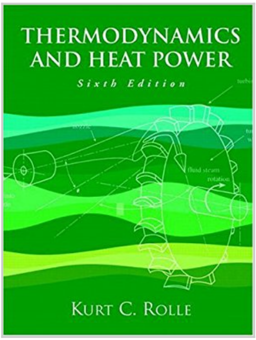

Thermodynamics and Heat Power (6th Edition)

By Kurt C. Rolle

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This book presents learners with the fundamental concepts of thermodynamics and their practical application to heat power, heat transfer, and heating and air conditioning. It addresses real-world problems in engineering and design - rather than focusing on abstract mathematics. Chapter topics include the thermodynamic system; work, heat, and reversibility; conservation of mass and the first law of thermodynamics; equations of state and calorimetry; availability and useful work; the internal combustion engine and the Otto and Diesel cycles; gas turbines, jet propulsion, and the Brayton cycle; steam power generation and the Rankine cycle; refrigeration and heat pumps; and much more. For use in engineering technology programs.

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Editorial Review

From the Publisher
A new edition of this popular, practical presentation of thermodynamics and its applications...the one specifically designed for mechanical, manufacturing, industrial, and engineering technology programs. Thermodynamics and Heat Power, Fourth Edition provides a complete introduction to convection, conduction, and radiation heat transfer; and examines application of thermodynamic principles to power-producing and consuming mechanical devices such as nozzles, pumps, turbines, gas and steam engines, heat pumps, and refrigeration systems.

From the Back Cover

Designed specifically for use in engineering technology programs, this popular text presents the fundamental concepts of thermodynamics and their practical applications to heat power, heat transfer, and heating and air conditioning. The text addresses real-world problems in engineering and design rather than abstract mathematics.

New to this edition:

- Inclusion of optional discussions on using *Engineering Equation Solver* (EES) as a commercial software tool for solving many of the problems encountered in thermodynamics and heat power
- Addition of refrigerant blends R-407c and R-502 to the discussion of refrigerants in response to the increased applications of refrigerant blends in mechanical refrigeration
- Expanded presentation of fuel cells

Features of this text:

- Unique **optional *Calculus for Clarity*** sections for students who have a background in differential and integral calculus
- A consistent system of symbols and units that makes equal use of **SI and English units** in practice problems, example problems, and thermodynamic and property tables
- An eight-chapter treatment of **heat power/combustion/transfer and HVAC** that is one of the most extensive available in a text at this level

This edition has been prepared with the same goals and intentions of the past five editions: to present, in a clear, correct, and complete manner, the fundamental concepts of thermodynamics and heat transfer and to demonstrate their applications. I have held closely to the presentation of the fifth edition and emphasized design and real-world applications. The understanding or use of calculus is not mandatory for studying the text or doing most of the practice problems. I still feel that the subject matter is too important and practical to be inaccessible to those who do not have a strong background in mathematics.

The major addition to this volume is the inclusion of discussions on using *Engineering Equation Solver (EES)* as a commercial software tool for solving many of the problems encountered in thermodynamics and heat power. EES, available from F-Chart Software (www.fchart.com), is a powerful package for obtaining and using thermodynamic properties and for solving sets of simultaneous equations, but if the reader does not have access to EES then this presentation can be ignored without detracting from the text.

The nine software programs that I have made available in previous editions have been revised into a Windows or event-driven format to be more comfortable and user friendly. I hope that they can aid the student in understanding the subject matter and solving many of the problems. These programs are available on the CD packaged with the Instructor's Solutions Manual. It includes programs that can be used to analyze some of the processes and cycles discussed in the text, that can perform the necessary computations for parametric studies, and that connotate *design* for many professionals.

With the increased applications of refrigerant blends in mechanical refrigeration, I have added two refrigerant blends, R-407c and R-502, to the discussion of refrigerants in chapter 12. Further, I have included a discussion of the phase change of mixtures in chapter 13, with particular emphasis on the refrigerant blends, including the observed temperature glide during a phase change for specific blends.

Because of the increased interest in *fuel cells,* I have expanded the presentation and discussion of these devices.

Finally, I have rearranged the appendix table of properties to be more logical and convenient. A complete listing of the appendix tables is now included in the Table of Contents.

Both SI (Systeme International) and English units are used in this edition. There still is a need for today's students to be fluent in both systems, so the text is split about evenly between the two systems. Practice problems are keyed for both systems, and example problems show the conversions between the systems. The book contains adequate material and enough practice problems to permit emphasis on one of the two units.

The sequence of presentation roughly follows the order of definitions, statements of laws or principles, and applications. The importance of understanding the definitions cannot be overstated. The vocabulary of thermodynamics contains many words of common usage (such as *temperature, heat,* and *work*) that are given precise meaning through definitions. Without this precision, most technical problem solving would be vague or impossible. Laws or principles are stated as truths that have no observed contradictions in nature. Applications of the laws are then presented to give the reader a sampling of the types of problems clarified by the thermodynamic approach.

In proceeding from the basic laws to specific applications, the reader is presented with a common methodology for all problems of a thermodynamics nature. From the statements of laws, a few precise equations are developed from which students can proceed with an analysis. The reader is shown how to make statements regarding the physical characteristics of the material involved and how to make simplifying but realistic assumptions that allow for reducing general equations to specific ones. The reader is then shown how to proceed with calculations to obtain quantitative answers. Included are some derivations of specific equations from the general relationships and compilations or tables displaying specific equations. It should be emphasized that an understanding of the underlying assumptions that allow the use of specific relationships is most important.

A book for engineering technology that covers such a popular subject as thermodynamics cannot be expected to present much new or original work. What is presented is well known in the scientific community but is, I believe, presented here in a manner that is especially clear and easily accessible to students.

In chapter 1, material is presented that is expected to set the stage for the sequence of study in thermodynamics. Readers are strongly urged to study the sections on thermodynamic calculations and the method of problem solving. Particular attention should be directed to the subject of computing areas under curves and the use of the computer for these efforts. The program used to facilitate these calculations with the trapezoid rule method is contained on the CD included in the Instructor's Solutions Manual, but it is short enough to be readily copied or entered onto a separate disk.

In chapter 2, the idea of a system is introduced and emphasis is placed on identifying important properties of the systems. Some treatment is given to the instrumentation used in measuring those properties, such as pressure gages and thermometers.

Chapter 3 contains the definitions of work and heat as well as a discussion of how energy changes from one form to another. Also, the idea of a reversible process is introduced and then used throughout the book. The first law of thermodynamics is presented in chapter 4 as a conservation principle applicable to a system. It was decided to consider systems as open, closed, or isolated rather than using the term *control volume.* Some arguments can be made against this terminology, but I felt that this was the best way to reduce the language to the fewest words.

In chapter 5, the reader is shown how to describe the state of a system. First, the three common phases of substances—solid, liquid, and vapor—are discussed with the assistance of phase diagrams. Pressure-volume-temperature relations are introduced with explanations given for when a system can be assumed to be a perfect gas or an incompressible solid or liquid. Compressible gases and liquids are considered and other models are also mentioned. Equations that are used to predict internal energy and enthalpy from temperature are then introduced. Perfect gases and incompressible liquids or solids are given the most attention. Some of the experimental methods for measuring internal energy or enthalpy changes are presented, and then pure substances are discussed. Extensive references are made to the appendix tables of properties (appendix B).

Chapter 6 is somewhat of a watershed for the conservation of energy. The material has been extensively revised and expanded from my previous work, attention being given to processes of pure substances other than ideal gases. Mastery of the material in this chapter would be a good indicator of understanding the material in the first five chapters.

In chapter 7, entropy is presented through the ideas of a cyclic device and heat engines. One never knows how best to introduce an abstraction such as entropy, but its usefulness has been demonstrated and it is used abundantly in the literature. If students are to use thermodynamics in their professional endeavors, they must have an understanding of entropy.

The concepts of available energy are presented based on the useful work idea and the definitions of irreversibility. A consideration of energy by itself, even with some idea of the second law of thermodynamics, can lead to some apparent misconceptions regarding the capabilities of heat engines, batteries, and other power devices. If there are time constraints, the material on available energy given in chapter 8 can be eliminated without loss in continuity.

The material in chapters 9 through 14 represents applications of thermodynamics frequently called *heat power.* Each chapter is reasonably self-contained and distinct, including such topics as existing technological devices and thermodynamic analysis of those devices. In chapters 13 and 14, mixtures are considered more fully than in the fifth edition. In chapter 13, nonreacting mixtures of ideal gases and gases and vapors are analyzed. Psychrometrics, air-water mixtures in particular, are given most attention. In chapter 14, combustion of fuel-air mixtures is treated. This area is one that surely will be emphasized by engineers and technologists in coming years, beyond simply knowing the heating value of fuels. The concepts of air pollution and waste disposal are but two areas involving combustion processes that will require special attention in the future.

In chapter 15, the elements of heat transfer are considered. Although the subject of heat transfer cannot be covered adequately in a single chapter, it is hoped that the more important and straightforward problems addressed by this subject will be appreciated. Many engineering technology curricula do not have a course in heat transfer, or students are not required to take a course in the thermosciences beyond introductory thermodynamics. This chapter is intended expressly for those students. It might also serve as a refresher for individual preparations for professional licensing examinations.

Heating, ventilating, and air conditioning (HVAC) are considered in chapter 16. Here the emphasis is on how thermodynamics and heat transfer can be applied to a very practical, service-oriented field. If one wishes to cover this treatment of HVAC, it would be appropriate to cover the material in chapter 15 immediately before that in chapter 16.

Chapter 17 contains some nontraditional applications of thermodynamics with the intention of showing that the concepts of thermodynamics can be used to analyze any system.

In using this book, the following order of chapters is suggested for a three-semester-hour course in thermodynamics: 1, 2, 3, 4, 5, 6, 7, and at least 9, 11, and 12. An Instructor's Solutions Manual is available to instructors who desire further suggestions of possible sequences of study.

Users Review

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Dennis Byrd:

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