

Name _____ Section _____

EM406
Examination I
September 28, 2006

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

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

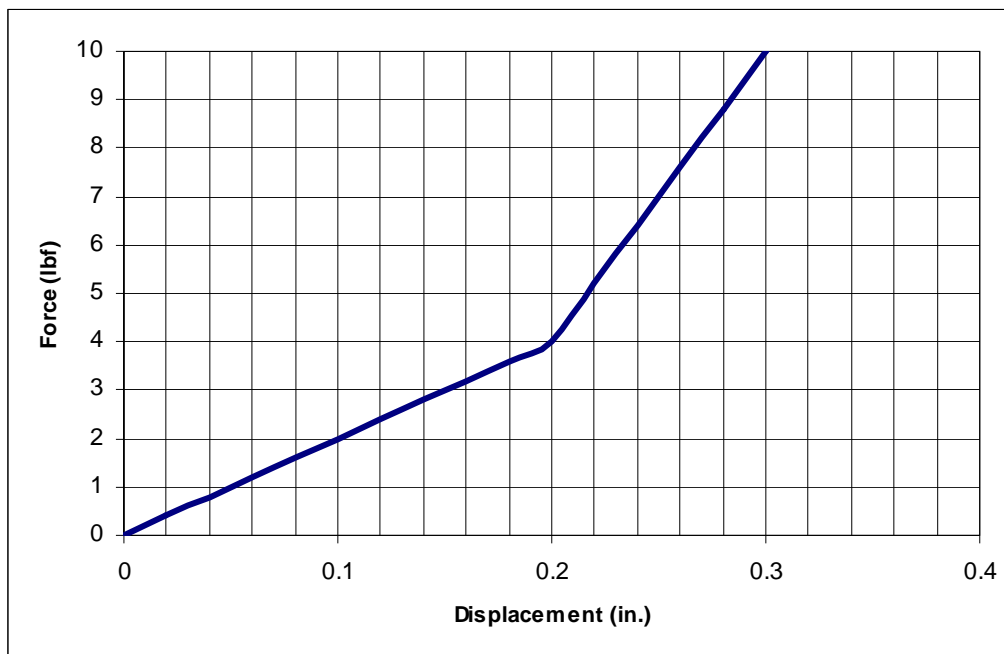
Problem 1a

In the lab you used a performance index, J , to determine the goodness of fit for your models. Given experimental data, x_{exp} , and results from a model, x_{model} , how do you find J ? (3 pts)

Problem 1a

A force versus deflection plot is made for a non-linear spring as shown. Object A weighs 2 lbs and object B weighs 6 pounds.

Which will have a larger natural frequency when suspended from this spring? (3 pts)



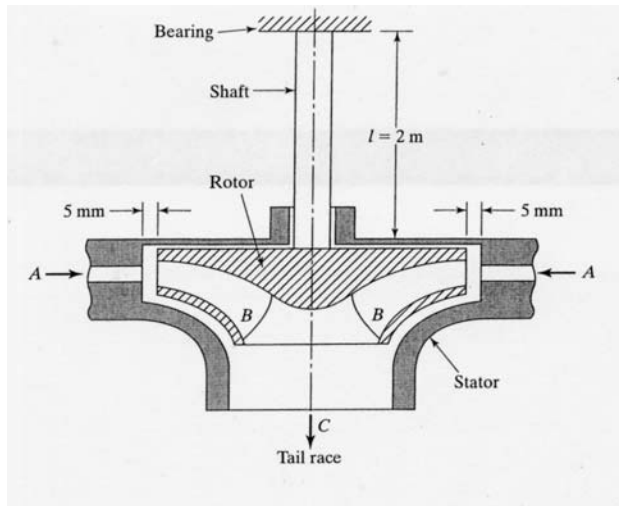
What is the natural frequency of object B when suspended from this spring? (4 pts)

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Problem 2

35 pts
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The water turbine shown in the figure is designed to operate at 360 rpm. The rotor is estimated to have a rotational imbalance of 0.1 kg-m. The mass of the rotor is 250 kg. The table has the information on the shaft connected to the rotor. We need to determine whether this rotational imbalance might cause interference with the stator. Calculate the bending displacement amplitude at steady state, in mm.



Shaft Mass	123.5	kg
Elastic Modulus	2.07×10^{11}	N/m ²
Moment of Inertia I	4.91×10^{-6}	m ⁴
Diameter	0.100	m

A piece of equipment is placed on a shake table by 4 slender rods (only two are shown in the Figure 1). The mass, m , is 100 kg and $k_1 = 100,000$ N/m. A model of this system is shown in Figure 2.

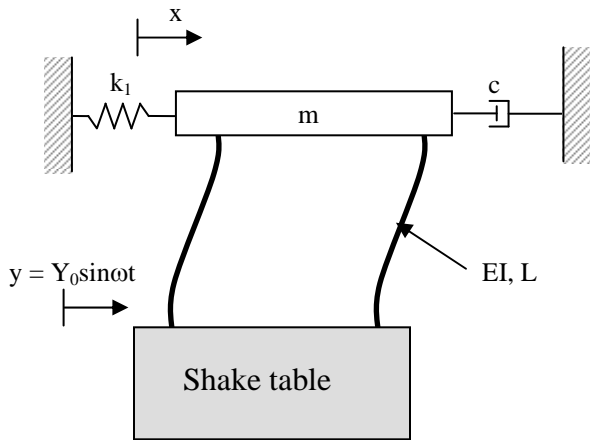


Figure 1 – Schematic of equipment

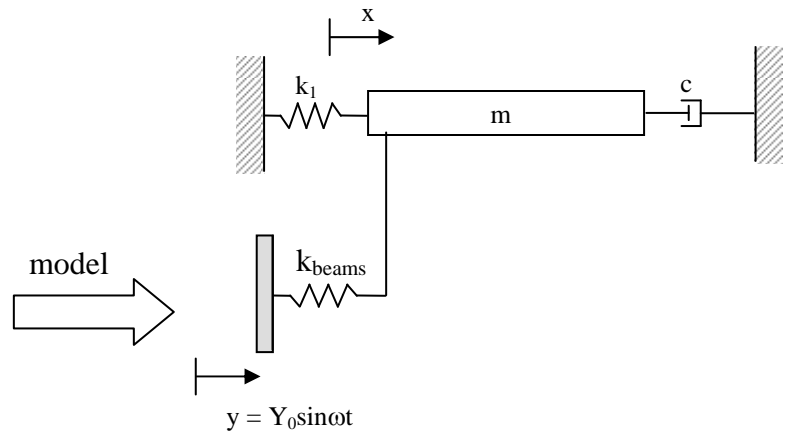


Figure 2 – Model of experiment

- a) Determine the equation of motion in terms of k_1 , c , k_{beams} and m . (Do not just write it down. Be sure to show all your work).

An experiment is performed and it is found that the peak response occurs at $\omega = 55$ rad/s and that $\zeta = 0.33$.

- b) What is the value of k_{beam} ?
 c) What is the steady state response, $x_{ss}(t)$, assuming an input displacement of $y(t) = 10\cos 70t$ mm.
 d) Determine the magnitude force transmitted to the support on the right.

