

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-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

Steve Rigdon



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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/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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