

# Problem 1.13

1.13 A couple  $M$  of magnitude  $1500 \text{ N} \cdot \text{m}$  is applied to the crank of an engine. For the position shown, determine (a) the force  $P$  required to hold the engine system in equilibrium, (b) the average normal stress in the connecting rod  $BC$ , which has a  $450\text{-mm}^2$  uniform cross section.



Use piston, rod, and crank together as free body. Add wall reaction  $H$  and bearing reactions  $A_x$  and  $A_y$ .

$$\sum M_A = 0:$$

$$(0.280 \text{ m})H - 1500 \text{ N} \cdot \text{m} = 0$$

$$H = 5.3571 \times 10^3 \text{ N}$$



Use piston alone as free body. Note that rod is a two-force member; hence the direction of force  $F_{BC}$  is known. Draw the force triangle and solve for  $P$  and  $F_{BC}$  by proportions.

$$l = \sqrt{200^2 + 60^2} = 208.81 \text{ mm}$$

$$\frac{P}{H} = \frac{200}{60} \quad \therefore \quad P = 17.86 \times 10^3 \text{ N}$$

$$P = 17.86 \text{ kN}$$

$$\frac{F_{BC}}{H} = \frac{208.81}{60} \quad \therefore \quad F_{BC} = 18.643 \times 10^3 \text{ N}$$

Rod  $BC$  is a compression member. Its area is  $450 \text{ mm}^2 = 450 \times 10^{-6} \text{ m}^2$

$$\text{Stress, } \sigma_{BC} = \frac{-F_{BC}}{A} = \frac{-18.643 \times 10^3}{450 \times 10^{-6}} = -41.4 \times 10^6 \text{ Pa}$$

$$(b) \quad \sigma_{BC} = -41.4 \text{ MPa}$$

# Mhhe Beer Johnston Student Solutions Manual

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## **Mhhe Beer Johnston Student Solutions Manual:**

*EBOOK: Vector Mechanics for Engineers: Statics (SI units)* Ferdinand Beer, E. Johnston, David Mazurek, 2012-10-16

**Target Audience** This text is designed for the first course in Statics offered in the sophomore year.

**Overview** The main objective of a first course in mechanics should be to develop in the engineering student the ability to analyze any problem in a simple and logical manner and to apply to its solution a few well understood basic principles. This text is designed to help the instructor achieve this goal. Vector analysis is introduced early in the text and is used in the presentation and discussion of the fundamental principles of mechanics. Vector methods are also used to solve many problems, particularly three dimensional problems where these techniques result in a simpler and more concise solution. The emphasis in this text however remains on the correct understanding of the principles of mechanics and on their application to the solution of engineering problems and vector analysis is presented chiefly as a convenient tool. In order to achieve the goal of being able to analyze mechanics problems the text employs the following pedagogical strategy. Practical applications are introduced early. New concepts are introduced simply. Fundamental principles are placed in simple contexts. Students are given extensive practice through sample problems, special sections entitled Solving Problems on Your Own, extensive homework problem sets, review problems at the end of each chapter, and computer problems designed to be solved with computational software.

**Resources Supporting This Textbook** Instructor's and Solutions Manual features typeset one per page solutions to the end of chapter problems. It also features a number of tables designed to assist instructors in creating a schedule of assignments for their course. The various topics covered in the text have been listed in Table I and a suggested number of periods to be spent on each topic has been indicated. Table II prepares a brief description of all groups of problems. Sample lesson schedules are shown in Tables III, IV, and V together with various alternative lists of assigned homework problems. For additional resources related to users of this SI edition please visit <http://www.mheducation.com>. <http://www.mheducation.com/beerjohnston> McGraw Hill Connect Engineering a web based assignment and assessment platform is available at <http://www.mhhe.com/beerjohnston> and includes algorithmic problems from the text, Lecture PowerPoints, an image bank, and animations. Hands on Mechanics is a website designed for instructors who are interested in incorporating three dimensional hands on teaching aids into their lectures. Developed through a partnership between the McGraw Hill Engineering Team and the Department of Civil and Mechanical Engineering at the United States Military Academy at West Point, this website not only provides detailed instructions for how to build 3 D teaching tools using materials found in any lab or local hardware store but also provides a community where educators can share ideas, trade best practices, and submit their own original demonstrations for posting on the site. Visit <http://www.handsonmechanics.com>. McGraw Hill Tegrity a service that makes class time available all the time by automatically capturing every lecture in a searchable format for students to review when they study and complete assignments. To learn more about Tegrity watch a 2 minute Flash demo at <http://tegritycampus.mhhe.com>.

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## **Table of Contents Mhhe Beer Johnston Student Solutions Manual**

1. Understanding the eBook Mhhe Beer Johnston Student Solutions Manual
  - The Rise of Digital Reading Mhhe Beer Johnston Student Solutions Manual
  - Advantages of eBooks Over Traditional Books
2. Identifying Mhhe Beer Johnston Student Solutions Manual
  - 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 Mhhe Beer Johnston Student Solutions Manual
  - User-Friendly Interface
4. Exploring eBook Recommendations from Mhhe Beer Johnston Student Solutions Manual
  - Personalized Recommendations
  - Mhhe Beer Johnston Student Solutions Manual User Reviews and Ratings
  - Mhhe Beer Johnston Student Solutions Manual and Bestseller Lists
5. Accessing Mhhe Beer Johnston Student Solutions Manual Free and Paid eBooks

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