

E4 Using material properties (Chapter 3)

These exercises introduce the reader to 2 useful resources: the data sheets of Appendix A and the Solutions to Standard Problems of Appendix B.

E4.1 A cantilever beam has a length $L = 50$ mm, a width $b = 5$ mm and a thickness $t = 1$ mm. It is made of an aluminum alloy. By how much will the end deflect under an end-load of 5 N? Use data from Appendix A4 for the (mean) value of Young's modulus of aluminum alloys, the equation for the elastic deflection of a cantilever from Appendix B3 and for the second moment of a beam from Appendix B2 to find out.

Answer. The deflection δ of a cantilever under an end load F is, from Appendix B,

$$\delta = \frac{FL^3}{3EI} \quad \text{with} \quad I = \frac{bt^3}{12}$$

The mean Young's modulus E for aluminum, from Appendix A4, is 75 GPa. Inserting the data from the question results in an end deflection $\delta = 6.7$ mm.

E4.2 A spring, wound from stainless steel wire with a wire diameter $d = 1$ mm, has $n = 20$ turns of radius $R = 10$ mm. How much will it extend when loaded with a mass F of 1 kg? Assume the shear modulus G of stainless steel to be $3/8 E$ where E is Young's modulus, retrieve this from Appendix A4, and use the expression for the extension of springs from Appendix B6 to find out.

Answer. The extension u of a spring under a force $F = F_g = 9.81$ N (here g is the acceleration due to gravity) is

$$u = \frac{64FR^3n}{Gd^4}$$

Young's modulus for stainless steel is 200 GPa, so shear modulus $G = 76$ GPa. Inserting the data gives a deflection $u = 10.4$ mm.

E4.3 A thick-walled tube has an inner radius $r_i = 10$ mm and an outer radius $r_o = 15$ mm. It is made from polycarbonate, PC. What is the maximum torque that the tube can carry without the onset of yield? Retrieve the (mean) yield strength σ_y of PC from Appendix A5, the expression for the torque at onset of yield from Appendix B6 and that for the polar moment of a thick walled tube from Appendix B2 to find out.

Answer. The torque at the onset of yield for a thick walled tube is

$$T_f = \frac{K\sigma_y}{2r_o} \quad \text{with} \quad K = \frac{\pi}{2}(r_o^4 - r_i^4)$$

The mean yield strength of σ_y of PC from Appendix A5 is 65 MPa.

Inserting the data from the question gives a torque at the onset of yield of $T_f = 138$ N.m.

E4.4 A round bar, 20 mm in diameter, has a shallow circumferential notch with a depth $v = 1$ mm with a root radius $r = 10$ microns. The bar is made of a low carbon steel with a yield strength of $\sigma_y = 250$ MPa. It is loaded axially with a nominal stress, σ_{nom} (the axial load divided by the un-notched area). At what value of σ_{nom} will yield first commence at the root of the notch? Use the stress concentration estimate of Appendix B8 to find out.

Answer. The stress concentration caused by notch of depth v and root radius r is

$$\frac{\sigma_{max}}{\sigma_{nom}} = 1 + a\left(\frac{v}{r}\right)^{1/2} \quad \text{with} \quad a = 2 \quad \text{for tension}$$

Yield first starts when $\sigma_{max} = \sigma_y$. Inserting the data from the question gives a nominal stress for first yield of 11.9 MPa. Stress concentrations can be very damaging – in this example, a cyclic stress of only ± 12 MPa will ultimately initiate a fatigue crack at the notch root.

Materials Selection Exercises And Solutions Ashby

**Susan McCahan, Phil Anderson, Mark
Kortschot, Peter E. Weiss, Kimberly A.
Woodhouse**

Materials Selection Exercises And Solutions Ashby:

Materials Selection in Mechanical Design Michael F. Ashby, 2004-12-30 Understanding materials their properties and behavior is fundamental to engineering design and a key application of materials science Written for all students of engineering materials science and design this book describes the procedures for material selection in mechanical design in order to ensure that the most suitable materials for a given application are identified from the full range of materials and section shapes available Fully revised and expanded for this third edition *Materials Selection in Mechanical Design* is recognized as one of the leading texts and provides a unique and genuinely innovative resource Features new to this edition New chapters on topics including process selection material and shape selection design of hybrid materials environmental factors and industrial design Reader friendly approach and attractive easy to use two color presentation The methods developed in the book are implemented in Granta Design s widely used CES Educational software Materials are introduced through their properties materials selection charts now available on line capture the important features of all materials allowing rapid retrieval of information and application of selection techniques Merit indices combined with charts allow optimization of the materials selection process Sources of material property data are reviewed and approaches to their use are given Material processing and its influence on the design are discussed New chapters on environmental issues industrial engineering and materials design are included as are new worked examples and exercise materials New case studies have been developed to further illustrate procedures and to add to the practical implementation of the text The new edition of the leading materials selection text Expanded and fully revised throughout with new material on key emerging topics an even more student friendly approach and attractive easy to use two color presentation

Materials and the Environment
Michael F. Ashby, 2012-05-04 *Materials and the Environment* Eco Informed Material Choice Second Edition is the first book devoted solely to the environmental aspects of materials and their selection production use and disposal by one of the world s foremost materials authorities It explores human dependence on materials and its environmental consequences and provides perspective background methods and data for thinking about and designing with materials to minimize their environmental impact Organized into 15 chapters this new edition looks at the history of our increasing dependence on materials and energy It explains where materials come from and how they are used in a variety of industries along with their life cycle and their relationship to energy and carbon It also examines controls and economic instruments that hinder the use of engineering materials considers sustainability from a materials perspective and highlights the importance of low carbon power and material efficiency Furthermore it discusses the mechanical thermal and electrical properties of engineering metals polymers ceramics composites and natural materials in relation to environmental issues The volume includes new chapters on Materials for Low Carbon Power and Material Efficiency all illustrated by in text examples and expanded exercises There are also new case studies showing how the methods discussed in the book can be applied to real world

situations This book is intended for instructors and students of Engineering Materials Science and Industrial Product Design as well as for materials engineers and product designers who need to consider the environmental implications of materials in their designs Introduces methods and tools for thinking about and designing with materials within the context of their role in products and the environmental consequences Contains numerous case studies showing how the methods discussed in the book can be applied to real world situations Includes full color data sheets for 40 of the most widely used materials featuring such environmentally relevant information as their annual production and reserves embodied energy and process energies carbon footprints and recycling data New to this edition New chapter of Case Studies of Eco audits illustrating the rapid audit method New chapter on Materials for Low Carbon Power examines the consequences for materials supply of a major shift from fossil fuel based power to power from renewables New chapter exploring Material Efficiency or design and management for manufacture to provide the services we need with the least production of materials Recent news clips from the world press that help place materials issues into a broader context are incorporated into all chapters End of chapter exercises have been greatly expanded The datasheets of Chapter 15 have been updated and expanded to include natural and man made fibers

Engineering Materials 1 David R.H. Jones, Michael F. Ashby, 2018-11-30 Widely adopted around the world Engineering Materials 1 is a core materials science and engineering text for third and fourth year undergraduate students it provides a broad introduction to the mechanical and environmental properties of materials used in a wide range of engineering applications The text is deliberately concise with each chapter designed to cover the content of one lecture As in previous editions chapters are arranged in groups dealing with particular classes of properties each group covering property definitions measurement underlying principles and materials selection techniques Every group concludes with a chapter of case studies that demonstrate practical engineering problems involving materials The 5th edition boasts expanded properties coverage new case studies more exercises and examples and all around improved pedagogy Engineering Materials 1 Fifth Edition is perfect as a stand alone text for a one semester course in engineering materials or a first text with its companion Engineering Materials 2 An Introduction to Microstructures and Processing in a two semester course or sequence New chapters on magnetic optical thermal and electrical properties with appropriate case studies of applications Improved pedagogy featuring more relevant photographs new glossary of terms additional worked examples plus 50% more exercises than in previous edition now graded according to difficulty Improved discussion of supply and demand in Chapter 2 Discussion at various points throughout the book of how nanomaterials can differ from larger scale materials in their properties New case studies on medical materials biomaterials

Introduction to Materials Science and Engineering Michael F. Ashby, Hugh Shercliff, David Cebon, 2023-08-01 Introduction to Materials Science and Engineering A Design Led Approach is ideal for a first course in materials for mechanical civil biomedical aerospace and other engineering disciplines The authors systematic method includes first analyzing and selecting properties to match materials to design through the use

of real world case studies and then examining the science behind the material properties to better engage students whose jobs will be centered on design or applied industrial research As with Ashby's other leading texts the book emphasizes visual communication through material property charts and numerous schematics better illustrate the origins of properties their manipulation and fundamental limits Design led approach motivates and engages students in the study of materials science and engineering through real life case studies and illustrative applications Requires a minimum level of math necessary for a first course in Materials Science and Engineering Highly visual full color graphics facilitate understanding of materials concepts and properties Chapters on materials selection and design are integrated with chapters on materials fundamentals enabling students to see how specific fundamentals can be important to the design process Several topics are expanded separately as Guided Learning Units Crystallography Materials Selection in Design Process Selection in Design and Phase Diagrams and Phase Transformations For instructors a solutions manual image bank and other ancillaries are available at <https://educate.elsevier.com/book/details/9780081023990>

Materials Michael F. Ashby, Hugh Shercliff, David Cebon, 2009-11-20 Materials Engineering Science Processing and Design Second Edition was developed to guide material selection and understanding for a wide spectrum of engineering courses The approach is systematic leading from design requirements to a prescription for optimized material choice This book presents the properties of materials their origins and the way they enter engineering design The book begins by introducing some of the design limiting properties physical properties mechanical properties and functional properties It then turns to the materials themselves covering the families the classes and the members It identifies six broad families of materials for design metals ceramics glasses polymers elastomers and hybrids that combine the properties of two or more of the others The book presents a design led strategy for selecting materials and processes It explains material properties such as yield and plasticity and presents elastic solutions for common modes of loading The remaining chapters cover topics such as the causes and prevention of material failure cyclic loading fail safe design and the processing of materials Design led approach motivates and engages students in the study of materials science and engineering through real life case studies and illustrative applications Highly visual full color graphics facilitate understanding of materials concepts and properties Chapters on materials selection and design are integrated with chapters on materials fundamentals enabling students to see how specific fundamentals can be important to the design process Links with the Cambridge Engineering Selector CES EduPack the powerful materials selection software See www.grantadesign.com for information NEW TO THIS EDITION Guided Learning sections on crystallography phase diagrams and phase transformations enhance students learning of these key foundation topics Revised and expanded chapters on durability and processing for materials properties More than 50 new worked examples placed throughout the text

Materials and Design Michael F. Ashby, Kara Johnson, 2013-12-19 Materials are the stuff of design From the very beginning of human history materials have been taken from the natural world and shaped modified and adapted for everything from primitive

tools to modern electronics This renowned book by noted materials engineering author Mike Ashby and industrial designer Kara Johnson explores the role of materials and materials processing in product design with a particular emphasis on creating both desired aesthetics and functionality The new edition features even more of the highly useful materials profiles that give critical design processing performance and applications criteria for each material in question The reader will find information ranging from the generic and commercial names of each material its physical and mechanical properties its chemical properties its common uses how it is typically made and processed and even its average price And with improved photographs and drawings the reader is taken even more closely to the way real design is done by real designers selecting the optimum materials for a successful product The best guide ever published on the on the role of materials past and present in product development by noted materials authority Mike Ashby and professional designer Kara Johnson now with even better photos and drawings on the Design Process Significant new section on the use of re cycled materials in products and the importance of sustainable design for manufactured goods and services Enhanced materials profiles with addition of new materials types like nanomaterials advanced plastics and bio based materials **Materials Experience** Elvin Karana, Owain Pedgley, Valentina Rognoli, 2013-10-24 There currently exists an abundance of materials selection advice for designers suited to solving technical product requirements In contrast a stark gap can be found in current literature that articulates the very real personal social cultural and economic connections between materials and the design of the material world In *Materials Experience* Fundamentals of Materials and Design thirty four of the leading academicians and experts alongside 8 professional designers have come together for the first time to offer their expertise and insights on a number of topics common to materials and product design The result is a very readable and varied panorama on the world of materials and product design as it currently stands Contributions by many of the most prominent materials experts and designers in the field today with a foreword by Mike Ashby The book is organized into 4 main themes sustainability user interaction technology and selection Between chapters you will find the results of interviews conducted with internationally known designers These designer perspectives will provide a time out from the academic articles with emphasis placed on fascinating insights product examples and visuals *How Materials Matter* Graeme Were, 2019-03-27 How does design and innovation shape people s lives in the Pacific Focusing on plant materials from the region *How Materials Matter* reveals ways in which a variety of people from craftswomen and scientists to architects and politicians work with materials to transform worlds Recognizing the fragile and ephemeral nature of plant fibres this work delves into how the biophysical properties of certain leaves and their aesthetic appearance are utilized to communicate information and manage different forms of relations It breaks new ground by situating plant materials at the centre of innovation in a region *Mathematical Modelling of Weld Phenomena: No. 4* H. Cerjak, 2024-11-01 Contains the papers presented at the fourth International Seminar Numerical Analysis of Weldability held in September 1997 at Schloss Seggau near Graz Austria *Material Selections by a Hybrid*

Multi-Criteria Approach Fabrizio D'Errico, 2015-01-16 This Brief presents a new method that is based on the author and his students shared experience in applying a structured procedure that has as its main goal the creation of a material selection technique that uses language and employs a platform that is not restricted to engineers Based on a hybrid approach that exploits both traditional and semi quantitative concepts it moves forward step by step and uses a platform based on a Quality Function Deployment matrix framework Candidate materials are screened out and finally assessed by two user friendly graphic analysis tools one based on the value curve of the product and the other on an original Bubble Maps tool The Brief is written for all those whose aim is for a better understanding of how to integrate and speed up the entire product development process from the initial product concept and engineering design phases to design specs manufacturability and product marketing with optimal choice of materials

Mathematical Modelling of Weld Phenomena 4 H. Cerjak, 1998 Contains the papers presented at the fourth International Seminar Numerical Analysis of Weldability held in September 1997 at Schloss Seggau near Graz Austria

Proceedings of the 20th Congress of the International Ergonomics Association (IEA 2018) Sebastiano Bagnara, Riccardo Tartaglia, Sara Albolino, Thomas Alexander, Yushi Fujita, 2018-08-10 This book presents the proceedings of the 20th Congress of the International Ergonomics Association IEA 2018 held on August 26 30 2018 in Florence Italy By highlighting the latest theories and models as well as cutting edge technologies and applications and by combining findings from a range of disciplines including engineering design robotics healthcare management computer science human biology and behavioral science it provides researchers and practitioners alike with a comprehensive timely guide on human factors and ergonomics It also offers an excellent source of innovative ideas to stimulate future discussions and developments aimed at applying knowledge and techniques to optimize system performance while at the same time promoting the health safety and wellbeing of individuals The proceedings include papers from researchers and practitioners scientists and physicians institutional leaders managers and policy makers that contribute to constructing the Human Factors and Ergonomics approach across a variety of methodologies domains and productive sectors This volume includes papers addressing the following topics Ergonomics in Design Activity Theories for Work Analysis and Design and Affective Design

Designing Engineers Susan McCahan, Phil Anderson, Mark Kortschot, Peter E. Weiss, Kimberly A. Woodhouse, 2015-01-27 Designing Engineers First Edition is written in short modules where each module is built around a specific learning outcome and is cross referenced to the other modules that should be read as pre requisites and could be read in tandem with or following that module The book begins with a brief orientation to the design process followed by coverage of the design process in a series of short modules The rest of the book contains a set of modules organized in several major categories Communication Critical Thinking Teamwork Project Management and Design for Specific Factors e g environmental human factors intellectual property A resource section provides brief reference material on economics failure and risk probability and statistics principles problem solving and estimation

Handbook of

Research on Recent Developments in Materials Science and Corrosion Engineering Education Lim, Hwee

Ling, 2015-02-28 The latest research innovations and enhanced technologies have altered the discipline of materials science and engineering As a direct result of these developments new trends in Materials Science and Engineering MSE pedagogy have emerged that require attention The Handbook of Research on Recent Developments in Materials Science and Corrosion Engineering Education brings together innovative and current advances in the curriculum design and course content of MSE education programs Focusing on the application of instructional strategies pedagogical frameworks and career preparation techniques this book is an essential reference source for academicians engineering practitioners researchers and industry professionals interested in emerging and future trends in MSE training and education **Manufacturing and Design** Erik

Tempelman, Hugh Shercliff, Bruno Ninaber van Eyben, 2014-03-03 Manufacturing and Design presents a fresh view on the world of industrial production thinking in terms of both abstraction levels and trade offs The book invites its readers to distinguish between what is possible in principle for a certain process as determined by physical law what is possible in practice the production method as determined by industrial state of the art and what is possible for a certain supplier as determined by its production equipment Specific processes considered here include metal forging extrusion and casting plastic injection molding and thermoforming additive manufacturing joining recycling and more By tackling the field of manufacturing processes from this new angle this book makes the most out of a reader s limited time It gives the knowledge needed to not only create well producible designs but also to understand supplier needs in order to find the optimal compromise Apart from improving design for production this publication raises the standards of thinking about producibility Emphasizes the strong link between product design and choice of manufacturing process Introduces the concept of a production triangle to highlight tradeoffs between function cost and quality for different manufacturing methods Balanced sets of questions are included to stimulate the reader s thoughts Each chapter ends with information on the production methods commonly associated with the principle discussed as well as pointers for further reading Hints to chapter exercises and an appendix on long exercises with worked solutions available on the book s companion site <http://booksite.elsevier.com/9780080999227>

The International Journal of Mechanical Engineering Education ,1988 **Choice** ,1981 *Sci-tech News* ,2003 *Journal of Applied Mechanics* ,1977 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 [Metals Abstracts](#) ,1980

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