A Student's Guide to Laplace Transforms

The Laplace transform is a useful mathematical tool encountered by students of physics, engineering, and applied mathematics, within a wide variety of important applications in mechanics, electronics, thermodynamics, and more. However, students often struggle with the rationale behind these transforms and the physical meaning of the transform results. Using the same approach that has proven highly popular in his other *Student's Guides*, Professor Fleisch addresses the topics that his students have found most troublesome, providing a detailed and accessible description of Laplace transforms and how they relate to Fourier and Z-transforms, written in plain language, and including numerous, fully worked examples. The book is accompanied by a website containing a rich set of freely available supporting materials, including interactive solutions for every problem in the text, and a series of podcasts in which the author explains the important concepts, equations, and graphs of every section of the book.

DANIEL FLEISCH is Emeritus Professor of Physics at Wittenberg University, where he specialises in electromagnetics and space physics. He is the author of five other books with the *Student's Guide* series, published by Cambridge University Press: *A Student's Guide to Maxwell's Equations* (2008); *A Student's Guide to Vectors and Tensors* (2011); *A Student's Guide to the Mathematics of Astronomy* (2013), *A Student's Guide to Waves* (2015), and *A Student's Guide to the Schrödinger Equation* (2020).

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Preface

The purpose of this book is to help you build a foundation for understanding the Laplace transform and its relationship to the Fourier transform and the Z-transform. These transforms are useful in a wide variety of scientific and engineering applications, not only because they can be used to solve differential equations, but also because they provide an alternative perspective for extracting information from complex functions, signals, and data sequences. And although there are many conventional texts and websites that deal with integral and discrete-time transforms, the emphasis in those resources is often on the mechanics of taking the transform or its inverse. That is certainly important, but it's also important to develop an understanding of the rationale for the transformation process and the meaning of the result.

To help you develop that understanding, this book is written in plain language and is supported by a rich suite of freely available online materials. Those materials include complete, interactive solutions to every problem in the text, in-depth discussions of supplemental topics, and a series of video podcasts in which the author explains the key concepts, equations, and figures in every section of every chapter.

Like all the texts in Cambridge's *Student's Guide* series, this book is intended to serve as a supplement to the comprehensive texts that you may have encountered in your courses or as part of your continuing education. So although you will find plenty of examples of the forward and inverse Fourier, Laplace, and Z-transform in this book, those examples are designed to introduce fundamental concepts and techniques that will allow you to move on to intermediate and advanced treatments of these transforms.

If you have read any of my other Student's Guides, you're probably aware that I try hard to present challenging concepts in a way that's technically accurate but less intimidating than the presentation in many physics and

engineering textbooks. In that effort, I'm inspired by the words of Thomas Sprat in his *History of the Royal Society*, in which he writes that the Royal Society encourages its members to use "a close, naked, natural way of speaking; positive expressions; clear senses; a native easiness: bringing all things as near the Mathematical plainness, as they can: and preferring the language of Artizans, Countrymen, and Merchants, before that, of Wits, or Scholars."

If that approach sounds about right, you may find this book helpful.

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