

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:

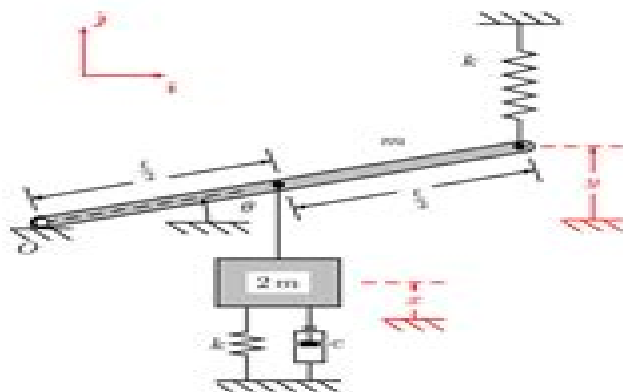
- find the equations of motion;
- Identify the damping ratio and natural frequency in terms of the parameters m , c , k , and ℓ .
- For:

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

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

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

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.

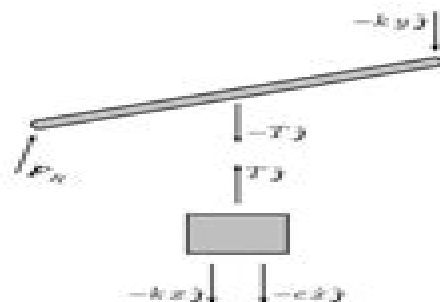
A free body diagram for this system is shown to the right. Note that the tension in the cable between the bar and the block is unknown and represented with T while the reaction force $\mathbf{F}_R$ is included, although both its magnitude and direction are unspecified. In terms of the identified coordinates,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

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

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

Hussin A.Rothana



Mechanical Vibration Solved Problems:

Unveiling the Power of Verbal Beauty: An Mental Sojourn through **Mechanical Vibration Solved Problems**

In some sort of inundated with monitors and the cacophony of instantaneous communication, the profound energy and emotional resonance of verbal beauty usually disappear in to obscurity, eclipsed by the continuous onslaught of sound and distractions. Yet, located within the lyrical pages of **Mechanical Vibration Solved Problems**, a charming function of literary splendor that impulses with organic emotions, lies an wonderful trip waiting to be embarked upon. Composed with a virtuoso wordsmith, that interesting opus books viewers on a mental odyssey, gently exposing the latent potential and profound impact stuck within the elaborate web of language. Within the heart-wrenching expanse with this evocative analysis, we shall embark upon an introspective exploration of the book is key subjects, dissect their charming publishing design, and immerse ourselves in the indelible effect it leaves upon the depths of readers souls.

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