LAB #4 report. MAE 106. UCI. Winter 2005

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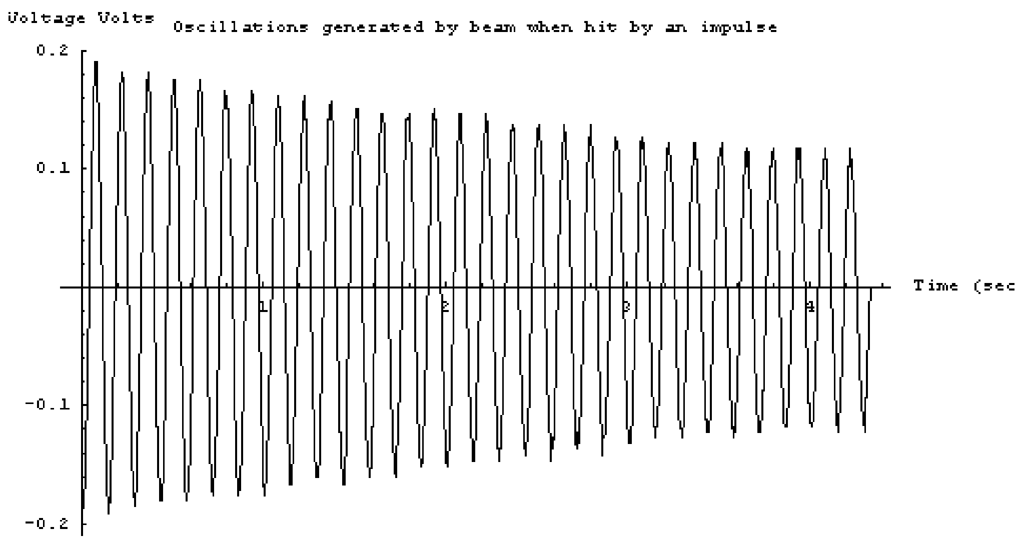
1 Answer 1.



2 Answer 2.

Using Newton's law $F = Ma$, then we get, when the origin of the coordinates systems is taken as the center of the mass, and taking the upwards motions and forces as positive and downwards forces as negative

$$-Mg + k\ x + c\frac{dx}{dt} = -M\frac{d^2x}{dt^2}$$

Where Mg is the weight of the mass. This is the force that causes the mass to be displaced from its initial position. Let me call this force as F (which is constant in this case)

When we take the origin of the coordinates system as the inertial reference of frame, whose origin is distant y from the center of the mass, then we get

$$F = M\frac{d^2\left(x+y\right)}{dt^2} + c\frac{dx}{dt} + \ k\ x$$

where $\frac{d^2(x+y)}{dt^2} = \frac{d}{dt}\left(\frac{d}{dt}\left(x+y\right)\right) = \frac{d}{dt}\left(\dot{x}+\dot{y}\right) = \ddot{x}+\ddot{y}$

Hence the equation of motion becomes

$$F = M\left(\ddot{x}+\ddot{y}\right) + c\frac{dx}{dt} + \ k\ x$$

3 Answer 3

Apply Laplace transform to the above ODE, we get

$$
\begin{aligned}
F(s) &= M\left(s^2 X(s) + s^2 Y(s)\right) + csX(s) + kX(s) \\
F(s) &= Ms^2 X(s) + Ms^2 Y(s) + csX(s) + kX(s) \\
F(s) &= X(s)\left[\, Ms^2 + cs + k\right] + Ms^2 Y(s)
\end{aligned}
$$

So, to find the transfer function between $Y(s)$ and $X(s)$, set $F(s) = 0$ we get

$$
\frac{Y(s)}{X(s)} = -\frac{Ms^2 + Cs + k}{Ms^2} = -\frac{s^2 + \frac{C}{M}s + \frac{k}{M}}{s^2}
$$

4 Answer 4

For the 0.2 g nominal range, the specification sheet says that the natural frequency $\omega_n = 275$ Hz and $\xi = 0.7$

Hence since $\omega_n = \sqrt{\frac{k}{m}}$ then

$$
\frac{k}{m} = 275^2 = 75\,625
$$

and

$$
\begin{aligned}
\frac{c}{m} &= 2\xi\omega_n \\
&= 2 \times .7 \times 275 \\
&= 385
\end{aligned}
$$