

1 Free Vibration of Single Degree-of-freedom Systems

1.1 Solved Problems

Problem 1:

For the mechanical system shown to the right, the uniform rigid bar has mass m and pinned at point O . For this system:

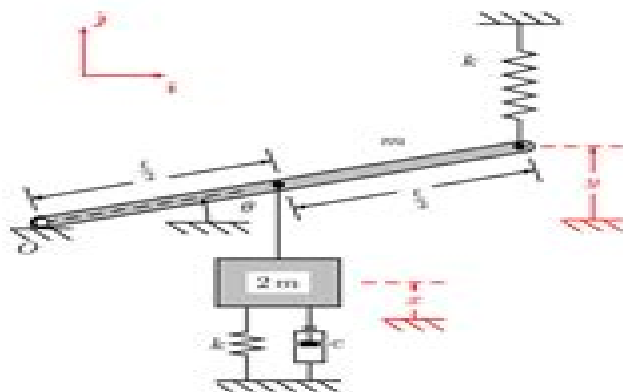
- find the equations of motion;
- Identify the damping ratio and natural frequency in terms of the parameters m , c , k , and ℓ .
- For:

$$m = 1.50\text{kg}, \quad \ell = 45\text{cm}, \\ c = 0.125\text{N/(m/s)}, \quad k = 250\text{N/m},$$

find the angular displacement of the bar $\theta(t)$ for the following initial conditions:

$$\theta(0) = 0, \quad \dot{\theta}(0) = 10\text{rad/s}.$$

Assume that in the horizontal position the system is in static equilibrium and that all angles remain small.



Solution:

- In addition to the coordinate θ identified in the original figure, we also define x and y as the displacement of the block and end of the bar respectively. The directions $\hat{i}$ and $\hat{j}$ are defined as shown in the figure.

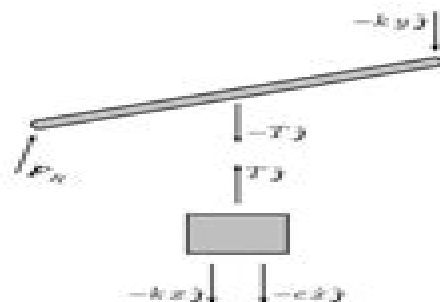
A free body diagram for this system is shown to the right. Note that the tension in the cable between the bar and the block is unknown and represented with T while the reaction force $\mathbf{F}_R$ is included, although both its magnitude and direction are unspecified. In terms of the identified coordinates, the angular acceleration of the bar α_θ and the linear acceleration of the block $\mathbf{a}_c$ are

$$\alpha_\theta = \ddot{\theta} \hat{k}, \quad \mathbf{a}_c = \ddot{x} \hat{j}.$$

We can also relate the identified coordinates as

$$x = \frac{\ell}{2} \theta, \quad y = \ell \theta.$$

The equations of motion for this system can be obtained with linear momentum balance applied to the block and angular momentum balance about O on the bar. These can be



Mechanical Vibration Solved Problems

RS Peters



Mechanical Vibration Solved Problems:

Unveiling the Magic of Words: A Review of "**Mechanical Vibration Solved Problems**"

In a global defined by information and interconnectivity, the enchanting power of words has acquired unparalleled significance. Their power to kindle emotions, provoke contemplation, and ignite transformative change is really awe-inspiring. Enter the realm of "**Mechanical Vibration Solved Problems**," a mesmerizing literary masterpiece penned with a distinguished author, guiding readers on a profound journey to unravel the secrets and potential hidden within every word. In this critique, we shall delve into the book's central themes, examine its distinctive writing style, and assess its profound effect on the souls of its readers.

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