

**Problems and Solutions Section 2.4 (2.37 through 2.50)**

- 2.37** A machine weighing 2000 N rests on a support as illustrated in Figure P2.37. The support deflects about 5 cm as a result of the weight of the machine. The floor under the machine is somewhat flexible and moves, because of the motion of a nearby machine, harmonically near resonance ( $r = 1$ ) with an amplitude of 0.2 cm. Model the floor as base motion, and assume a damping ratio of  $\zeta = 0.01$ , and calculate the transmitted force and the amplitude of the transmitted displacement.



**Figure P2.37**

**Solution:**

Given:  $Y = 0.2$  cm,  $\zeta = 0.01$ ,  $r = 1$ ,  $mg = 2000$ N. The stiffness is computed from the static deflection and weight:

$$\text{Deflection of 5 cm implies: } k = \frac{mg}{\Delta} = \frac{mg}{5\text{cm}} = \frac{2000}{0.05} = 40,000 \text{ N/m}$$

$$\text{Transmitted displacement from equation (2.70): } X = Y \left[ \frac{1 + (2\zeta r)^2}{(1 - r^2)^2 + (2\zeta r)^2} \right]^{1/2} = 10 \text{ cm}$$

$$\text{Transmitted force from equation (2.77): } F_T = kYr^2 \left[ \frac{1 + (2\zeta r)^2}{(1 - r^2)^2 + (2\zeta r)^2} \right]^{1/2} = 4001 \text{ N}$$

- 2.38** Derive Equation (2.70) from (2.68) to see if the author has done it correctly.

**Solution:**

Equation (2.68) states:

$$x_r(t) = \omega_s Y \left[ \frac{\omega_s^2 + (2\zeta\omega_s)^2}{(\omega_s^2 - \omega_b^2)^2 + (2\zeta\omega_s\omega_b)^2} \right]^{1/2} \cos(\omega_s t - \theta_s - \theta_r)$$

$$\text{The magnitude is: } X = \omega_s Y \left[ \frac{\omega_s^2 + (2\zeta\omega_s)^2}{(\omega_s^2 - \omega_b^2)^2 + (2\zeta\omega_s\omega_b)^2} \right]^{1/2}$$

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**Swaminathan Sankaran**



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## **Table of Contents Solutions To Chapter 5 Problems 37 Aerostudents**

1. Understanding the eBook Solutions To Chapter 5 Problems 37 Aerostudents
  - The Rise of Digital Reading Solutions To Chapter 5 Problems 37 Aerostudents
  - Advantages of eBooks Over Traditional Books
2. Identifying Solutions To Chapter 5 Problems 37 Aerostudents
  - 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 Solutions To Chapter 5 Problems 37 Aerostudents
  - User-Friendly Interface
4. Exploring eBook Recommendations from Solutions To Chapter 5 Problems 37 Aerostudents
  - Personalized Recommendations
  - Solutions To Chapter 5 Problems 37 Aerostudents User Reviews and Ratings
  - Solutions To Chapter 5 Problems 37 Aerostudents and Bestseller Lists
5. Accessing Solutions To Chapter 5 Problems 37 Aerostudents Free and Paid eBooks
  - Solutions To Chapter 5 Problems 37 Aerostudents Public Domain eBooks
  - Solutions To Chapter 5 Problems 37 Aerostudents eBook Subscription Services
  - Solutions To Chapter 5 Problems 37 Aerostudents Budget-Friendly Options

6. Navigating Solutions To Chapter 5 Problems 37 Aerostudents eBook Formats
  - ePub, PDF, MOBI, and More
  - Solutions To Chapter 5 Problems 37 Aerostudents Compatibility with Devices
  - Solutions To Chapter 5 Problems 37 Aerostudents Enhanced eBook Features
7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Solutions To Chapter 5 Problems 37 Aerostudents
  - Highlighting and Note-Taking Solutions To Chapter 5 Problems 37 Aerostudents
  - Interactive Elements Solutions To Chapter 5 Problems 37 Aerostudents
8. Staying Engaged with Solutions To Chapter 5 Problems 37 Aerostudents
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Solutions To Chapter 5 Problems 37 Aerostudents
9. Balancing eBooks and Physical Books Solutions To Chapter 5 Problems 37 Aerostudents
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection Solutions To Chapter 5 Problems 37 Aerostudents
10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
11. Cultivating a Reading Routine Solutions To Chapter 5 Problems 37 Aerostudents
  - Setting Reading Goals Solutions To Chapter 5 Problems 37 Aerostudents
  - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of Solutions To Chapter 5 Problems 37 Aerostudents
  - Fact-Checking eBook Content of Solutions To Chapter 5 Problems 37 Aerostudents
  - 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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