

Chapter 2 Solutions

Problem 2.1

Let $\mathbf{v} = \mathbf{a} \times \mathbf{b}$, or in indicial notation,

$$v_i \hat{\mathbf{e}}_i = a_j \hat{\mathbf{e}}_j \times b_k \hat{\mathbf{e}}_k = \epsilon_{ijk} a_j b_k \hat{\mathbf{e}}_i$$

Using indicial notation, show that,

$$(a) \quad \mathbf{v} \cdot \mathbf{v} = a^2 b^2 \sin^2 \theta,$$

$$(b) \quad \mathbf{a} \times \mathbf{b} \cdot \mathbf{a} = 0,$$

$$(c) \quad \mathbf{a} \times \mathbf{b} \cdot \mathbf{b} = 0.$$

Solution

(a) For the given vector, we have

$$\begin{aligned} \mathbf{v} \cdot \mathbf{v} &= \epsilon_{ijk} a_j b_k \hat{\mathbf{e}}_i \cdot \epsilon_{pqk} a_q b_p \hat{\mathbf{e}}_i = \epsilon_{ijk} a_j b_k \epsilon_{pqk} a_q b_p \delta_{ip} = \epsilon_{ijk} a_j b_k \epsilon_{iqk} a_q b_i \\ &= (\delta_{jq} \delta_{ik} - \delta_{ji} \delta_{kq}) a_j b_k a_q b_i = a_j a_i b_k b_i - a_j b_k a_k b_i \\ &= (\mathbf{a} \cdot \mathbf{a})(\mathbf{b} \cdot \mathbf{b}) - (\mathbf{a} \cdot \mathbf{b})(\mathbf{a} \cdot \mathbf{b}) = a^2 b^2 - (ab \cos \theta)^2 \\ &= a^2 b^2 (1 - \cos^2 \theta) = a^2 b^2 \sin^2 \theta \end{aligned}$$

(b) Again, we find

$$\mathbf{a} \times \mathbf{b} \cdot \mathbf{a} = \mathbf{v} \cdot \mathbf{a} = (\epsilon_{ijk} a_j b_k \hat{\mathbf{e}}_i) \cdot a_q \hat{\mathbf{e}}_q = \epsilon_{ijk} a_j b_k a_q \delta_{iq} = \epsilon_{ijk} a_j b_k a_i = 0$$

This is zero by symmetry in i and j .

(c) This is

$$\mathbf{a} \times \mathbf{b} \cdot \mathbf{b} = \mathbf{v} \cdot \mathbf{b} = (\epsilon_{ijk} a_j b_k \hat{\mathbf{e}}_i) \cdot b_q \hat{\mathbf{e}}_q = \epsilon_{ijk} a_j b_k b_q \delta_{iq} = \epsilon_{ijk} a_j b_k b_i = 0$$

Again, this is zero by symmetry in k and i .

Problem 2.2

With respect to the triad of base vectors \mathbf{u}_1 , \mathbf{u}_2 , and \mathbf{u}_3 (not necessarily unit vectors), the triad $\mathbf{u}^1, \mathbf{u}^2$, and \mathbf{u}^3 is said to be a *reciprocal basis* if $\mathbf{u}_i \cdot \mathbf{u}^j = \delta_{ij}$ ($i, j = 1, 2, 3$). Show that to satisfy these conditions,

$$\mathbf{u}^1 = \frac{\mathbf{u}_2 \times \mathbf{u}_3}{[\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_3]}; \quad \mathbf{u}^2 = \frac{\mathbf{u}_3 \times \mathbf{u}_1}{[\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_3]}; \quad \mathbf{u}^3 = \frac{\mathbf{u}_1 \times \mathbf{u}_2}{[\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_3]}$$

and determine the reciprocal basis for the specific base vectors

$$\begin{aligned} \mathbf{u}_1 &= 2\hat{\mathbf{e}}_1 + \hat{\mathbf{e}}_2, \\ \mathbf{u}_2 &= 2\hat{\mathbf{e}}_2 - \hat{\mathbf{e}}_3, \\ \mathbf{u}_3 &= \hat{\mathbf{e}}_1 + \hat{\mathbf{e}}_2 + \hat{\mathbf{e}}_3. \end{aligned}$$

Solution Manual For Continuum Mechanics Plasticity

David W A. Rees



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Solutions Manual for Continuum Mechanics and Plasticity Wu/Han-Chin, 2006-09-01 *Advances in Continuum Mechanics* Otto Brüller, Volker Mannl, Jerzy Najar, 2012-12-06 Recognized authors contributed to this collection of original papers from all fields of research in continuum mechanics Special emphasis is given to time dependent and independent permanent deformations damage and fracture Part of the contributions is dedicated to current efforts in describing material behavior with regard to e.g. anisotropy thermal effects softening ductile and brittle fracture porosity and granular structure Another part deals with numerical aspects arising from the implementation of material laws in the calculations of forming processes soil mechanics and structural mechanics Applications of theory and numerical methods belong to the following areas Comparison with experimental results from material testing metal forming under thermal and dynamic conditions failure by damage fracture and localized deformation modes The variety of treated topics provides a survey of the actual research in these fields therefore the book is addressed to those interested in special problems of continuum mechanics as well as to those interested in a general knowledge **Classical and Computational Solid Mechanics** Yuan-cheng Fung, Pin Tong, 2001 This invaluable book has been written for engineers and engineering scientists in a style that is readable precise concise and practical It gives first priority to the formulation of problems presenting the classical results as the gold standard and the numerical approach as a tool for obtaining solutions The classical part is a revision of the well known text *Foundations of Solid Mechanics* with a much expanded discussion on the theories of plasticity and large elastic deformation with finite strains The computational part is all new and is aimed at solving many major linear and nonlinear boundary value problems **Theory of Plasticity** Jagabandhu Chakrabarty, 2012-12-02 Plasticity is concerned with the mechanics of materials deformed beyond their elastic limit A strong knowledge of plasticity is essential for engineers dealing with a wide range of engineering problems such as those encountered in the forming of metals the design of pressure vessels the mechanics of impact civil and structural engineering as well as the understanding of fatigue and the economical design of structures Theory of Plasticity is the most comprehensive reference on the subject as well as the most up to date no other significant Plasticity reference has been published recently making this of great interest to academics and professionals This new edition presents extensive new material on the use of computational methods plus coverage of important developments in cyclic plasticity and soil plasticity A complete plasticity reference for graduate students researchers and practicing engineers no other book offers such an up to date or comprehensive reference on this key continuum mechanics subject Updates with new material on computational analysis and applications new end of chapter exercises Plasticity is a key subject in all mechanical engineering disciplines as well as in manufacturing engineering and civil engineering Chakrabarty is one of the subject's leading figures **Fundamentals of Metal Forming** Robert H. Wagoner, Jean-Loup Chenot, 1996-04-26 Designed as a textbook for courses on metal forming elasticity plasticity or continuum mechanics this

work incorporates finite element methods and operations analysis Emphasis is placed on physical intuition and numerous exercises are used throughout *Meshless Methods in Solid Mechanics* Youping Chen, James Lee, Azim Eskandarian, 2006-12-31 This book covers the fundamentals of continuum mechanics the integral formulation methods of continuum problems the basic concepts of finite element methods and the methodologies formulations procedures and applications of various meshless methods It also provides general and detailed procedures of meshless analysis on elastostatics elastodynamics non local continuum mechanics and plasticity with a large number of numerical examples Some basic and important mathematical methods are included in the Appendixes For readers who want to gain knowledge through hands on experience the meshless programs for elastostatics and elastodynamics are provided on an included disc

ABAQUS Theory Manual ,1997 *Technical Abstract Bulletin* ,1964 **Applied Mechanics Reviews** ,1981

Mechanics of Solids and Structures David W A. Rees, 2000 **Solutions Manual to Accompany Essentials of Materials Science** Albert G. Guy, 1976 **Classical And Computational Solid Mechanics (Second Edition)**

Yuen-cheng Fung, Pin Tong, Xiaohong Chen, 2017-05-25 The second edition provides an update of the recent developments in classical and computational solid mechanics The structure of the book is also updated to include five new areas Fundamental Principles of Thermodynamics and Coupled Thermoelastic Constitutive Equations at Large Deformations Functional Thermodynamics and Thermoviscoelasticity Thermodynamics with Internal State Variables and Thermo Elasto Viscoplasticity Electro Thermo Viscoelasticity Viscoplasticity and Meshless Method These new topics are added as self contained sections or chapters Many books in the market do not cover these topics This invaluable book has been written for engineers and engineering scientists in a style that is readable precise concise and practical It gives the first priority to the formulation of problems presenting the classical results as the gold standard and the numerical approach as a tool for obtaining solutions

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U.S. Government Research Reports, 1964 **Progress in Structural Mechanics**

Holm Altenbach, Jörg Hohe, Christian Mittelstedt, 2024-01-01 The book is devoted to the retirement of Prof Wilfried Becker a *liber amicorum* for a well known specialist in the field of structural mechanics Many excellent scientists from institutions around the world wrote their scientific chapters stressing the Becker's influence to structural mechanics Thus this collection discusses a lot of important problems and applications of mechanics

Singular Solutions in Plasticity Sergei Alexandrov, 2017-07-12 This book deals with singular solutions that appear in the vicinity of maximum friction surfaces for several rigid plastic models In particular it discusses precise asymptotic expansions as a necessary ingredient for the development of efficient numerical methods to solve boundary value problems that involve the maximum friction law as a boundary condition An applied aspect of the singular solutions considered is that these solutions are capable of predicting the development of narrow hard layers near frictional interfaces in manufacturing processes

Journal of Applied Mechanics, 1972 Publishes original research in all branches of mechanics including aerodynamics aeroelasticity boundary layers computational mechanics constitutive modeling of materials dynamics elasticity flow and fracture heat transfer hydraulics impact internal flow mechanical properties of materials micromechanics plasticity stress analysis structures thermodynamics turbulence vibration and wave propagation

Crystal Plasticity Wojciech Polkowski, 2021-04-27 The book presents a collection of 25 original papers including one review paper on state of the art achievements in the theory and practice of crystals plasticity The articles cover a wide scope of research on materials behavior subjected to external loadings starting from atomic scale simulations and a new methodological aspect to experiments on a structure and mechanical response upon a large scale processing Thus a presented contribution of researchers from 18 different countries can be virtually divided into three groups namely i modelling and simulation ii methodological aspects and iii experiments on process structure properties relationship Furthermore a large variety of materials are investigated including more conventional steels copper titanium nickel aluminum and magnesium alloys and advanced ones composites or high entropy alloys The book should be interesting for senior students researchers and engineers working within discipline of materials

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