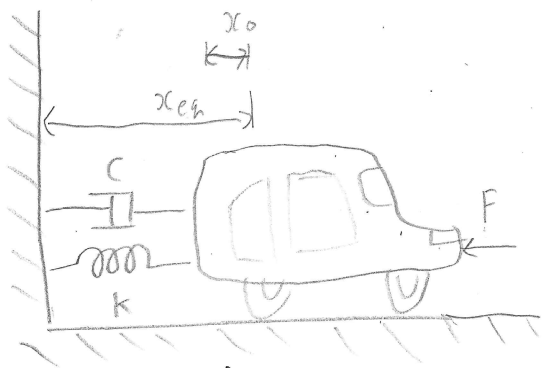
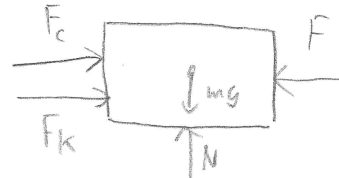


20-R-VIB-DY-36 Beginner

A  $m = 2000 \text{ kg}$  testing vehicle is undergoing a vibrations experiment. It is attached to a wall via damper,  $c = 100 \text{ Ns/m}$ , and spring,  $k = 250 \text{ N/m}$ . Given that the spring is compressed  $0.05 \text{ m}$  from equilibrium before a periodic force  $f = 100 \cos 15t$  is applied to the vehicle, determine the phase angle and magnification factor.



Solution:



$$\sum F_x = -m\ddot{x}$$

$$c\dot{x} + kx + kx_0 - 100 \cos 15t = -m\ddot{x}$$

$$m\ddot{x} + c\dot{x} + kx = 100 \cos 15t$$

$$\phi = \tan^{-1} \left[ \frac{2 \frac{c}{c_c} \frac{\omega_0}{\omega_n}}{1 - \left( \frac{\omega_0}{\omega_n} \right)^2} \right] = -0.003339399 \text{ rad}$$

$$MF = \frac{1}{\sqrt{\left[ 1 - \left( \frac{\omega_0}{\omega_n} \right)^2 \right]^2 + \left[ 2 \frac{c}{c_c} \frac{\omega_0}{\omega_n} \right]^2}} = 0.000557$$

$$\omega_n = \sqrt{\frac{k}{m}} = 0.354 \text{ rad/s}$$

$$c_c = \sqrt{4mk} = 1414.21 \text{ Ns/m}$$