his subject not as a hero or saint, but with all his contradictions, changes, and doubts. And that he does. For example, he describes how Bohm's enthusiasm for Bohmian mechanics waned over the years, how lackluster his defenses of it were by the 1960s, and how his interest returned to it in the 1980s. Freire avoids passing judgment on the value of Bohm's various ideas and approaches.

Readers will not learn Bohm's theories from this book. Those who want to understand Bohmian mechanics in its modern formulation and its status compared to the orthodox Copenhagen interpretation would do well to consult Detlef Dürr and Stefan Teufel's *Bohmian Mechanics: The Physics and Mathematics of Quantum Theory* (2009) or Jean Bricmont's *Making Sense of Quantum Mechanics* (2016). For those curious about the story behind the theory and the struggles and breakthroughs of its pioneer, *David Bohm* is a rich resource.

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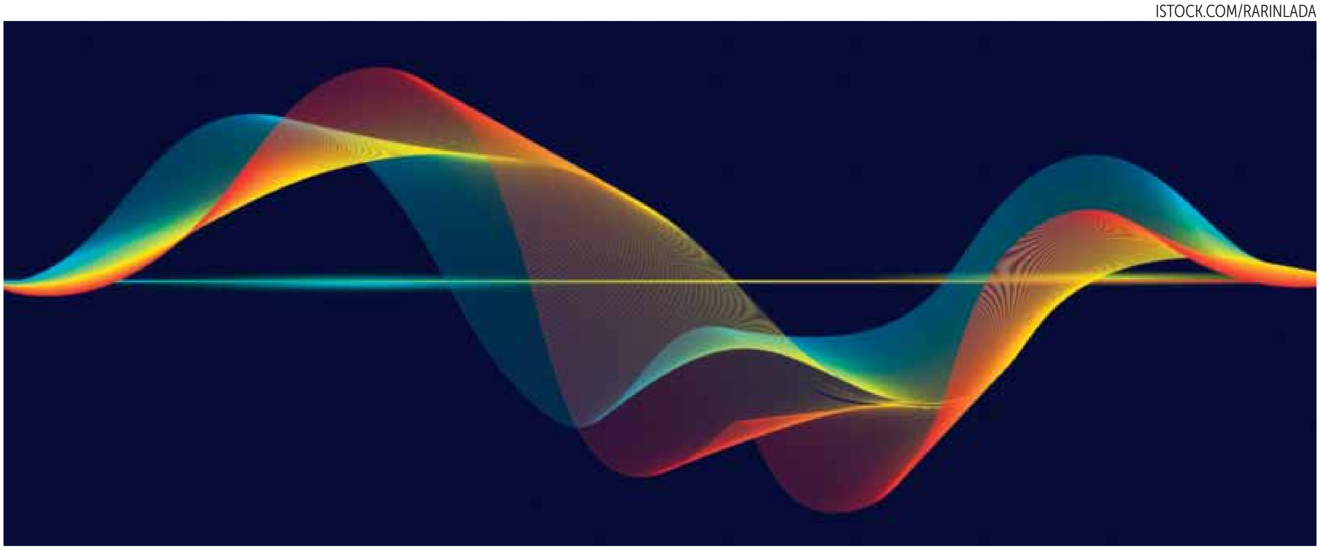
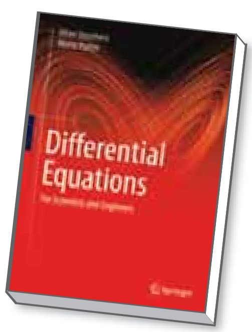


Testing the waters of differential equations

Differential Equations
For Scientists and Engineers
Allan Struthers and Merle Potter
Springer, 2019 (2nd ed.). $59.99



The textbook *Differential Equations: For Scientists and Engineers* by Allan Struthers and Merle Potter is an excellent starting point for undergraduates with a background in multivariable calculus who want to take the next step in their mathematical education. The book is framed as an ongoing discussion of the theory of differential equations. The authors frequently reference concepts and examples introduced earlier in the book to motivate further learning. That strategy makes the book feel like a continuing dialog between peers in which questions are asked and answers are proposed. The writing style is accessible to undergraduates, and students without much knowledge of differential equations will be able to jump right in.

Struthers and Potter choose not to prove the theorems they use throughout the book. Instead, they merely state them and then use them as tools to solve differential equations from physics, engineering, and biology. That practical approach makes *Differential Equations* an excellent resource for students who may not be mathematics majors. However, it also limits the scope of the book for advanced undergraduates, particularly mathematics majors who might have benefited from seeing more detailed proofs of some seminal theorems.

Chapter 1 is a detailed overview of concepts and techniques from linear algebra that are relevant to differential equations, and it includes plenty of explanations and examples. Much of its material is referenced and built on later in the book. As a probabilist, I was impressed by the way Markov chains were introduced as an example to motivate matrix–vector multiplication. Fundamental ideas from probability theory, including the Markov transition matrix and steady states of Markov chains, are explained effortlessly. The chapter concludes with an interesting, albeit short, discussion about how Google's algorithms determine page rankings for search results by solving an eigenvalue problem for a huge matrix.

Chapter 2 introduces simple methods for solving first-order differential equations. Most of the material will be a review for advanced undergraduate students, since they would have seen all the methods in one form or another in a calculus course. The last section discusses nonlinear first-order differential equations that are either separable or in exact form.

The authors point to chapter 3, titled "Linear Systems of Differential Equations," as the heart of the textbook. It begins with the long-term behavior of 2 × 2 systems in terms of eigenvalues and eigenvectors, then introduces methods of solving systems of linear first-order equations. That is a novel approach; most textbooks first discuss general techniques for solving systems and only examine long-term behavior after arriving at the solution. Struthers and Potter do a good job of starting with simple examples of linear systems, showing how to analyze those systems, and then generalizing the analytical techniques to arrive at concrete theorems.

A detailed discussion of beats of resonances is the highlight of chapter 4, "Higher-Order Differential Equations." The authors analyze damped-harmonic-oscillator equations with periodic forcing functions through a series of intelligently crafted examples. That section caters nicely to students with backgrounds in physics and engineering.

Laplace transforms are introduced in chapter 5 as tools that allow us to solve differential equations whose forcing functions are discontinuous. They also can be used, as the authors show, to deal with impulses. That approach gives instructors and students a clear motivation for studying Laplace transforms. The authors build up to solving second-order linear equations with Dirac delta force through a series of examples.

Chapter 6 is a good synopsis of the most commonly used numerical methods—including Euler's, Taylor's, and the Runge–Kutta—for solving differential equations and systems. In chapter 7, titled "Series Solutions for Differential Equations," the authors spend considerable time on the Hermite, Laguerre, and Bessel equations. However, all three are introduced rather abruptly, and the chapter could have benefited from a discussion of why those equations are important.

Except for the first chapter, all chapters contain a section called "For Further Study." That material deserves a special mention. Each section reads like a single long exercise problem but is in fact a step-by-step analysis of interesting problems coming from different scientific fields. The problems tie together techniques and concepts developed throughout the chapter, while at the same time teaching some new material. I will soon begin teaching an undergraduate class on differential equations and I think those sections will come in handy as a source of assignments. For example, the "For Further Study" section in chapter 3 leads students to the formal definition of matrix exponentials and gives them the opportunity to explore how the exponentials can be used to solve systems of first-order differential equations.

I am very happy to have been introduced to this excellent textbook. I plan to use it as an additional resource in the upcoming semester.

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Debating astronomy in Victorian newspapers

PD-US, VIA WIKIMEDIA COMMONS

PERCIVAL LOWELL at his observatory in Flagstaff, Arizona in 1914.

News from Mars
Mass Media and the Forging of a New Astronomy, 1860–1910
Joshua Nall
U. Pittsburgh Press, 2019. $50.00

In 1881, in a series of essays titled *The Poetry of Astronomy*, astronomer and popularizer Richard Proctor argued for the value of imagination in the practice of astronomy. He wrote that no one "who studies aright the teachings of the profoundest students of nature will fail to perceive that [they] have been moved in no small degree by poetic instincts, and that their best scientific work has owed as much to their imagination as to their reasoning and perceptive faculties." Comparing astronomy to poetry was no mere rhetorical flourish for Proctor–it was imagination, in his view, that transformed dry scientific data into knowledge. Imagination gave the astronomer access to causes and meanings that were not physically evident.

Proctor had no small stake in debates over how astronomy should be practiced and who had authority to produce astronomical knowledge claims. As historian Joshua Nall recounts in his book *News from Mars: Mass Media and the Forging of a New Astronomy, 1860–1910*, Proctor made his living publishing astronomical texts for public consumption. When writing for the public, Proctor drew authority from his own bona fides as a practicing astronomer. When addressing his peers in the scientific community, he argued that his ability to reach wide audiences and support himself with his scientific writing made him a true professional.

Mars was at the center of many of Proctor's debates