

Name _____ Section _____

EM406
Examination I
September 18, 2001

Problem	Score
1	/20
2	/10
3	/30
4	/40
Total	/100

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

Name _____
EM406 Examination I

Problem 1

20 pts
September 19, 2000

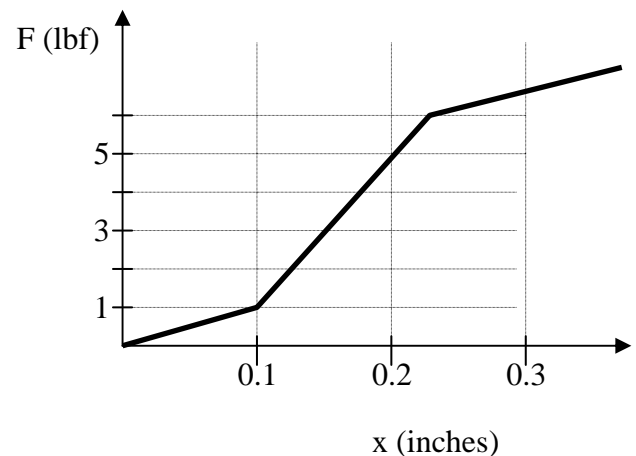
You have performed a vibration test on a machine that has a mass of 25 kg and stiffness of about 100,000 N/m and determined it to have a natural frequency of 63.2 rad/s and a damping ratio of 11%. Determine:

- The magnitude and phase of the steady state response of this system when subject to forcing $f(t) = 500 \sin 100t$.
- At what forcing frequency would this system experience a maximum steady state response.

Problem 2

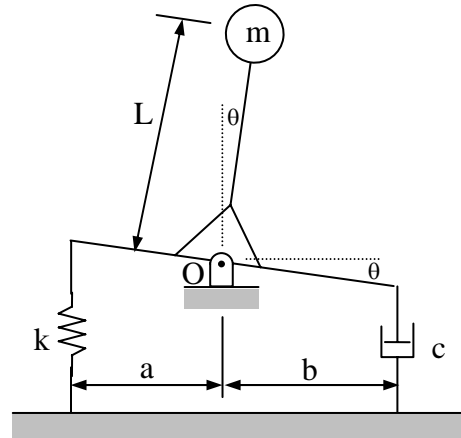
(10 pts)

A force versus deflection plot is made for a non-linear spring as shown. Determine the natural frequency for small oscillations of a 2 lbf object suspended from the spring.



A mass m is supported on a massless frame that rotates freely about pivot O as shown. When $\theta = 0$ the spring is unstretched. Assume small angles. Determine:

- The equation of motion
- The natural frequency of this system
- The damping ratio
- If this system is forced with a torque, $T = T_0 \sin \omega t$ what is the steady state response?
- The range of values for k for the system to be stable.



Name _____
EM406 Examination I

Problem 4

40 pts
September 18, 2001

When the tail rotor, including the drive system, of a helicopter is installed, the tail section is found to deflect 2 mm. The rotor and drive system weighs 20 kg. If the tail section is given an initial displacement of x_0 , the amplitude of oscillation is found to decrease by 50% after each cycle and the period of the oscillation is about 0.1 s. Determine:

- a) The natural frequency of the system,
- b) The damping ratio, ζ
- c) The damping, C , of the tail of the helicopter
- d) The mass of the tail section (without the tail rotor and drive system) assuming that the base can be modeled as being cantilevered. Does this answer make sense? Explain your answer.

Note: The mass of the tail itself cannot be neglected when determining the natural frequency.