Name _____ Section _____

EM406
Examination I
September 25, 2007

Problem	Score
1	/35
2	/40
4	/25
Total	/100

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

Name _____ 35 pts

EM406 Examination I **Problem 1** September 25, 2007

It is required to mount a sensitive package of equipment in an aircraft using a spring/dashpot system in parallel as shown in Fig.Q1. The total mass of the equipment and its support platform is 4 kg and the excitation from the aircraft is 'seismic' and of the form $U = 0.001 \cos \omega t$. The operational frequency range is from 25 to 100 Hz.

The spring needs to be such that it must restrain the equipment to a deflection of no more than 5 mm when the aircraft is in a high-speed maneuver and pulling 10 g. Determine the maximum oscillatory displacement of the equipment package over the operational frequency range if the damping ratio is 0.2, and sketch the frequency response function and label any important points. **Note: Save the actual calculations until you have finished the rest of the exam.**

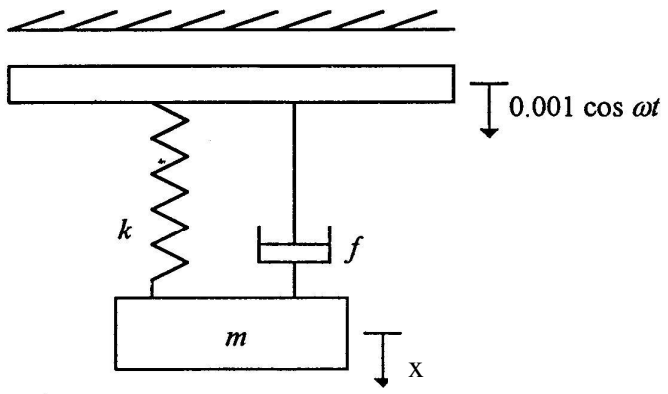


Fig. Q1.

Name _____ 40 pts

EM406 Examination I **Problem 2** September 25, 2007

A machine has a total mass of 500 kg which includes a rotor of mass 100 kg with 5 mm eccentricity and which rotates about a horizontal axis at 600 rev/min. The machine is mounted on springs of total stiffness 450 kN/m with negligible damping and is constrained to move vertically.

a) Determine the amplitude of vibration and find the damping required to reduce this to one half the original value.
b) Compare the amplitudes of dynamic forces transmitted to the support for the two mountings.

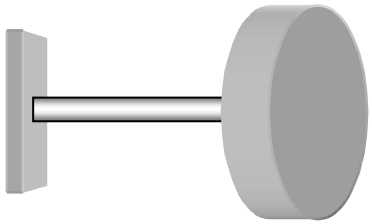
Note: Save the actual calculations until you have finished the rest of the exam. If you have clearly labeled equations, known quantities defined and unknowns listed, that is sufficient for most of the points.

Name _____ 25 pts

EM406 Examination I **Problem 3** September 25, 2007

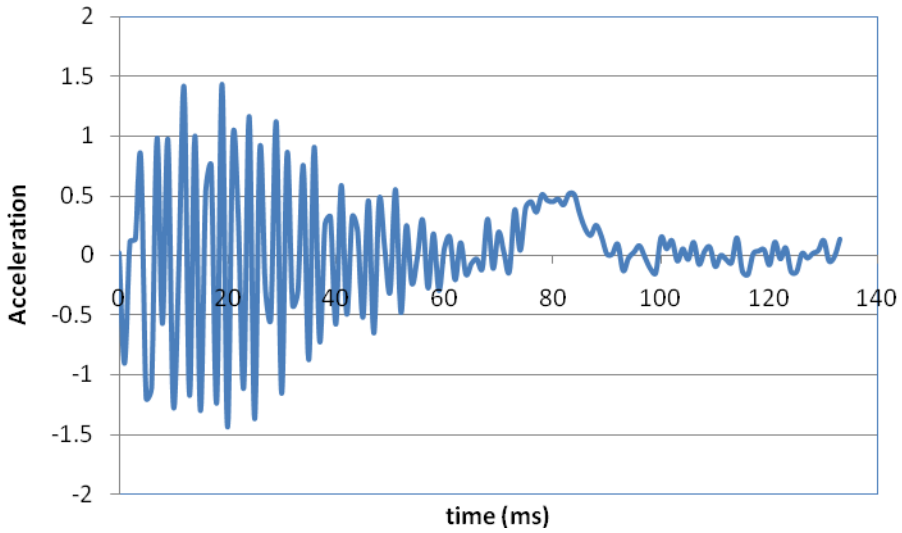
Problem 3a (6 pts)

A 10 pound rotor is coupled to a 1 ft shaft by a rigid coupling as shown below. The diameter of the steel shaft has properties: E = 30 x 10^6 psi and G = 11.6 x 10^6 psi. The area moment of inertia is 0. 1 in^4 and the area of the shaft is 0.79 in^2. What is the natural frequency of the rotor in longitudinal vibration? Neglect the mass of the shaft.



Problem 3b (3 pts)

If you took the Hilbert transform of the signal shown below sketch what you would expect to see.



Problem 3c (3 pts)

A coworker has been analyzing a system and has determined the following differential equation.

$$a\ddot{x} + b\dot{x} - dx = f(t)$$

She has not made any mistakes in her derivation. How do you interpret the fact she has a negative sign?

Problem 3d (3 pts)
You are given a machine and four isolators (one for each corner of the machine) and a displacement measuring device (ruler, calipers, micrometers - whatever you want). How could you estimate the natural frequency of this system? You have no other equipment available to you and the mass and stiffness of the isolators are unknown.

Problem 3e (3 pts)
In lab we saw the phase of a single degree of system (when calculated in tfestimate) go from 0 to -180°. In class, and in the book, the phase plot goes from 0 to +180°. Why is there this difference?

Problem 3f (3 pts)
Assuming you designed an isolator assuming zero damping and a reduction of force of 80% will the actual reduction be larger or smaller since the real system will have some damping?

Problem 3g (4 pts)
Given an FRF for a single degree of freedom system what are two ways you can identify ζ and ω_n.