Name _____

EM406
Examination II
October 9, 2001

Problem	Score
1	/30
2	/20
3	/20
4	/30
Total	/100

This is an closed book/closed note exam with the following conditions.

1. You are allowed a maximum of 3 hours to take the exam
2. The exam must by completed at one sitting
3. You may only use your crib sheet, existing Maple worksheets and Matlab Simulink models.
4. You are not to discuss the exam with ANYONE!

Show all work for credit
AND
Turn in your signed help sheet

Honor Statement: I pledge my honor that I neither gave nor received help on this exam, and I only worked on the test during the time allotted.

Signed _____

Start time _____ End _____

This is a take home, closed notes, closed book and closed neighbor exam. You may use the one crib sheet that you prepared prior to the exam and any existing Matlab Simulink models and Maple worksheets you developed for this class.

You have three hours to work on this exam (it shouldn't take this long, but I don't want time to be a factor.

Do not talk to anyone else in the class about the exam prior to the time it is due.

Show all work for credit. If you use Maple or Matlab, staple a printout to the exam.

Turn in the signed crib sheet

You will be required to sign an honor statement and indicate the times you worked on the exam.

The test is due at 5:00 PM on Wednesday.

Name _____ 30 pts

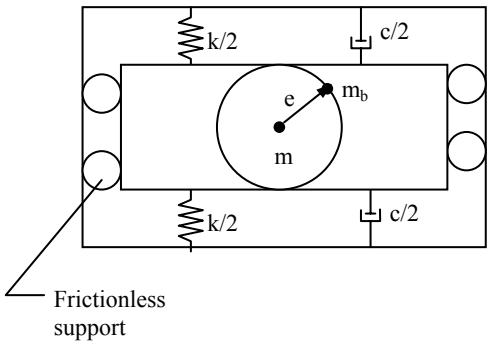
EM406 Examination II **Problem 1** October 9, 2001

A simplified model of a washing machine is illustrated below. A bundle of wet clothes forms a mass of 10 kg (m_b) in the machine and causes a rotating unbalance. The rotating mass is 20 kg (including m_b) and the diameter of the washer basket (2e) is 50 cm. Assume that the spin cycle rotates at 300 rpm. Let k = 1000 N/m and $\zeta = 0.05$.

a) Calculate the force transmitted to the sides of the washing machine.

b) Assuming the quantities, m, m_b, e, ω and the amount of damping are all fixed, design an isolation system (i.e. decide on a new value for k) so that the force transmitted so the side of the washing machine (considered as ground) is less than 100 N. Note: If you calculated a value less than 100 N in part a) you have a mistake.

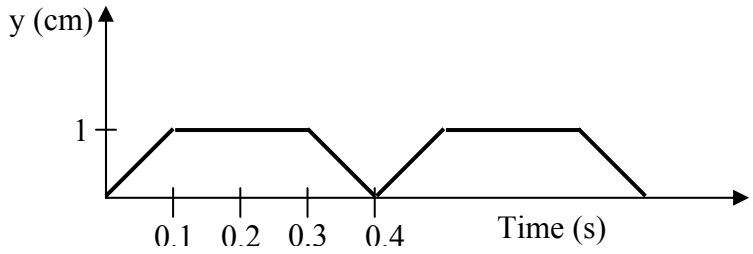
c) Discuss your model and answer. For example: Is this a good model? What assumptions are you making? Are these good assumptions in light of what you know about washing machines from personal experience? What else would you have to consider when trying to reduce the vibrations of a washing machine? Etc.

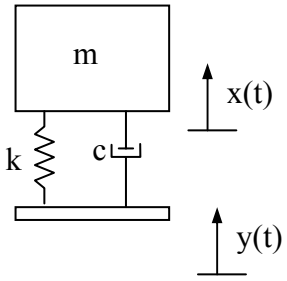


Name _____ 20 pts

EM406 Examination II **Problem 2** October 9, 2001

A second order system (m = 10 kg, k = 100,000 N/m, c = 200 N-s/m) is forced with a periodic input as shown below (only the portion of the input displacement for t>0 is shown).





Determine

a) the Fourier series for the input (write down the first 3 non-zero terms below)

b) the steady state response of the system (write down the first 3 non-zero terms below).

c) about how many terms do you need in your steady state solution to have a good approximation?

Clearly show below what you need to put in your Maple worksheet and include a printout of your Maple worksheet.

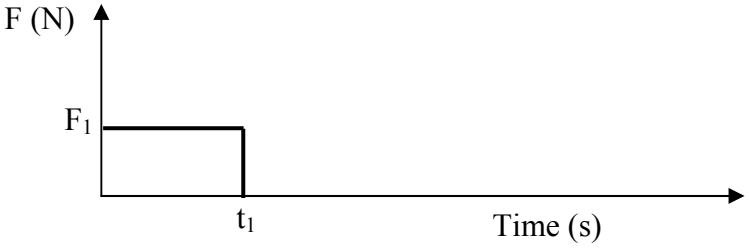
Name _____ 20 pts

EM406 Examination II **Problem 3** October 9, 2001

A second order system (m = 0.2 kg, k = 100 N/m, and c = 0.8 N-s/m) is subjected to the two situations shown below.

a) Initial conditions $x(0) = 0.01$, $\dot{x}(0) = 0.3$ m/s

b) Zero initial conditions plus the transient force shown below

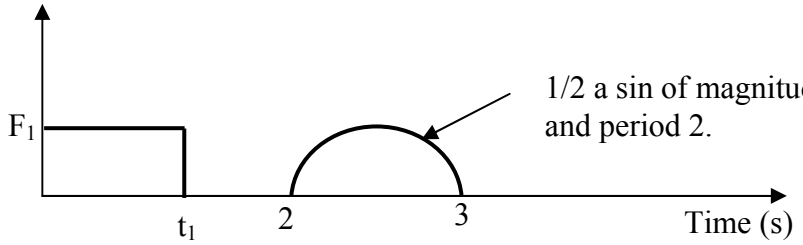


where F_1=20 N, b = 1 s.

Using Simulink determine the response of the system for the two cases shown above. Include a printout of your Simulink model, the forcing function, and the time response for $0 < t < 5$ s.

Extra Credit

Use Simulink to determine the time response when the system is subject to: zero initial conditions plus the transient force shown below (use the same F_1 and t_1 as in b)). Include a printout of your forcing function, and the time response for $0 < t < 5$ s.



Name _____ 30 pts

EM406 Examination II **Problem 4** October 9, 2001

The system shown below consists of two point masses m_1 and m_2 carried by weightless string subjected to a constant tension T. Assuming small transverse (perpendicular to the string) displacements $y_1(t)$ and $y_2(t)$

a) determine the differential equations of motion. Put in second order matrix form (10 pts)

If numbers are substituted into the equations found in part a) the following differential equations are obtained:

$$0.5\ddot{y}_1 + 200y_1 - 100y_2 = 0$$
$$0.3\ddot{y}_2 + 200y_2 - 100y_1 = 0$$

b) What are the natural frequencies of this system? (10 pts)
c) What are the natural modes of this system. Sketch them. (10 pts)