



The many uses of radio waves

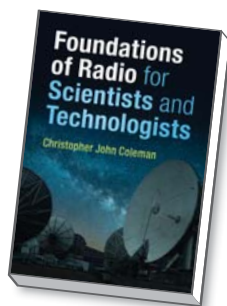
Radio enriches many aspects of our daily lives, from personal communications to weather forecasts. But how does radio accomplish those feats? Attempting to answer that question in a meaningful way leads one to realize that even the basics of modern radio draw from various topics ranging from condensed-matter physics to information theory. The challenge of describing radio's impact is compounded by the rapid evolution of radio technologies, the incredible miniaturization of hardware, and the ever-tightening bond that now exists between radio and the ubiquitous computer.

In the past, the art of radio could be covered thoroughly in a single volume, such as the classic *Electronic and Radio Engineering* (4th edition, 1955) by Frederick Terman. Now textbooks are more specialized: Jack Smith's *Modern Communication Circuits* (2nd edition, 1998) covers circuitry, David Pozar's *Microwave Engineering* (4th edition, 2012) discusses high-frequency techniques, Simon Haykin and Michael Moher's *Communication Systems* (5th edition, 2009) focuses on information theory and signal processing methodologies, and Jeffrey Reed's *Software Radio: A Modern Approach to Radio Engineering* (2002) concentrates on modern digital techniques. For a practical viewpoint, *The Radio Amateur's Hand-*

Foundations of Radio for Scientists and Technologists

Christopher John Coleman

Cambridge U. Press, 2018. \$89.99



book, published annually by the American Radio Relay League, is a wonderful resource.

In *Foundations of Radio for Scientists and Technologists*, Christopher Coleman introduces the interdisciplinary subject of modern radio to the nonspecialist. An associate professor of electrical and electronic engineering at the University of Adelaide in Australia, he takes the reader on an adventure of scientific discovery and engineering application. In a concise, articulate style, Coleman begins by providing the groundwork for electromagnetic theory, flowing smoothly from Gauss's law to the wave equation—with just enough mathematics for subject completeness without excessive detail—and guides the reader with historical milestones. That successful approach to the history and the math continues throughout the book.

From there, the challenges of selecting the right wave for a specific task give Coleman the opportunity to transition from field theory to passive circuits. In the course of that discussion, the reader learns about power transfer, the characteristics of tuned circuits, and the definition of the quality factor. A more advanced analysis of the frequency responses of both Butterworth and Chebyshev signal filters follows quite naturally.

Coleman emphasizes the need to impress information onto the radio wave and ultimately extract it in his discussion of active components. He uses examples of scientific discoveries to take the reader on a journey from basic vacuum tube theory to the operation of bipolar-junction and field-effect transistors that evolves into a review of operational amplifiers. The book covers the concept of noise and even mentions Shannon's maximum channel capacity. *Foundations of Radio for Scientists and Technologists* also discusses how circuits are folded into functional blocks for transmitters and receivers. It introduces feedback, negative resistance, and mixers, including single-diode and balanced configurations, superheterodyne receivers, and the various forms of modulation and demodulation.

The book next covers modern software-defined radio, beginning with the basic digital logic functions, sequential logic, and the discrete Fourier transform. It then presents the concepts of sampling, aliasing, windowing, and filtering, followed by discussions of data conversion, quantization noise, signal-to-noise ratio issues, and digital radio architectures.

The last several chapters cover wave propagation, starting with the transmission line and culminating in free-space propagation. Coleman addresses transmission-line theory quite extensively, along with resonators and coupled-line filters. Various types of antennas, including aperture antennas and arrays that describe sidelobes and grating lobes, are explored. A summary of the ionosphere covers the concepts of refractive index and plasma frequency. The Kirchhoff integral and the Huygens principle are used to analyze diffraction over a conducting screen, surface-wave propagation, and Bragg scattering.

The book concludes with a brief synopsis of modern radio applications. It introduces digital modulation modes and

channel capacity, followed by a short summary of spread-spectrum, cellular radio, and multiple-input multiple-output communications systems. Among the other applications of radio that are discussed are various radar systems and satellites for communications and navigation. A brief introduction to the natural sources of noise and radio astronomy is also included.

Coleman covers an incredible amount of material in this small volume. *Foundations of Radio for Scientists and Technologists* is presented in a concise, well-

organized, physics-based manner. Although the author assumes that the reader has a thorough understanding of calculus and basic physics, the development of certain topics lacks the in-depth mathematical derivations that a reader or instructor might expect from a specialized textbook. The level of treatment is appropriate for advanced undergraduate and graduate students in a two-semester course given by an instructor well versed in the subject matter. The reader should keep in mind that the book does not contain any worked examples

or exercises; those are presented in the book's online resources. Practicing scientists and engineers who simply want a thorough overview of the subject will also find the book quite gratifying, and they will appreciate the topical bibliography of additional information on selected subjects. Overall, this textbook is a pleasure to read and will serve as a comprehensive introduction to radio for the nonspecialist.

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GREG WEBB/IAEA

Inspectors at the Fukushima Daiichi power plant in 2013.

The past and future of nuclear regulation

Gregory Jaczko is a physicist who ventured into the political arena after he earned his PhD. In his subsequent career as a nuclear regulator, he had a rapid rise—and an equally sudden fall. In *Confessions of a Rogue Nuclear Regulator*, he tells his story and gives valuable insights into the inner workings of US nuclear regulation.

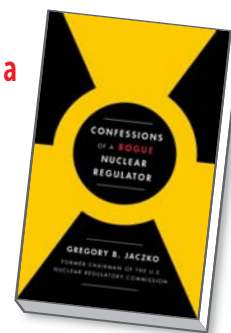
In 1999 Jaczko started as a congressional science fellow in the office of Representative Edward Markey (D-MA), a critic of the safety oversight of the US Nuclear Regulatory Commission (NRC). Jaczko then joined the staff of Democratic

senator Harry Reid, who was focused on stopping the licensing of the Yucca Mountain radioactive waste repository that the US Department of Energy was building in his home state of Nevada.

In 2005 Reid succeeded in getting Jaczko a seat on the five-member Nuclear Regulatory Commission. Four years later President Barack Obama appointed Jaczko NRC chairman. While campaigning in the Nevada primary, Obama had pledged that, if elected, he would end the licensing process for the Yucca Mountain repository. The site had been selected by Congress in 1987, when Reid was a jun-

Confessions of a Rogue Nuclear Regulator

Gregory B. Jaczko
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ior senator with little clout. After Obama's election, the two worked together to scuttle the repository and succeeded in 2011.

Jaczko's book is in large part a rebuttal to industry critics who attacked his decisions on a number of issues, including his recommendation that US citizens in Japan evacuate any area within an 80-kilometer radius of the Fukushima