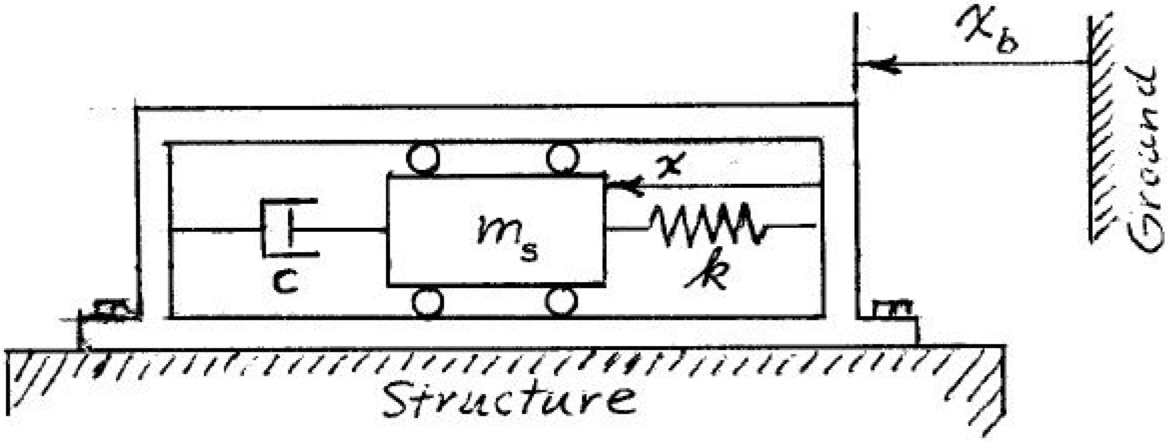
Solution to Problem 8/66, p. 622, in J. L. Meriam and L. G. Kraige, *Engineering Mechanics*, *Dynamics*, 5th Edition, Wiley, 2002. Solved here using Mathcad.

Given:



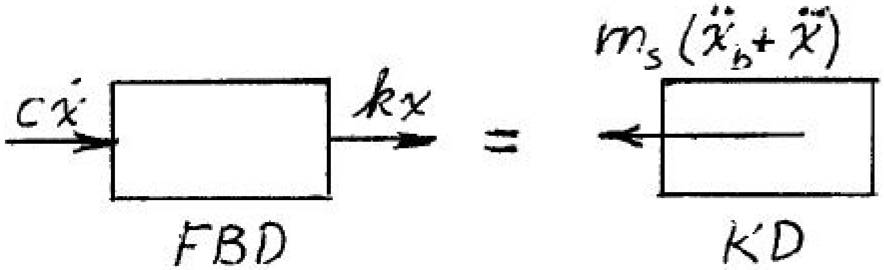
$m_s := 0.5\cdot kg$ $\quad k := 20\cdot\frac{N}{m}$ $\quad c := 3\cdot\frac{N\cdot s}{m}$

$x_b := X_b\cdot\sin(\omega\cdot t)$ $\quad f := 3\cdot Hz$ $\quad$ and $\quad x := X_0\cdot\sin(\omega\cdot t + \phi)$ $\quad X_0 := 2\cdot mm$

where $\quad \omega := 2\cdot\pi\cdot f$ $\quad \omega = 18.85\,\frac{rad}{s}$

Required: Find amplitude X_b of horizontal movement.

Solution:



From the FBD and KD, we get:

$$m_s\cdot\frac{d^2}{dt^2}x + c\cdot\frac{d}{dt}x + k\cdot x := -m_s\cdot\frac{d^2}{dt^2}x_b$$

$$m_s\cdot\frac{d^2}{dt^2}x + c\cdot\frac{d}{dt}x + k\cdot x := m_s\cdot X_b\cdot\omega^2\cdot\sin(\omega\cdot t)$$

From the *FE Reference Handbook* 10.2, page 126, we have

$$m\cdot\frac{d^2}{dt^2}x + c\cdot\frac{d}{dt}x + k\cdot x := F_0\cdot\sin(\omega\cdot t)$$

$$x := X_0\cdot\sin(\omega\cdot t + \phi)$$

$$X_0 := \frac{K\cdot F_0}{\sqrt{\left(1-\frac{\omega^2}{\omega_n{}^2}\right)^2 + \left(2\cdot\zeta\cdot\frac{\omega}{\omega_n}\right)^2}}$$

By comparison, for our problem: $F_0 := m_s\cdot X_b\cdot\omega^2$

We proceed to find X_b

$$\omega = 18.85\cdot\frac{rad}{s}$$

$$\omega_n := \sqrt{\frac{k}{m_s}} \qquad \omega_n = 6.325\cdot\frac{rad}{s} \qquad \frac{\omega}{\omega_n} = 2.98$$

$$\zeta := \frac{c}{2\sqrt{k\cdot m_s}} \qquad \zeta = 0.474$$

$$K := \frac{1}{k} \qquad K = 0.05\cdot\frac{m}{N}$$

$$X_b := \frac{\sqrt{\left(1-\frac{\omega^2}{\omega_n{}^2}\right)^2 + \left(2\cdot\zeta\cdot\frac{\omega}{\omega_n}\right)^2}}{\frac{\omega^2}{\omega_n{}^2}}\cdot X_0$$

$X_b = 1.886\cdot mm$ <------------ Answer