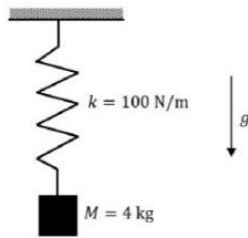


XE 71

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QUESTION: A spring mass system is shown in the figure . Take the value of acceleration due to gravity as $g = 9.81 \text{ m/s}^2$. The static deflection due to weight and the time period of the oscillations, respectively, are

(GATE 2023 XE)



Taking Inverse Laplace Transform:

Initial Conditions be at extreme point of SHM

$$x(t) = A \left(B \sin\left(\sqrt{\frac{k}{m}}t\right) + C \cos\left(\sqrt{\frac{k}{m}}t\right) \right) \quad (7)$$

$$x(t) = P \left(\sin\left(\sqrt{\frac{k}{m}}t + Q\right) \right) \quad (8)$$

$$x(t) = 0.3924 \left(\sin\left(\sqrt{\frac{100}{5}}t + \frac{\pi}{2}\right) \right) \text{ m} \quad (9)$$

$$x(t) = 39.24 \sin\left(5t + \frac{\pi}{2}\right) \text{ cm} \quad (10)$$

The static deflection due to weight and the time period of the oscillations, respectively are 39.24 cm and $\frac{2\pi}{5}$ s

Solution:

- Static deflection due to weight(sdw)
let x be sdw.
At mean position in equilibrium
??

$$Mg = kx \quad (1)$$

$$x = 39.24 \text{ cm} \quad (2)$$

- Time period of oscillation

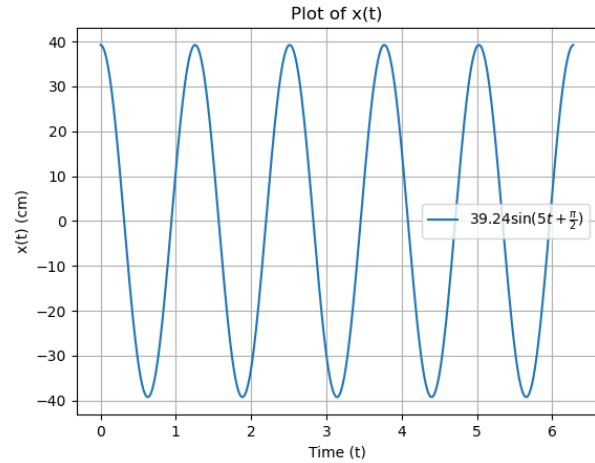
$$F = -kx \quad (3)$$

$$m \left(\frac{d^2x}{dt^2} \right) = -kx \quad (4)$$

Taking Laplace transform:

$$X(s) = \frac{msx(0) + x'(0)}{ms^2 + k} \quad (5)$$

$$X(s) = \frac{1}{\sqrt{\frac{k}{m}}} \left(A \frac{s - i\sqrt{\frac{k}{m}}}{s^2 + \frac{k}{m}} + B \frac{s + i\sqrt{\frac{k}{m}}}{s^2 + \frac{k}{m}} \right) \quad (6)$$



Variable	Description	Value
M	weight of block	4 kg
K	spring constant	$100 \frac{\text{N}}{\text{m}}$
x	Static deflection due to weight	39.24 cm
P	Amplitude	39.24 cm
Q	phase angle	$\frac{\pi}{2}$
A, B, C	integrating constants	none

TABLE 2
INPUT PARAMETERS