

tions of the difference between diffraction and interference ever written, a nicely written explanation of the difference between phase and group velocity and a wonderful discussion of many aspects of ferromagnetism. One factual gem I enjoyed is that a car's two headlights can be resolved at distances as far as 17 km!

There are some unfortunate lapses. Occasionally, there are mysterious statements such as "the frequency is 9." We are left to wonder, 9 what? Other proofing errors are not uncommon. Swartz and I have disagreed at times about the significance and use of units, and I can find more to disagree with here than I would have wished. In a "sourcebook," it would have been best to get all units correct and to eschew non-SI units for the most part. This has not been done: We find, among others, the gal, the poise and the gauss. The British thermal unit is sometimes printed correctly (Btu), other times as BTU. Worse, the calorie is emphasized at the expense of the joule.

An even more unfortunate failing for a sourcebook is a muddiness about the distinction between weight and mass and the failure to denote vectors as vectors uniformly, which can, in places, lead to awkward presentation. Velocity is often incorrectly used to mean speed. Most physicists speak of atomic mass, not atomic weight.

A few other things would have made this work more valuable. Some figures could have been bigger to help the reader. One figure (figure 4.11) was so tiny I would have had a hard time reading it if I hadn't remembered the original! More annotated references in the later chapters similar to those in the first few would have been a very welcome addition.

Overall, the first two wonderful chapters and the very nice treatments of various topics in the rest of the book overwhelm any reservations about recommending the book. This will indeed be a valuable addition to a teacher's bookshelf. I hope the next edition will be even more valuable.

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Radio-Frequency Electronics: Circuits and Applications

▶ Jon B. Hagen.
Cambridge U. P., New York, 1996.
358 pp. \$49.95 hc
ISBN 0-521-55356-3

In the first figure of *Radio-Frequency Electronics*, Jon Hagen delineates the

eight decades of the electromagnetic spectrum occupied by radio frequencies: from above 10 kHz to 1000 GHz, the latter corresponding to a wavelength of 0.3 mm. Within that range, we can identify several approximate lines of demarcation, where changes in circuit behavior occur. For example, above several megahertz, the inductance of relatively short lengths of wire can become significant. Above about 300 MHz, lumped constant elements (resistors, capacitors and inductors, which are each effectively concentrated at a single point) give way to distributed constant circuits typified by coaxial and waveguide transmission lines. This is the frequency regime generally referred to as microwaves.

Back in the late 1940s, several volumes in the MIT Radiation Laboratory Series (McGraw-Hill) dealt with rf circuits, devices and design philosophy. The driving force at that time was wartime-spawned radar. Hagen has recognized the need for a fresh look at rf systems and their applications. In addition to radar, his book includes communications (increasingly wireless), radio astronomy and, in the medical field, magnetic resonance imaging.

Hagen developed his text for a one-semester course in electrical engineering for students unfamiliar with rf circuits, devices and systems; for that purpose, I believe the book will be successful. There are 34 chapters covering transmission lines and matching networks, radio receivers and the associated problem of amplifier noise, modulation and detection schemes, oscillators, phaselocked loops and elements such as mixers, filters, transformers and couplers.

That coverage is indeed broad, but I believe that two other topics should have been included. The first concerns broadband—that is, untuned—rf amplifiers of both the small-signal and power variety. It is not the circuit design details that are needed so much as an idea of the many commercially available models. Modern nuclear magnetic resonance spectrometers and imagers depend heavily on those instruments, as well as on the pulse technology associated with pulsed NMR. Although Hagen does treat the transmission line modulators that are useful in radar, it is the more general types—originally referred to as hard-tube modulators—that deserve some discussion.

The book contains problem exercises for each chapter. They appear well designed to test a student's comprehension. The illustrations are well chosen and nicely complement the author's writing, which I found to be both informative and enjoyable to read. Hagen introduces the subject of

waveguides in this manner: "The ability of a hollow metal pipe to transmit electromagnetic waves can be demonstrated by holding it in front of your eye (you can see through it)."

I wonder how old-timers other than myself will react to Hagen's first reference to vacuum tubes. An asterisk leads the reader to a definition that begins, "A triode vacuum tube is analogous to an npn transistor." *Sic transit gloria mundi!* Incidentally, I would have chosen an *n*-channel field-effect transistor as a better analog.

Hagen believes that his book could be a reference for working engineers. That poses a problem. Most of the chapters are only about ten pages long; there is simply not enough in-depth material provided for each topic to satisfy that audience. An experienced rf engineer doesn't usually need an overview so much as detailed answers for solving some knotty problems. But that still leaves a potential readership of rf neophytes, who are enrolled in a formal course or are interested in self-study or who have some knowledge of the field and wish to browse to find out what's new. To that audience, I can and do recommend Hagen's book.

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Anomalies in Quantum Field Theory

▶ Reinhold A. Bertlmann
Oxford U. P., New York, 1996.
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In quantum field theory, the word "anomaly" has come to stand for a situation in which a conservation law that follows from naive manipulation of the Lagrangian is not present in the full-fledged quantum theory. It follows that any deductions based on such a conservation law could run counter to experiment. Indeed, this is what happened when David Sutherland and Martinus Veltman showed independently in 1967 that, according to current algebra, the neutral pion could not decay into two photons, when, in fact, it does. The resolution was provided in 1969 by John Bell and Roman Jackiw and, independently, by Stephen Adler. Through a careful analysis of the divergences of certain Feynman diagrams, they found a violation of the naive conservation law of axial charge that gave a decay rate in accordance with experiment.

The following years showed that