

2.3 Solution

(a) Determine the equation of motion of the beam in Fig. 1 in terms of tip displacement v .

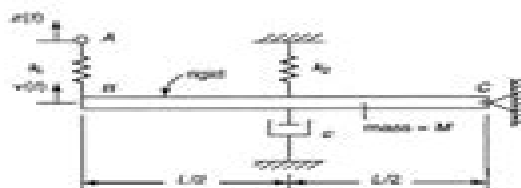


Figure 1



Figure 2

$$\sum M_C = I_C \ddot{\theta}$$

where

$$I_C = \frac{1}{3} M L^2$$

From the free-body diagram (Fig. 2 top),

$$f_{11} L - (f_{22} + f_{33}) \frac{L}{2} = I_C \ddot{\theta}$$

The constitutive relationships of the linear springs and the linear dashpot are:

$$f_{11} = k_1 [z(t) - v], \quad f_{22} = k_2 \frac{v}{2}, \quad f_{33} = c \frac{\dot{v}}{2}$$

From the deformation diagram (Fig. 2 bottom) and kinematics, for small θ ,

$$v = L\theta, \quad \text{or} \quad \theta = \frac{v}{L}$$

Combining the above equations, we get

$$k_1 [z(t) - v] L - \left(k_2 \frac{v}{2} + c \frac{\dot{v}}{2} \right) \frac{L}{2} = \frac{1}{3} M L^2 \left(\frac{\ddot{v}}{L} \right)$$

Finally, the equation of motion of the beam in terms of displacement v is

$$4M\ddot{v} + 3c\dot{v} + (12k_1 + 3k_2)v = 12k_1 z(t) \quad \text{Ans. (a)}$$

(b) Determine the equation of motion of the beam in terms of the spring force f_{11} .

In the above answer to Part (a), substitute the force-deformation of spring 1 in the form

$$v = z(t) - \frac{f_{11}}{k_1}$$

Then, the equation of motion for f_{11} is

$$4M\ddot{f}_{11} + 3c\dot{f}_{11} + (12k_1 + 3k_2)f_{11} = k_1(4M\ddot{z} + 3c\dot{z} + 3k_2 z) \quad \text{Ans. (b)}$$

Although the left-hand sides of these two equations of motion have exactly the same form, the right-hand side of Ans. (b) is more complicated.

Fundamentals Of Structural Dynamics

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Dynamics of Coupled Structures, Volume 1 Matt Allen, Randy Mayes, Daniel Rixen, 2014-04-16 This first volume of eight from the IMAC XXXII Conference brings together contributions to this important area of research and engineering The collection presents early findings and case studies on fundamental and applied aspects of Structural Dynamics including papers on Linear Systems Substructure Modelling Adaptive Structures Experimental Techniques Analytical Methods Damage Detection Damping of Materials Members Modal Parameter Identification Modal Testing Methods System Identification Active Control Modal Parameter Estimation Processing Modal Data Structural Dynamics Harry Grundmann, Gerhart I. Schuëller, 2002 The proceedings contain contributions presented by authors from more than 30 countries at EURO DYN 2002 The proceedings show recent scientific developments as well as practical applications they cover the fields of theory of vibrations nonlinear vibrations stochastic dynamics vibrations of structured elements wave propagation and structure borne sound including questions of fatigue and damping Emphasis is laid on vibrations of bridges buildings railway structures as well as on the fields of wind and earthquake engineering respectively Enriched by a number of keynote lectures and organized sessions the two volumes of the proceedings present an overview of the state of the art of the whole field of structural dynamics and the tendencies of its further development Structural Analysis Exam Study Guide cybellium, 2024-10-26 Designed for professionals students and enthusiasts alike our comprehensive books empower you to stay ahead in a rapidly evolving digital world Expert Insights Our books provide deep actionable insights that bridge the gap between theory and practical application Up to Date Content Stay current with the latest advancements trends and best practices in IT AI

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Table of Contents Fundamentals Of Structural Dynamics

1. Understanding the eBook Fundamentals Of Structural Dynamics
 - The Rise of Digital Reading Fundamentals Of Structural Dynamics
 - Advantages of eBooks Over Traditional Books
2. Identifying Fundamentals Of Structural Dynamics
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Fundamentals Of Structural Dynamics
 - User-Friendly Interface
4. Exploring eBook Recommendations from Fundamentals Of Structural Dynamics
 - Personalized Recommendations
 - Fundamentals Of Structural Dynamics User Reviews and Ratings
 - Fundamentals Of Structural Dynamics and Bestseller Lists
5. Accessing Fundamentals Of Structural Dynamics Free and Paid eBooks

- Fundamentals Of Structural Dynamics Public Domain eBooks
- Fundamentals Of Structural Dynamics eBook Subscription Services
- Fundamentals Of Structural Dynamics Budget-Friendly Options
- 6. Navigating Fundamentals Of Structural Dynamics eBook Formats
 - ePub, PDF, MOBI, and More
 - Fundamentals Of Structural Dynamics Compatibility with Devices
 - Fundamentals Of Structural Dynamics Enhanced eBook Features
- 7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Fundamentals Of Structural Dynamics
 - Highlighting and Note-Taking Fundamentals Of Structural Dynamics
 - Interactive Elements Fundamentals Of Structural Dynamics
- 8. Staying Engaged with Fundamentals Of Structural Dynamics
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Fundamentals Of Structural Dynamics
- 9. Balancing eBooks and Physical Books Fundamentals Of Structural Dynamics
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Fundamentals Of Structural Dynamics
- 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
- 11. Cultivating a Reading Routine Fundamentals Of Structural Dynamics
 - Setting Reading Goals Fundamentals Of Structural Dynamics
 - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Fundamentals Of Structural Dynamics
 - Fact-Checking eBook Content of Fundamentals Of Structural Dynamics
 - Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development

- Exploring Educational eBooks

14. Embracing eBook Trends

- Integration of Multimedia Elements
- Interactive and Gamified eBooks

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