XE 71

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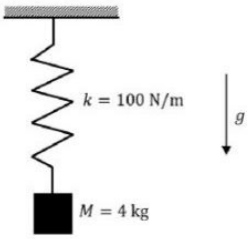
QUESTION: A spring mass system is shown in the figure . Take the value of acceleration due to gravity as $g = 9.81 m/s^2$.The static deflection due to weight and the time period of the oscillations,respectively,are

(GATE 2023 XE)



Solution:

1) Static deflection due to weight(sdw)
   let x be sdw.
   At mean position in equilibrium
   Table reference **??**

$$Mg = kx \tag{1}$$

$$x = 39.24cm \tag{2}$$

2) Time period of oscillation

$$F = -kx \tag{3}$$

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

Initial Conditions be at extreme point of SHM

$$x(0) = 0.3924 \tag{5}$$

$$\frac{dx}{dt} = 0 \text{ at } t = 0 \text{ (released from rest)} \tag{6}$$

Taking Laplace transform:

$$msx(0) + \frac{dx(0)}{dt} + kX(s) = 0 \tag{7}$$

Substituting initial values

$$X(s) = \frac{0.3924}{ms^2 + k} \tag{8}$$

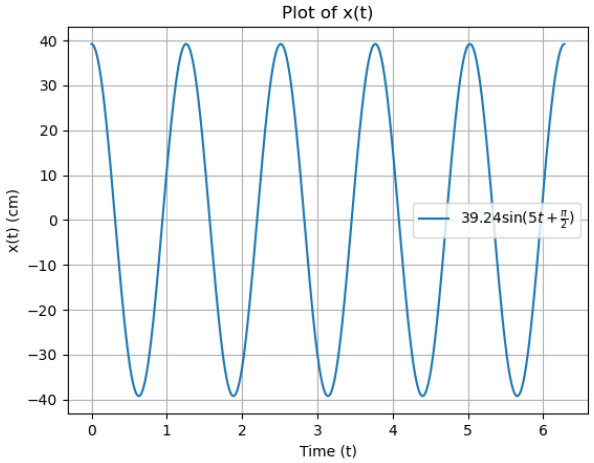
Taking Inverse Laplace Transform:

$$x(t) = 0.3924 \cos\left(\sqrt{\frac{k}{m}}t\right) \tag{9}$$

$$x(t) = 0.3924 \sin\left(5t + \frac{\pi}{2}\right) \text{ m} \tag{10}$$

$$x(t) = 39.24 \sin\left(5t + \frac{\pi}{2}\right) \text{ cm} \tag{11}$$

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



Variable	Description	Value
M	weight of block	4 kg
K	spring constant	$100\frac{N}{m}$
x	Static deflection due to weight	39.24 cm
$\frac{dx}{dt}$	velocity of particle	none

TABLE 2
INPUT PARAMETERS