Name ______________________________

EM406
Examination II
October 26, 2006

Problem	Score
1	/25
2	/35
3	/40
Total	/100

Show all work for credit
AND
Stay in your seat until the end of class
AND
Turn in your signed help sheet

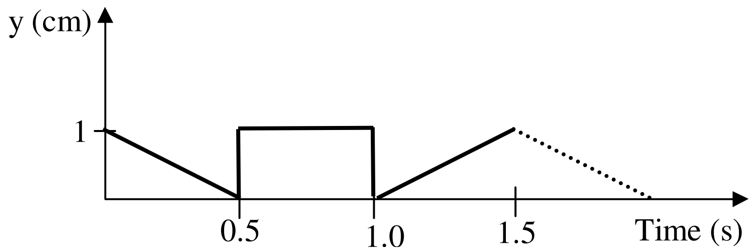
NOTE: Do not get bogged down on short answer problems!

Name ___________________________________ 25 pts

EM406 Examination III **Problem 1** October 26, 2006

Problem 1.1

A second order system is forced with a periodic input as shown below (only the portion of the input displacement for t>0 is shown – the dotted line is the beginning of the next cycle).



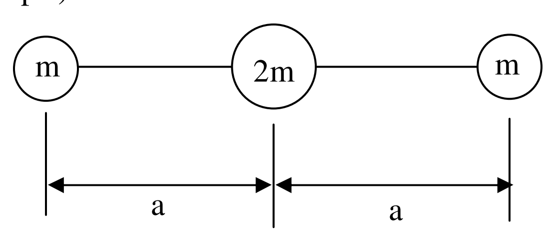
Determine

a) What is the fundamental frequency of the input? (4 pts)

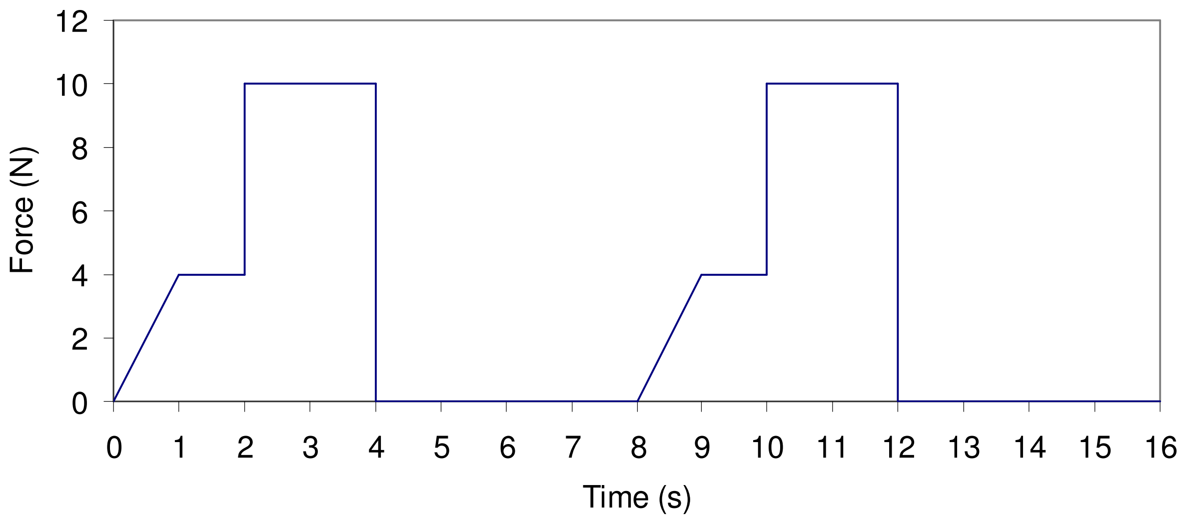
b) Is the function odd, even or neither? What is the implication of this when you look at your Maple worksheet results? (4 pts)

c) What is a_0 for this function? (4 pts)

Problem 1.2 What is the mass moment of inertia of the system shown below about its center of gravity? Assume each of the masses is a point mass (4 pts)



Problem 1.3 (4 pts)
Two cycles of a general periodic forcing function is shown below. **Write the Maple command** to input this particular function into the Fourier series worksheet provided to you earlier this quarter.



Problem 1.5 (5 pts)
Given experimental time responses for a system how can you determine the magnitude and phase of the frequency response function in Matlab?

Name ____________________________________ 35 pts
EM406 Examination III **Problem 2** October 26, 2006

A 2-DOF linear dynamic system has the mass and stiffness matrices given below.

$$M = \begin{bmatrix} 1.04 & 0 \\ 0 & 1.04 \end{bmatrix} \quad \text{and} \quad K = \begin{bmatrix} 10 & 3.2 \\ 3.2 & 25.36 \end{bmatrix}.$$

a) Write down the characteristic polynomial of the system. Do not find the roots of this polynomial, and you do not need to simplify the polynomial in any way. (7 pts)

b) The natural frequencies of the dynamic system are $\omega_1 = 3.0$ rad/sec and $\omega_2 = 5.0$ rad/sec. The mode shape associated with the first natural frequency is $\begin{bmatrix} 1 \\ -0.2 \end{bmatrix}$. Find the mode shape associated with the frequency $\omega_2 = 5.0$. (8 pts)

c) Specify an initial displacement pattern, $\begin{bmatrix} X_1 \\ X_2 \end{bmatrix}$, which would produce a free vibration having the single frequency $\omega_1 = 3.0$ rad/sec. You may assume zero initial velocity. (5 pts)

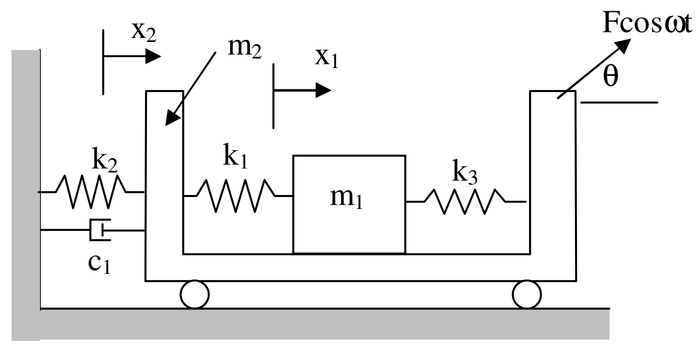
d) Suppose the initial displacement pattern for a free vibration was $\begin{bmatrix} 1 \\ 0 \end{bmatrix}$. Assume zero initial velocity and determine the time responses for x_1 and x_2. (15 pts)

Name ___________________________________ 40 pts

EM406 Examination III **Problem 3** October 26, 2006

The 2-DOF system shown below is forced harmonically with the force Fcosωt.

a) Using Lagrange's equations determine the equations of motion for the two masses shown. Show all work for credit. Write your final equations in 2nd order matrix form by filling in the matrices shown below.



$$\begin{bmatrix} & \\ & \end{bmatrix}\begin{Bmatrix} \ddot{x}_1 \\ \ddot{x}_2 \end{Bmatrix} + \begin{bmatrix} & \\ & \end{bmatrix}\begin{Bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{Bmatrix} + \begin{bmatrix} & \\ & \end{bmatrix}\begin{Bmatrix} x_1 \\ x_2 \end{Bmatrix} = \begin{Bmatrix} \\ \end{Bmatrix}$$

(continued on next page)

b) Assuming the equations of motion are found to be:

$$\begin{bmatrix} m_1 & 0 \\ 0 & 10 \end{bmatrix} \begin{Bmatrix} \ddot{x}_1 \\ \ddot{x}_2 \end{Bmatrix} + \begin{bmatrix} 5+k_3 & -(5+k_3) \\ -(5+k_3) & 20+k_3 \end{bmatrix} \begin{Bmatrix} x_1 \\ x_2 \end{Bmatrix} = \begin{Bmatrix} 0 \\ 4\cos\omega t \end{Bmatrix}$$

determine the steady-state response of mass 2 (neglect the homogeneous solution).

c) Determine the values of k_3 and m_1 so that mass 1 acts like vibration absorber for mass 2 and mass 1 has a displacement less than 0.05.