Introduction

HOW TO USE THIS BOOK

Core Engineering Concepts for Students and Professionals is meant to be used as a reference tool to supplement your engineering study and professional practice. You can either use it as your go-to reference when you need to refresh your memory of a specific subject, or you can read and study it from the beginning, in chapter order, for a thorough review of engineering. Unless you are taking a course or preparing for an exam, you will probably use it the first way. Much like you use a dictionary to look up words you’re unfamiliar with, you should use this book to look up the engineering subjects you need to know more about. You can use Core Engineering Concepts, and its detailed index, to find answers fast.

Using this book isn’t going to be that much different from using any other well-conceived reference. You will typically search for a topic, go to and read the appropriate material, use the nomenclature at the start of the chapter to clarify the meaning of variables and the choice of units, and then refer to relevant data in the accompanying tables and appendices. Some of those steps may require some explanation, which I’ve provided in the following paragraphs.

ORGANIZATION

Regardless of how you use Core Engineering Concepts, you should start by familiarizing yourself with the Table of Contents. To help you work through various topics, chapters have been combined into related groups. While it may not seem obvious, the groups have been logically arranged, and even though the book starts out with mathematics, the groups certainly do not increase in difficulty. They're all about the same. The printed subject tabs on each page will help you keep track of where you are and where you need to go. The appendices are accumulated at the end of the book. I've used the endpapers (inside front and back covers of the hardcover book) to duplicate text material that I think you'll need to reference frequently.

PRECEDENCE

As much as is practical, each chapter develops linearly and consecutively. By this, I mean that you usually won’t need concepts presented later in a chapter to understand the earlier concepts. Also, the chapters pretty much develop linearly within their groups of chapters. Even the groups are sequenced to build on one another. However, I say “as much as practical,” “usually,” and “pretty much” because this isn’t always possible. For example, the chapter on Electrostatics and Electromagnetics refers to an Ohm’s law analogy, even though Ohm’s law is presented in the subsequent chapter. In some cases, data to support an example are drawn from a subsequent chapter’s appendix. In such cases, in order to maintain the book’s linearity, I have provided forward-references (e.g., “See Sec. X.X”) when referring to something that will be presented later in the chapter.

Of course, if you use the index and jump into the middle of a chapter, all bets are off. You may have to backtrack in order to move forward.

NOMENCLATURE

Core Engineering Concepts uses industry-standard (also known as “normal and customary”) units, symbols, and terminology. Almost every chapter starts with lists of nomenclature, symbols, and subscripts that define the variables and units used in text, formulas, illustrations, and tables. The nomenclature is as industry-standard as possible; symbols are consistent between chapters, particularly between related chapters. The equations are consistent with the units defined in the nomenclature. You should never have to play the “What’s this variable?” game or wonder what units work in an equation.

UNITS

When it comes to units, your environment will determine what is normal and customary. As a student, most of your coursework will undoubtedly be in SI units, because that is what the engineering education system uses in the United States. As a practicing engineer, you will probably work in customary U.S. (“English” or “British”) units. That’s just the way it is. For a multi-purpose book such as this, that disparity means a little duplication here and there.

Equations in this book are given for both customary U.S. and SI units. Examples, figures, tables, and appendices are similarly supported with dual values, conversions, and dual dimensioning. No matter what set of units you prefer, this book has you covered.

Exact conversions are not used in examples. Rather, an emphasis is placed on making the problems parallel in terms of complexity. For example, a 1 kg mass might be dual-dimensioned as a 2 lbm mass, even though 2.2 lbm is a more accurate conversion. For dual-dimensioned
examples, the SI solution is presented before the customary U.S. solution.

**SUPPORTING DATA**

In keeping with this book's goal to be a complete reference, hundreds of tables and more than a hundred appendices are included to support your real-world needs for data. The appendices are consolidated after the last chapter, and they are numbered (labeled) with the chapter number they support. It is my intention that the tables of data and appendices will save you from having to do more research once you've refreshed your memory regarding the topic.

**INDEXING**

Some subjects appear in more than one chapter, and some tidbits are buried within unrelated sections. You can use the index liberally to locate all content related to a particular subject. This book has been extensively indexed, backward and forward, and with the names and logical alternatives of all key concepts. For example, “Torricelli's speed of efflux,” “Efflux, speed of,” “Speed of efflux,” “Speed of a jet,” “Velocity, jet,” and “Discharge velocity” all refer to the same place, even though those exact words might not appear anywhere on the page. So when you are looking for something, the odds are, no matter what your search phrase, you'll find your subject.

**RELEVANCE AND CODE DEPENDENCY**

If you are researching a subject that has legal or statutory implications, or is enforceable or regulated (e.g., the maximum sound power level that employees can be exposed to for 8 hours), you can start with this book, but always follow up by referencing current codes, standards, and regulations. For the most part, though, the subjects in this book are not code-dependent or subject to change. Regardless of when and how you use this book—every day during your engineering degree program or on a case-by-case basis in your professional career—the information in this book will be appropriate and applicable.

**IF YOU ARE NOT FAMILIAR WITH CUSTOMARY U.S. UNITS**

If you are making a transition from SI units, Ch. 2 ("Systems of Units") will be particularly helpful in understanding the peculiarities of the various “English” systems of units. The list of abbreviations in “Engineering Abbreviations, Acronyms, and Units” will help you with conventions (e.g., pcf, gpm, and psia) that U.S. engineers take for granted.

You will find that many of the customary U.S. equations in this book contain the ratio \( \frac{g}{g_c} \). For calculations at standard gravity, the numerical value of this ratio is 1.00. Therefore, it is necessary to incorporate this quantity only when you are working with nonstandard gravities.

**IF YOU ARE NOT FAMILIAR WITH SI UNITS**

If you are transitioning from customary U.S. to SI units, Ch. 2 will be helpful, but probably the most useful part of this book will be the table of “Equivalent Units of Derived and Common SI Units” located on the inside back cover (“endpaper”).

**IF YOU ARE A STUDENT**

If you are a student, you can use *Core Engineering Concepts* for supplemental lectures or as an alternative to visiting your professor or teaching assistant during office hours. I don't suggest that you use it as an alternative to attending class, of course. It is inevitable that the day you cut class will be the day of a pop quiz, the day the professor tells a really good joke, or the day you would have been invited on a great double date.

**IF YOU ARE A PRACTICING ENGINEER**

As I described in the Preface, if you are a practicing engineer, I expect you will store this book until you have a need for it. However, until you are promoted into management or your job deteriorates into rote boredom, it is quite likely that your need for this book will be frequent. Unless you are part of the 1% of engineering graduates who have kept all their textbooks, I hope that this becomes the most referenced book of your career.

**IF YOU ARE PREPARING FOR THE FE EXAM**

It is inevitable that you or others will want to know whether *Core Engineering Concepts* can be used to prepare for the Fundamentals of Engineering (FE) exam, also known as the Engineer-in-Training exam. Although this book was not written specifically for the exam, it was written with the exam in mind, as evidenced by Ch. 82 (“The FE Exam”). So, with only a few caveats, the answer is, “Of course you can use this book to prepare for the FE exam!”

In fact, for someone who has been out of school for a long time, or for someone who managed to graduate without taking a course in thermodynamics or any one of a number of other dreaded subjects, this book represents one of the easiest ways to become familiar with new topics. One of the caveats is that you'll end up being over-prepared, because this book goes wider and deeper into engineering than does the FE exam. Another caveat is that, despite having hundreds of solved example problems, this book does not have a corresponding collection of multiple-choice, exam-like practice problems. However, PPI (*www.ppi2pass.com*) has a number of problem-oriented books to supplement your study.
IF YOU ARE PREPARING FOR THE PE EXAM

While adequate in breadth and depth for an FE exam review, this book is not adequate for PE exam review. Visit the PPI website at www.ppi2pass.com to see all of the reference manuals, practice problem books, sample exams, and other products for the PE exam.

IF YOU ARE AN INSTRUCTOR OF AN ENGINEERING SURVEY COURSE

If you are an instructor of an Introduction to Engineering, Survey of Engineering, or a Senior Seminar (capstone) course, Core Engineering Concepts will support just about any lecture on engineering principles that you can come up with. As someone who has stood at the front of a classroom filled with budding engineers, I am confident that this book will be well-received by your students. Not only will they have a great exam review tool, but they'll also have a textbook that will remain useful throughout their entire careers.

There are various ways of organizing such courses. Some courses are instructed by a single instructor; others use a tag-team approach. Some are exam-specific, limiting what is covered to the bare essentials; others are general reviews of engineering. Some courses deal with what is happening in industry; others are theoretical. Some courses start off solving problems, while others start with theory and concepts. Some courses depend almost entirely on the assigned textbook, while others are based on handouts prepared by the instructor. There is no “best” way. But some ways are easier than others.

There are some topics that will require more time in class than you have to cover them, and some students will need more time in a topic than other students. With over 80 chapters of important engineering topics, Core Engineering Concepts is a reference tool your students can use to augment both their understanding of topics you don't have time to cover in class, as well as to review those topics in which they need more practice.

IF YOU ARE AN INSTRUCTOR OF AN FE REVIEW COURSE

Long ago, I prepared my first set of handouts for an engineering fundamentals course I taught in California. Those handouts referenced all the long formulas, illustrations, and tables of data that I did not have the inclination to put on the chalkboard. In subsequent administrations of courses, I reorganized the handouts into chapters that closely paralleled the organization, contents, and emphasis of my lectures. Those chapters eventually became a mature book—the Engineer-in-Training Reference Manual (affectionately known as the “Big Yellow Book”), inarguably the most popular FE exam preparation tool ever published. The text in some chapters so closely paralleled my verbal presentation that I was occasionally accused of giving lectures by reading from my own book. Oh well.

The advantages that Core Engineering Concepts gives you are as follows. (1) You don't have to prepare any handout notes. (2) Formulas, terminology, methods, and units are largely consistent with industry standards and the FE exam. (3) The book is organized progressively, with subsequent chapters building on previous chapters. (4) The nomenclature and other authoring conventions are consistent throughout. Once you get used to the presentation in one chapter, you and your students won't be surprised by subsequent chapters. (5) This book's foundation includes the best of the “Big Yellow Book” whose material has been refined and augmented over decades by legions of examinees.

The difficulties you will face in using this book in an FE review course are as follows. (1) You will have to limit your instructional coverage to the scope of the FE exam. (2) You will need to obtain exam-like sample problems for your lecture, homework problems, and a sample exam (if you give one) from another source. Both of these are quite satisfactorily addressed in a number of ways. First and foremost, if you are teaching a review course for the FE exam without the benefit of recent, first-hand experience, you can download a free FE instructor's kit at www.ppi2pass.com/FERC. This kit contains suggestions for organizing a course, lectures, example problems, and homework assignments, as well as overheads (slides, transparencies, etc.) in PowerPoint format. The lectures in the instructor's kit will keep you from straying outside the exam's scope. And the kit's homework problem sets will provide the exposure to exam-like problems that your students need.

You'll find that lecture coverage of some exam subjects is necessarily brief. For one thing, time is not on your side in a review course. For another, the benefit to covering certain subjects is only minimal. For example, how many exam questions do you really think will be on eigenvectors? Unless you have two quarters in which to teach your FE review course, your students' time can be better spent covering common exam fare.

A second option addressing students' seemingly insatiable need for ever more example and practice problems and sample exams is by assigning problems from PPI's online Exam Cafe or from other PPI books. This second option will be limited by economics and the manner by which your course is administered.

Depending on the available time, budget, and intended audience, there are many ways to organize an FE review course. However, all good course formats have the same result: the students struggle with the work load during the course . . . and then they breeze through the examination.