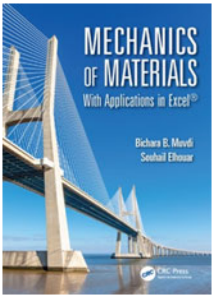

Mechanics of Materials: With Applications in Excel

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CRC Press, Taylor & Francis Group, 6000 Broken Sound Parkway NW, Suite 300, Boca Raton, FL 33487-2742, USA. 2016. Distributed by Taylor & Francis Group, 2 Park Square, Milton Park, Abingdon OX14 4RN, UK. xiv; 707 pp. Illustrated. £105. (20% discount available to RAeS members via www.crcpress.com using AKQ07 promotion code). ISBN 978-1-466-57071-9.

The authors promote their text by claiming it provides a unique and integrated, two-part teaching approach to this long-established/widely understood subject. Traditional printed matter is dealt with in chapters 1–9, yet the book as a whole is marketed on the supposed strength of its electronic enhancement applications element (chapter 10). Over 1,200 problems with solutions are set for homework.

Chapter 1 on axial loads provides nine very basic vector-based worked examples, the goal being to convert externally applied loads into balancing internal load distributions. The switch from load to stress begins with two quite long and unnecessary platitudes (not repeated here). Moreover, while it is fair enough to mention the difference between average stress (e.g. on page 1) and stress at a point (e.g. page 2), early on, is it not slightly premature to make a meal of Saint Venant's principle and stress elements (on pages 9 and 10) when the most basic relationship of all – load versus displacement – is not discussed until page 34? The reviewer also points out that figure 1.9 should be in the previous section, while the reader, new to the subject, will look in vain for the shear pin in figure 1.11(a) and (b), which forms the basis and major part of section 1.3.3. Further on (pages 16–20), 39 triangulated truss problems are injected, without a hint of how to solve them, there being no mention of the method of joints or the method of sections. Suffice to note mechanical properties are treated theoretically. A few actual properties are to be found in appendix D. There is a lot more in chapter 1, but it is time to move on.

The first eight pages of chapter 2 on torsional loads apply the same procedure for torque as explained for axial loads in chapter 1. The authors' approach to the engineers' theory of torsion is conventional, except the shear modulus G is a mathematical constant, and remains yet to be defined. Section 2.3.4 on material properties in shear is likewise largely algebraic, the only exception being a few notional torque/twist tabulations, typical of data obtained from a standard torsion testing machine. No actual material properties are given. Section 2.5 on the design of power-transmission shafts naturally considers power, torque and rotational speed, but the discourse is entirely about stresses in isolated shafts. The essential principle of mechanical power transmission,

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namely gearing up or down, is not discussed, although problems 2.35, 2.36, 2.58 and 2.59 do require the reader to analyse stresses in twin shafts several pages before the equation 'power = torque ÷ angular speed' appears in the text. It is also very odd to find the first mention of Hooke's law (page 106) in the middle of a chapter headed 'Torsional Loads' and directly followed by torsional stress concentration effects. Other topics include torsion shafts of non-circular cross section and Prandtl's soap film membrane analogy. Elastoplastic behaviour concludes the chapter.

The content of chapters 3, 4, 5 and 6, all headed 'Bending Loads', is far more aptly defined by the associated sub-headings: Stresses, Additional Stress Topics, Deflections under Symmetric Loading and Additional Topics, although the commentary is far too 'wordy' and hardly ever straightforward. What, for example, is the first-year student to make of the statement: "It follows that centroidal axes perpendicular to the axis of symmetry is also a principal axis of inertia (area to be more precise) regardless of whether it is an axis of symmetry or not". Not only does this waffle appear in the second paragraph of the so-called introduction (of chapter 3 on page 149), but the authors simply "urge the interested reader to consult Appendix C2, for clarification". Better to start by reading section 3.2, where shear and moment relationships are considered supported by excellent Computer-Aided Design (CAD) illustrations, followed by section 3.4 on bending stresses, in which the engineers' theory of bending is partially developed, the (E/R) term being left for later, while the 'SAYIB' equation, for vertical shear stress under symmetrical loading, is considered in alternative notation. The introduction to shear flow in section 3.5.2 is poorly illustrated by a bulky rectangular chunk of matter (page 181), when the thin-walled channel, angle and web (see page 185) are far more representative. Allowable stress design and stress concentration factors are considered in sections 3.7 and 3.8. Chapter 4 on 'Bending Loads: Additional Stress Topics' covers both symmetric and anti-symmetric loading and considers laminated beams, made up of several different materials. Concrete beams (of interest to civil engineers) are also briefly discussed, followed by the relatively complete equations, which apply to unsymmetrical loading cases.

A more formal introduction to thin-walled open cross-section beams (important reading for aerostructure students) is followed by a few pages of relatively complex mathematics, which help predict the behaviour of curved beams (crane hooks and the like); a section on elastoplastic hinge analysis and finally section 4.7 on fatigue, which offers a very basic study of equi tension/compression cycles, as first studied by Wohler 150 years ago. A diagram of R. R. Moore's fatigue testing machine is of interest, while the log–log plots showing cycles versus stress and the Gerber/Goodman/Soderbergh lines of 'safe haven', supported by the relevant mathematics, are all part of early learning.

In 'Bending Loads: Deflections Under Symmetric Loading' (chapter 5), skipping the page-long introduction in section 5.1, the authors get around to explaining the relevance of the curvature term, missing from the stress term derived in chapter 3 (e.g. in section 3.23). The following methods used to determine beam deflections include two successive integrations: deflection function, supposition and area movement method.

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Statically indeterminate beams are considered in sections 6.5 and 6.6.

Chapter 6 on 'Bending Loads: Additional Deflection Topics' explains how singularity functions in the form $f(x) = (x - a)n$ as in equation (6.1) are used when the loading is segmented. Deflections due to unsymmetrical load cases are covered in section 6.4, and Castiglano's second theorem is explained and applied in section 6.6, while the chapter ends with section 6.7 on impact loads. Indeed, a page count indicates that chapters 3, 4, 5 and 6, all headed 'Bending Loads', account for one-third of the book.

'Analysis of Stress' (chapter 7) and 'Analysis of Strain' (chapter 8) emphasise the theoretical need to analyse stress and strain at a point, rather than in terms of an average stress over a measurable area. Two-dimensional stress and plain strain are terms defined, and principal stresses and principal strains on planes inclined to the direction of loading are considered. Mohr's circle (widely used as a graphical procedure) is illustrated, but not formally explained for a further 13 pages. Three-dimensional stress/strain systems are then introduced in section 7.6, while the difference between thin-walled and thick-walled pressure vessels is also explained in sections 7.7 and 7.8. Chapter 7 concludes with a reasonable discourse on four of the five traditional theories of elastic failure, two of which are applied to ductile materials and two to explain failure in brittle materials, subject to biaxial loading.

Given the duality between stress and strain, it should come as no surprise that 'Analysis of Strain' (chapter 8) has much in common with 'Analysis of Stress' (chapter 7), the main difference being the authors' belated development of the elastic constants E, G, μ and V, while similarity is to be found between Mohr's circle for stress (page 397, figure 7.7) and Mohr's circle for strain (page 491, figure 8.12). It is for the reader to spot the difference. All who have an interest in laboratory testing procedures should home in on section 8.7, which, in very basic terms, explains how three electrical resistance strain gauges applied to a specimen at (0°, 45°, 90°) or (60°, 60°, 60°) and radiating from a point are wired to form a Wheatstone bridge network (mentioned but not illustrated). How to configure 'pairs' of gauges in order to eliminate unwanted bending and temperature effects is not revealed, but most negligent is that the all-important gauge factor (typically 2 for resistance gauges, but up to 150 or more for semi-conductor gauges) used to convert the electrical bridge output to physical micro-strain is not mentioned at all.

'Columns' (Chapter 9) addresses the problem of elastic instability of long slender struts, when 'overloaded' in compression. The stability of classical columns (Ionic, Doric etc.) is of course not considered. The authors explain (at O/A-level standard) the difference between stable, neutral and unstable conditions, thereby paving the way for Euler's theory of ideal strut behaviour. The effect of various end fixings and constraint constants (for pinned and built-in conditions) is given, and the limitation of Euler theory explained, with the secant formula being used to illustrate the effect of eccentric (offset) loading. Numerous empirical rules extracted from the American Institute of Steel Construction (AISC) are also included.

In 'Excel Spreadsheet Applications' (chapter 10) the authors point out that the use of computers to analysis (they mean analyse) design problems has become an integral part of 21st century engineering practice, hence their desire to pursue the topic here.

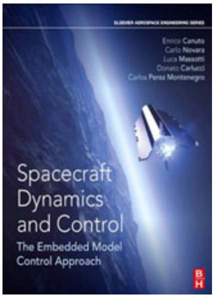
Suffice to note that a little prior acquaintance with Microsoft Excel software is required, but other than that there are many coloured screen images to guide the reader on their way. Suffice to list the four worked examples provided:

1. Drawing shear and moment diagrams
2. Drawing Mohr's circle
3. Principal stresses in three-dimensional stress elements
4. Computation of combined stresses

But one has to ask: How many of the 1,200 plus problems set in chapters 1–9 will ever see the light of day? Appendices A–H are, however, an essential contribution to the subject. This book is immaculately produced. The high quality of the illustrations seems most impressive, while the text would appear to be technically correct throughout. The reviewer always tries to present the hard work of others in a favourable light and has read almost every page, some sections many times over, but still cannot gel with the authors' approach to the subject.

The reviewer knows that there are several, far more lucid, highly respected, texts on offer, but in fairness to the authors of this book, the reviewer suggests that prospective buyers, having read this review, should also ponder the words of a previous reviewer on the back cover of the book.

Peter C. Gasson, CEng MIMechE, FRAeS



Spacecraft Dynamics and Control: The Embedded Model Control Approach

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Elsevier Butterworth-Heinemann, The Boulevard, Langford Lane, Kidlington, Oxford OX5 1GB, UK. 2018. viii; 781 pp. Illustrated. £119. ISBN 978-0-08100700-6.

Spacecraft Dynamics and Control approaches the problem of controlling a spacecraft from a model-based control perspective. Both orbit and attitude control are dealt with, although with more focus on the latter.

The orbital part includes a presentation of the classical two-body problem in chapter 3, orbital perturbations in chapter 4 and the integration of perturbed dynamics in chapter 5. Some useful elements for mission analysis are also provided, including the most relevant types of geocentric orbits, Lambert's problem, Hohmann transfers, gravity assists and periodic and quasi-periodic orbits in the restricted three-body problem.

The attitude sections cover different methods to represent the spacecraft attitude in chapter 2, main perturbing torques in