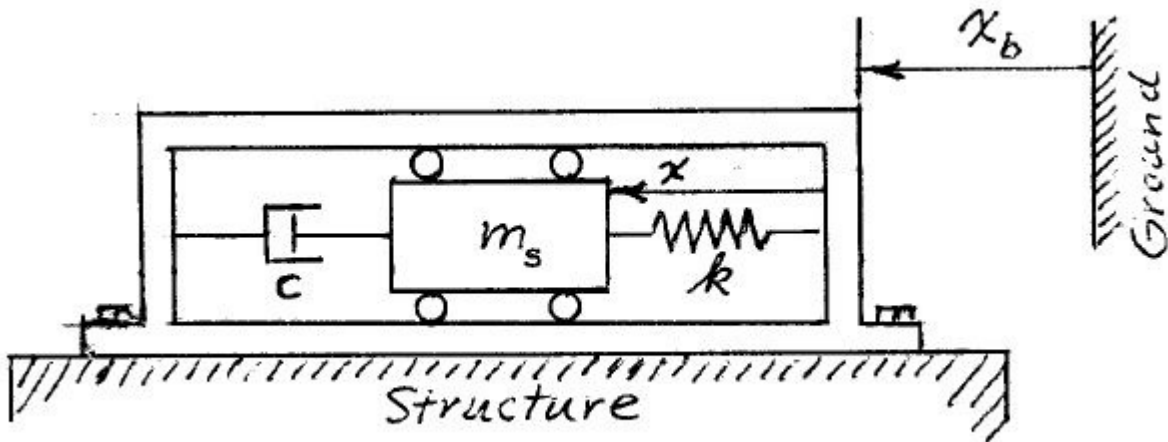


Solution to Problem 8/66, p. 622, in J. L. Meriam and L. G. Kraige, *Engineering Mechanics, Dynamics*, 5th Edition, Wiley, 2002. Solved here using Mathcad.

Given:



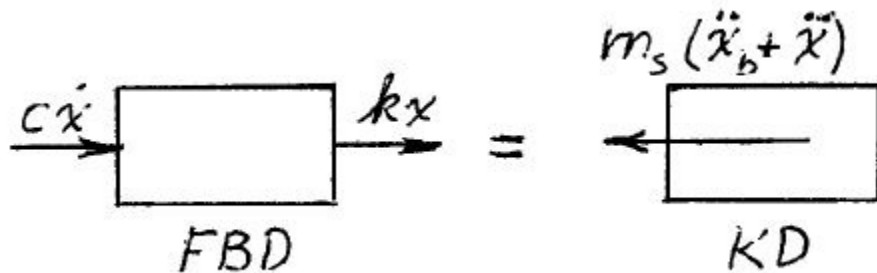
$$m_s := 0.5 \cdot \text{kg} \quad k := 20 \cdot \frac{\text{N}}{\text{m}} \quad c := 3 \cdot \frac{\text{N} \cdot \text{s}}{\text{m}}$$

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

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

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* 10.3, page 113, 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

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

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

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

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

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

$X_b = 1.886 \text{ mm}$ <----- Answer