages** with the exception of the full length problems. Full length problems are to be done in the test book.

Circle the letter**s** of the correct answers. Each question may have multiple correct answers. Circle each correct answer for each problem. *Read all questions very carefully.* One point for each correctly circled or not circled item. (30 points total)

1. What modeling method/s apply for determining the system equations of motion when Coulomb damping is present in a system?

   a. Lagrange's Equations

   b. Newton's Law

   c. The Energy Method

   d. The Fourier method

2. A linear-undamped SDOF system is excited at 9 Hz ($F = 10\cos(18\pi t)$). It has a natural frequency of 10 Hz. Assuming zero initial conditions, its frequency of motion will be:

   a. 9 Hz

   b. 10 Hz

   c. 9.5 Hz

   d. 19.5 Hz

3. The settling time of a system can be changed by modifying . . .

   a. m

   b. c

   c. k

   d. η

4. Gravity may **always (as in "for any system")** be neglected in determining

   a. ω

   b. ω_d

   c. ω_{dr}

   d. Stresses in a vibrating system

   e. m

5. Damping has the greatest impact on the response of most systems system

   a. near $r = 0$

   b. near $r = 1$

   c. near $r = \infty$

   d. When the forcing function is random

6. The convolution integral

   a. can be used to obtain the response to an excitation of any form

b. will not give the correct answer for a harmonically excited system

c. applies only for impulse excitations

d. only applies to free response

7. Coulomb damping

a. works best at resonance

b. works worst at resonance

c. is a precise model of friction damping

d. is equivalent to (the same as) viscous damping

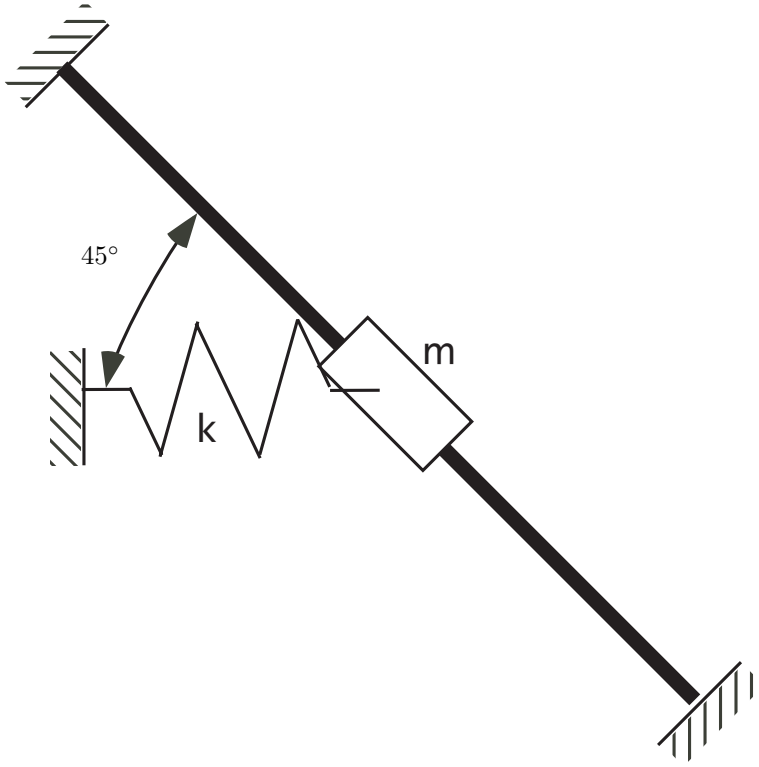
Full Length Problems (20 points each)

1. Find the natural frequencies of a system for which the mass normalized mode shapes and stiffness matrix are

$$S = \begin{bmatrix} 0.40825 & 0.70711 \\ 0.40825 & -0.70711 \end{bmatrix}, \qquad K = \begin{bmatrix} 65 & -35 \\ -35 & 65 \end{bmatrix}$$

2. Find the response of a SDOF undamped system to a force defined by $F(t) = 20$ N for $0 < t < 2$ sec and $F(t) = 10$ N for $2 < t$ sec.

3. Obtain the equations of motion for the system below. The spring is shown in its unstretched configuration and has a length l. *Include the effect of gravity.*



4. Graduate Students/Undergraduate Bonus (25%): Solve the following equation for the steady state response $w(x,t)$ where $c = \sqrt{\tau/\rho}$.

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

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: For problem 1, what is the mass matrix? (5 points)