

## Thermodynamics An Engineering Pproach 4th Edition Solution

The book is engineering oriented and covers a large variety of topics ranging from fundamental principles to performance evaluation and applications. It is written systematically and completely on the subject with a summary of state-of-the-art fuel cell technology, filling the need for a timely resource. This is a unique book serving academic researchers, engineers, as well as people working in the fuel cell industry. It is also of substantial interest to students, engineers, and scientists in mechanical engineering, chemistry and chemical engineering, electrochemistry, materials science and engineering, power generation and propulsion systems, and automobile engineering.

This innovative book uses unifying themes so that the boundaries between thermodynamics, heat transfer, and fluid mechanics become transparent. It begins with an introduction to the numerous engineering applications that may require the integration of principles and tools from these disciplines. The authors then present an in-depth examination of the three disciplines, providing readers with the necessary background to solve various engineering problems. The remaining chapters delve into the topics in more detail and rigor. Numerous practical engineering applications are mentioned throughout to illustrate where and when certain equations, concepts, and topics are needed. A comprehensive introduction to thermodynamics, fluid mechanics, and heat transfer, this title: Develops governing equations and approaches in sufficient detail, showing how the equations are based on fundamental conservation laws and other basic concepts. Explains the physics of processes and phenomena with language and examples that have been seen and used in everyday life. Integrates the presentation of the three subjects with common notation, examples, and problems. Demonstrates how to solve any problem in a systematic, logical manner. Presents material appropriate for an introductory level course on thermodynamics, heat transfer, and fluid mechanics.

This book is devoted to the analysis and applications of energy, exergy, and environmental issues in all sectors of the economy, including industrial processes, transportation, buildings, and services. Energy sources and technologies considered are hydrocarbons, wind and solar energy, fuel cells, as well as thermal and electrical storage. This book provides theoretical insights, along with state-of-the-art case studies and examples and will appeal to the academic community, but also to energy and environmental professionals and decision makers.

Cengel and Cimbala's Fluid Mechanics Fundamentals and Applications, communicates directly with tomorrow's engineers in a simple yet precise manner. The text covers the basic principles and equations of fluid mechanics in the context of numerous and diverse real-world engineering examples. The text helps students develop an intuitive understanding of fluid mechanics by emphasizing the physics, using figures, numerous photographs and visual aids to reinforce the physics. The highly visual approach enhances the learning of Fluid mechanics by students. This text distinguishes itself from others by the way the material is presented - in a progressive order from simple to more difficult, building each chapter upon foundations laid down in previous chapters. In this way, even the traditionally challenging aspects of fluid mechanics can be learned effectively. McGraw-Hill's Connect, is also available as an optional, add on item. Connect is the only integrated learning system that empowers students by continuously adapting to deliver precisely what they need, when they need it, how they need it, so that class time is more effective. Connect allows the professor to assign homework, quizzes, and tests easily and automatically grades and records the scores of the student's work. Problems are randomized to prevent sharing of answers and may also have a "multi-step solution" which helps move the students' learning along if they experience difficulty.

This second companion volume on engineering studies considers engineering practice including contextual analyses of engineering identity, epistemologies and values. Key overlapping questions examine such issues as an engineering identity, engineering self-understandings enacted in the professional world, distinctive characters of engineering knowledge and how engineering science and engineering design interact in practice. Authors bring with them perspectives from their institutional homes in Europe, North America, Australia and Asia. The volume includes 24 contributions by more than 30 authors from engineering, the social sciences and the humanities. Additional issues the chapters scrutinize include prominent norms of engineering, how they interact with the values of efficiency or environmental sustainability. A concluding set of articles considers the meaning of context more generally by asking if engineers create their own contexts or are they created by contexts. Taken as a whole, this collection of original scholarly work is unique in its broad, multidisciplinary consideration of the changing character of engineering practice.

This book investigates the adsorption dynamics of water, methanol, ethanol, and ammonia vapor on loose and consolidated adsorbent beds, as well as the impact of this aspect on the overall performance of adsorption systems for heat transformation. In particular, it presents the results of kinetic measurements made using the large temperature jump (LTJ) method, the most efficient way to study adsorption dynamics under realistic operating conditions for adsorptive heat transformers. The information provided is especially beneficial for all those working on the development of novel adsorbent materials and advanced adsorbers for heating and cooling applications. Today, technologies and systems based on adsorption heat transformation (AHT) processes offer a fascinating option for meeting the growing worldwide demand for air conditioning and space heating. Nevertheless, considerable efforts must still be made in order to enhance performance so as to effectively compete with commonly used electrical compression and absorption machines. For this purpose, intelligent design for adsorption units should above all focus on finding a convenient choice of adsorbent material by means of a comprehensive analysis that takes into account both thermodynamic and dynamic aspects. While the thermodynamic properties of the AHT cycle have been studied extensively, the dynamic optimization of AHT adsorbers is still an open issue. Several efforts have recently been made in order to analyze AHT dynamics, which greatly influence overall AHT performance.

Cengel and Cimbala's Fluid Mechanics Fundamentals and Applications, communicates directly with tomorrow's engineers in a simple yet precise manner, while covering the basic principles and equations of fluid mechanics in the context of numerous and diverse real-world engineering examples. The text helps students develop an intuitive understanding of fluid mechanics by emphasizing the physics, using figures, numerous photographs and visual aids to reinforce the physics. The highly visual approach enhances the learning of fluid mechanics by students. This text distinguishes itself from others by the way the material is presented - in a progressive order from simple to more difficult, building each chapter upon foundations laid down in previous chapters. In this way, even the traditionally challenging aspects of fluid mechanics can be learned effectively. McGraw-Hill's Connect, is also available as an optional, add on item. Connect is the only integrated learning system that empowers students by continuously adapting to deliver precisely what they need, when they need it, how they need it, so that class time is more effective. Connect allows the professor to assign homework, quizzes, and tests easily and automatically grades and records the scores of the student's work. Problems are randomized to prevent sharing of answers and may also have a "multi-step solution" which helps move the students' learning along if they experience difficulty.

Engineering students in a wide variety of engineering disciplines from mechanical and chemical to biomedical and materials engineering must master the principles of transport phenomena as an essential tool in analyzing and designing any system or systems wherein momentum, heat and mass are transferred. This textbook was developed to address that need, with a clear presentation of the fundamentals, ample problem sets to reinforce that knowledge, and tangible examples of how this knowledge is put to use in engineering design. Professional engineers, too, will find this book invaluable as reference for everything from heat exchanger design to chemical processing system design and more. \* Develops an understanding of the thermal and physical behavior of multiphase systems with phase change,

including microscale and porosity, for practical applications in heat transfer, bioengineering, materials science, nuclear engineering, environmental engineering, process engineering, biotechnology and nanotechnology \* Brings all three forms of phase change, i.e., liquid vapor, solid liquid and solid vapor, into one volume and describes them from one perspective in the context of fundamental treatment \* Presents the generalized integral and differential transport phenomena equations for multi-component multiphase systems in local instance as well as averaging formulations. The molecular approach is also discussed with the connection between microscopic and molecular approaches \* Presents basic principles of analyzing transport phenomena in multiphase systems with emphasis on melting, solidification, sublimation, vapor deposition, condensation, evaporation, boiling and two-phase flow heat transfer at the micro and macro levels \* Solid/liquid/vapor interfacial phenomena, including the concepts of surface tension, wetting phenomena, disjoining pressure, contact angle, thin films and capillary phenomena, including interfacial balances for mass, species, momentum, and energy for multi-component and multiphase interfaces are discussed \* Ample examples and end-of-chapter problems, with Solutions Manual and PowerPoint presentation available to the instructors

Understanding the sustainable use of energy in various processes is an integral part of engineering and scientific studies, which rely on a sound knowledge of energy systems. Whilst many institutions now offer degrees in energy-related programs, a comprehensive textbook, which introduces and explains sustainable energy systems and can be used across engineering and scientific fields, has been lacking. Energy: Production, Conversion, Storage, Conservation, and Coupling provides the reader with a practical understanding of these five main topic areas of energy including 130 examples and over 600 practice problems. Each chapter contains a range of supporting figures, tables, thermodynamic diagrams and charts, while the Appendix supplies the reader with all the necessary data including the steam tables. This new textbook presents a clear introduction of basic vocabulary, properties, forms, sources, and balances of energy before advancing to the main topic areas of: • Energy production and conversion in important physical, chemical, and biological processes, • Conservation of energy and its impact on sustainability, • Various forms of energy storage, and • Energy coupling and bioenergetics in living systems. A solution manual for the practice problems of the textbook is offered for the instructor. Energy: Production, Conversion, Storage, Conservation, and Coupling is a comprehensive source, study guide, and course supplement for both undergraduates and graduates across a range of engineering and scientific disciplines. Resources including the solution manual for this textbook are available for instructors on sending a request to Dr. Yaoar Demirel at ydemirel@unl.edu

With complete coverage of the basic principles of heat transfer and a broad range of applications in a flexible format, Heat and Mass Transfer: Fundamentals and Applications, by Yunus Cengel and Afshin Ghajar provides the perfect blend of fundamentals and applications. The text provides a highly intuitive and practical understanding of the material by emphasizing the physics and the underlying physical phenomena involved. This text covers the standard topics of heat transfer with an emphasis on physics and real-world every day applications, while de-emphasizing mathematical aspects. This approach is designed to take advantage of students' intuition, making the learning process easier and more engaging. McGraw-Hill is also proud to offer Connect with the fifth edition of Cengel's Heat and Mass Transfer: Fundamentals and Applications. This innovative and powerful new system helps your students learn more efficiently and gives you the ability to assign homework problems simply and easily. Problems are graded automatically, and the results are recorded immediately. Track individual student performance - by question, assignment, or in relation to the class overall with detailed grade reports. ConnectPlus provides students with all the advantages of Connect, plus 24/7 access to an eBook. Cengel's Heat and Mass Transfer includes the power of McGraw-Hill's LearnSmart--a proven adaptive learning system that helps students learn faster, study more efficiently, and retain more knowledge through a series of adaptive questions. This innovative study tool pinpoints concepts the student does not understand and maps out a personalized plan for success.

An advanced, practical approach to the first and second laws of thermodynamics Advanced Engineering Thermodynamics bridges the gap between engineering applications and the first and second laws of thermodynamics. Going beyond the basic coverage offered by most textbooks, this authoritative treatment delves into the advanced topics of energy and work as they relate to various engineering fields. This practical approach describes real-world applications of thermodynamics concepts, including solar energy, refrigeration, air conditioning, thermofluid design, chemical design, constructal design, and more. This new fourth edition has been updated and expanded to include current developments in energy storage, distributed energy systems, entropy minimization, and industrial applications, linking new technologies in sustainability to fundamental thermodynamics concepts. Worked problems have been added to help students follow the thought processes behind various applications, and additional homework problems give them the opportunity to gauge their knowledge. The growing demand for sustainability and energy efficiency has shined a spotlight on the real-world applications of thermodynamics. This book helps future engineers make the fundamental connections, and develop a clear understanding of this complex subject. Delve deeper into the engineering applications of thermodynamics Work problems directly applicable to engineering fields Integrate thermodynamics concepts into sustainability design and policy Understand the thermodynamics of emerging energy technologies Condensed introductory chapters allow students to quickly review the fundamentals before diving right into practical applications. Designed expressly for engineering students, this book offers a clear, targeted treatment of thermodynamics topics with detailed discussion and authoritative guidance toward even the most complex concepts. Advanced Engineering Thermodynamics is the definitive modern treatment of energy and work for today's newest engineers.

Papers presented at the second biennial Information Systems Foundations ('Constructing and Criticising') Workshop, held at The Australian National University in Canberra from 16-17 July 2004. The focus of the workshop was, as for the first in the series, the foundations of Information Systems as an academic discipline. The particular emphasis was on the adequacy and completeness of theoretical underpinnings and the research methods employed.

This textbook provides a concise, systematic treatment of essential theories and practical aspects of refrigeration and air-conditioning systems. It is designed for students pursuing courses in mechanical engineering both at diploma and degree level with a view to equipping them with a fundamental background necessary to understand the latest

methodologies used for the design of refrigeration and air-conditioning systems. After reviewing the physical principles, the text focuses on the refrigeration cycles commonly used in air-conditioning applications in tropical climates. The subject of psychrometry for analysing the various thermodynamic processes in air conditioning is particularly dealt with in considerable detail. The practical design problems require comprehensive use of tables and charts prepared by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). This text incorporates such tables and charts so that the students are exposed to solving real-life design problems with the help of ASHRAE Tables. Finally, the book highlights the features, characteristics and selection criteria of hardware including the control equipment. It also provides the readers with the big picture in respect of the latest developments such as thermal storage air conditioning, desiccant cooling, chilled ceiling cooling, Indoor Air Quality (IAQ) and thermal comfort. Besides the students, the book would be immensely useful to practising engineers as a ready reference.

With new chapters, homework problems, case studies, figures, and examples, *Ballistics: Theory and Design of Guns and Ammunition*, Third Edition encourages superior design and innovative applications in the field of ballistics. It examines the analytical and computational tools for predicting a weapon's behavior in terms of pressure, stress, and velocity, demonstrating their applications in ammunition and weapons design. New coverage in the Third Edition includes gas-powered guns, and naval ordinance. With its thorough coverage of interior, exterior and terminal ballistics, this new edition continues to be the standard resource for those studying the technology of guns and ammunition. The first two editions of *Concise Chemical Thermodynamics* proved to be a very popular introduction to a subject many undergraduate students perceive to be difficult due to the underlying mathematics. With its concise explanations and clear examples, the text has for the past 40 years clarified for countless students one of the most complicated branches of science. First published in 1995, *The Engineering Handbook* quickly became the definitive engineering reference. Although it remains a bestseller, the many advances realized in traditional engineering fields along with the emergence and rapid growth of fields such as biomedical engineering, computer engineering, and nanotechnology mean that the time has come to bring this standard-setting reference up to date. New in the Second Edition 19 completely new chapters addressing important topics in bioinstrumentation, control systems, nanotechnology, image and signal processing, electronics, environmental systems, structural systems 131 chapters fully revised and updated Expanded lists of engineering associations and societies *The Engineering Handbook*, Second Edition is designed to enlighten experts in areas outside their own specialties, to refresh the knowledge of mature practitioners, and to educate engineering novices. Whether you work in industry, government, or academia, this is simply the best, most useful engineering reference you can have in your personal, office, or institutional library.

*Fuel Cell Engines* is an introduction to the fundamental principles of electrochemistry, thermodynamics, kinetics, material science and transport applied specifically to fuel cells. It covers scientific fundamentals and provides a basic understanding that enables proper technical decision-making.

Accompanying DVD-ROM contains the Limited Academic Version of EES (Engineering Equation Solver) software with scripted solutions to selected text problems.

The focus of *Thermodynamics: Concepts and Applications* is on traditional thermodynamics topics, but structurally the book introduces the thermal-fluid sciences. Chapter 2 includes essentially all material related to thermodynamic properties clearly showing the hierarchy of thermodynamic state relationships. Element conservation is considered in Chapter 3 as a way of expressing conservation of mass. Constant-pressure and volume combustion are considered in Chapter 5 - Energy Conservation. Chemical and phase equilibria are treated as a consequence of the 2nd law in Chapter 6. 2nd law topics are introduced hierarchically in one chapter, important structure for a beginner. The book is designed for the instructor to select topics and combine them with material from other chapters seamlessly. Pedagogical devices include: learning objectives, chapter overviews and summaries, historical perspectives, and numerous examples, questions and problems and lavish illustrations. Students are encouraged to use the National Institute of Science and Technology (NIST) online properties database.

The 4th Edition of *Cengel & Boles Thermodynamics: An Engineering Approach* takes thermodynamics education to the next level through its intuitive and innovative approach. A long-time favorite among students and instructors alike because of its highly engaging, student-oriented conversational writing style, this book is now the most widely adopted thermodynamics text in the U.S. and in the world. This book differs from other thermodynamics texts in its objective which is to provide engineers with the concepts, tools, and experience needed to solve practical real-world energy problems. The presentation integrates computer tools (e.g., EES) with thermodynamic concepts to allow engineering students and practising engineers to solve problems they would otherwise not be able to solve. The use of examples, solved and explained in detail, and supported with property diagrams that are drawn to scale, is ubiquitous in this textbook. The examples are not trivial, drill problems, but rather complex and timely real world problems that are of interest by themselves. As with the presentation, the solutions to these examples are complete and do not skip steps. Similarly the book includes numerous end of chapter problems, both typeset and online. Most of these problems are more detailed than those found in other thermodynamics textbooks. The supplements include complete solutions to all exercises, software downloads, and additional content on selected topics. These are available at the book web site [www.cambridge.org/KleinandNellis](http://www.cambridge.org/KleinandNellis).

Thermal systems play an increasingly symbiotic role alongside mechanical systems in varied applications spanning materials processing, energy conversion, pollution, aerospace, and automobiles.

Responding to the need for a flexible, yet systematic approach to designing thermal systems across such diverse fields, *Design and Optimization of Thermal*

*Natural Phenomena* consist of simultaneously occurring transport processes and chemical reactions. These processes may interact with each other and lead to instabilities, fluctuations, and evolutionary systems. This book explores the unifying role of thermodynamics in natural phenomena. *Nonequilibrium Thermodynamics*, Second Edition analyzes the transport processes of energy, mass, and momentum transfer processes, as well as chemical reactions. It considers various processes occurring simultaneously, and provides students with more realistic analysis and modeling by accounting possible interactions between them. This second edition updates and expands on the first edition by focusing on the balance equations of mass, momentum, energy, and entropy together with the Gibbs equation for coupled processes of physical, chemical, and biological systems. Every chapter contains examples and practical problems to be solved. This book will be effective in senior and graduate education in chemical, mechanical, systems, biomedical, tissue, biological, and biological systems engineering, as well as physical, biophysical, biological, chemical, and biochemical sciences. Will help readers in understanding and modelling some of the coupled and complex systems, such as coupled transport and chemical reaction cycles in biological systems Presents a unified approach for interacting processes - combines analysis of transport and rate processes Introduces the theory of nonequilibrium thermodynamics and its use in simultaneously occurring transport processes and chemical reactions of physical, chemical, and

biological systems A useful text for students taking advanced thermodynamics courses

This expansive reference on the use of clean energy technologies in the aviation industry focuses on tools and solutions for maximizing the energy efficiency of aircrafts, airports, and other auxiliary components of air transit. Key topics range from predicting impacts of avionics and control systems to energy/exergy performance analyses of flight mechanics and computational fluid dynamics. The book includes findings both from experimental investigations and functional extant systems, ranging from propulsion technologies for aerospace vehicles to airport design to energy recovery systems. Engineers, researchers and students will benefit from the broad reach and numerous engineering examples provided.

Ron DiPippo, Professor Emeritus at the University of Massachusetts Dartmouth, is a world-regarded geothermal expert. This single resource covers all aspects of the utilization of geothermal energy for power generation from fundamental scientific and engineering principles. The thermodynamic basis for the design of geothermal power plants is at the heart of the book and readers are clearly guided on the process of designing and analysing the key types of geothermal energy conversion systems. Its practical emphasis is enhanced by the use of case studies from real plants that increase the reader's understanding of geothermal energy conversion and provide a unique compilation of hard-to-obtain data and experience. An important new chapter covers Environmental Impact and Abatement Technologies, including gaseous and solid emissions; water, noise and thermal pollutions; land usage; disturbance of natural hydrothermal manifestations, habitats and vegetation; minimisation of CO<sub>2</sub> emissions and environmental impact assessment. The book is illustrated with over 240 photographs and drawings. Nine chapters include practice problems, with solutions, which enable the book to be used as a course text. Also includes a definitive worldwide compilation of every geothermal power plant that has operated, unit by unit, plus a concise primer on the applicable thermodynamics. \* Engineering principles are at the heart of the book, with complete coverage of the thermodynamic basis for the design of geothermal power systems \*

Practical applications are backed up by an extensive selection of case studies that show how geothermal energy conversion systems have been designed, applied and exploited in practice \* World renowned geothermal expert DiPippo has including a new chapter on Environmental Impact and Abatement Technology in this new edition

Thermodynamics, An Engineering Approach, covers the basic principles of thermodynamics while presenting a wealth of real-world engineering examples, so students get a feel for how thermodynamics is applied in engineering practice. This text helps students develop an intuitive understanding by emphasizing the physics and physical arguments.

Cengel and Boles explore the various facets of thermodynamics through careful explanations of concepts and use of numerous practical examples and figures, having students develop necessary skills to bridge the gap between knowledge, and the confidence to properly apply their knowledge. The 9th edition offers new video and applet tools inside Connect. McGraw-Hill Education's Connect, is also available as an optional, add on item. Connect is the only integrated learning system that empowers students by continuously adapting to deliver precisely what they need, when they need it, how they need it, so that class time is more effective. Connect allows the professor to assign homework, quizzes, and tests easily and automatically grades and records the scores of the student's work. Problems are randomized to prevent sharing of answers and may also have a "multi-step solution" which helps move the students' learning along if they experience difficulty.

Covers the basic principles and equations of fluid mechanics in the context of numerous and diverse real-world engineering examples. This title helps students develop an intuitive understanding of fluid mechanics by emphasizing the physics, using figures, numerous photographs and visual aids to reinforce the physics.

Master the principles and applications of today's renewable energy sources and systems Written by a team of recognized experts and educators, this authoritative textbook offers comprehensive coverage of all major renewable energy sources. The book delves into the main renewable energy topics such as solar, wind, geothermal, hydropower, biomass, tidal, and wave, as well as hydrogen and fuel cells. By stressing real-world relevancy and practical applications, Fundamentals and Applications of Renewable Energy helps prepare students for a successful career in renewable energy. The text contains detailed discussions on the thermodynamics, heat transfer, and fluid mechanics aspects of renewable energy systems in addition to technical and economic analyses. Numerous worked-out example problems and over 850 end-of-chapter review questions reinforce main concepts, formulations, design, and analysis. Coverage includes: Renewable energy basics Thermal sciences overview Fundamentals and applications of Solar energy Wind energy Hydropower Geothermal energy Biomass energy Ocean energy Hydrogen and fuel cells • Economics of renewable energy • Energy and the environment

Foundation of Mechanical Engineering is solely written with the view to help B.E. I year students to master the difficult concepts. Needless to emphasize, this new book has been designed a self learning capsule. With this aim in view, the material has been organised in a logical order and lots of solved problems and line diagrams have been incorporated to enable students to thoroughly master of the subject. It is believed that this book, solely for B.E. I year students of all branches of Engineering, will captivate the attention of senior students as well as teachers.

Energy Efficient Thermal Management of Data Centers examines energy flow in today's data centers. Particular focus is given to the state-of-the-art thermal management and thermal design approaches now being implemented across the multiple length scales involved. The impact of future trends in information technology hardware, and emerging software paradigms such as cloud computing and virtualization, on thermal management are also addressed. The book explores computational and experimental characterization approaches for determining temperature and air flow patterns within data centers. Thermodynamic analyses using the second law to improve energy efficiency are introduced and used in proposing improvements in cooling methodologies. Reduced-order modeling and robust multi-objective design of next generation data centers are discussed.

Thermodynamics An Engineering Approach

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The 2016 International Conference on Advances in Energy and Environment Research (ICAEER 2016) took place on August 12-14, 2016 in Guangzhou, China. ICAEER 2016 has been a meeting place for innovative academics and industrial experts in the field of energy and environment research. The primary goal of the conference is to promote research and developmental activities in energy and environment research and further to promote scientific information exchange between researchers, developers, engineers, students, and practitioners working all around the world. The conference will be organized every year making it an ideal platform for people to share views and experiences in energy and environment research and related areas. ICAEER 2016 is dedicated to presenting and publishing novel and fundamental advances in energy and environment research fields. Scholars and specialists on ICAEER 2016, originating from over 10 countries or regions, have shared their knowledge and interesting research results. During the conference, an international stage was prepared for the participants to present their theoretical studies and practical applications.

This book describes the fundamentals and applications of compact heat exchangers in energy generation. The text focuses on their efficiency impacts on power systems, particularly emphasizing alternative energy sources such as Concentrated Solar Power and nuclear plants. The various types of compact heat exchanger surfaces and designs are given thorough consideration before the author turns his attention to describing how these compact heat exchangers can be applied to innovative plant designs, and how to conduct operational and safety analyses to optimize thermal efficiency. The book is written at an undergraduate level, but will be useful to practicing engineers and scientists as well.

Thermal-Fluid Sciences is a truly integrated textbook for engineering courses covering thermodynamics, heat transfer and fluid mechanics. This integration is based on: 1. The fundamental conservation principles of mass, energy, and momentum; 2. A hierarchical grouping of related topics; 3. The early introduction and revisiting of practical device examples and applications. As with all great textbooks the focus is on accuracy and accessibility. To enhance the learning experience Thermal-Fluid Sciences features full color illustrations. The robust pedagogy includes: chapter learning objectives, overviews, historical vignettes, numerous examples which follow a consistent problem-solving format enhanced by innovative self tests and color coding to highlight significant equations and advanced topics. Each chapter concludes with a brief summary and a unique checklist of key concepts and definitions. Integrated tutorials show the student how to use modern software including the NIST Database (included on the in-text CD) to obtain thermodynamic and transport properties.

The building sector exerts huge pressure on the built and natural environment and despite significant efforts to minimise the consequences, the International Energy Agency submitted that, by 2050, emissions related to buildings could double. However, in the building sector, significant improvement in energy use and reduction in greenhouse gas emissions can be achieved, given the potential to do this at no cost, using new technology. Since most buildings that exist now will still exist in 2050, the greatest energy savings can be made through refurbishment. In the future, legislation on carbon usage, as well as innovative technologies and knowledge, will trigger aggressive emission reductions in buildings, and this will compel installers of retrofit options to consider embodied emissions in order to achieve the best-value retrofit plan. This book, in response to the growing environmental importance of retrofit options, describes the development of a powerful decision support system, detailing both theoretical and practical insights, for the evaluation of environmentally and economically optimal retrofit options for non-domestic buildings. The chapters within it discuss engineering, energy, environment and economics in the context of climate change and sustainability, while a methodological framework of a decision support system is used to analyse a range of building energy retrofit options. The theoretical developments provided in this book can be transferred to other industries beyond the built environment and will be useful to researchers, energy systems engineers, architects, building energy managers, supply chain and procurement managers, sustainability managers and policy makers.

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