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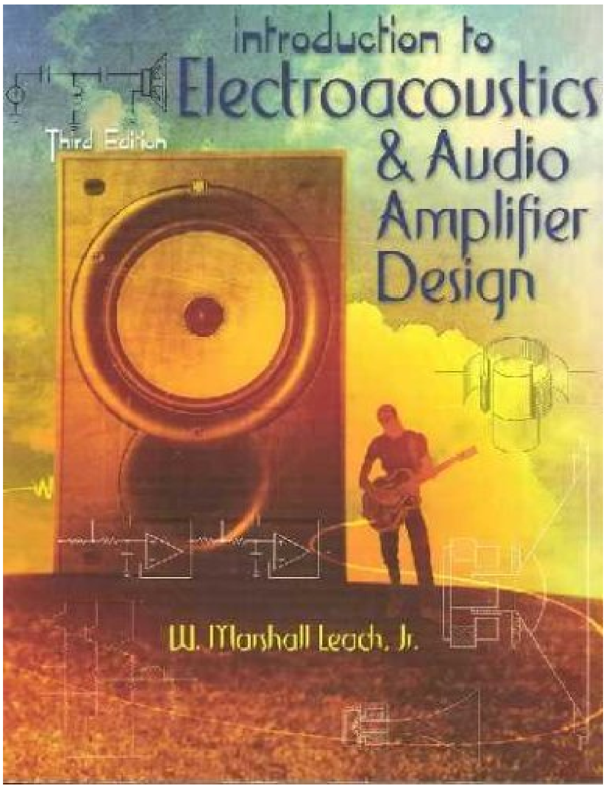

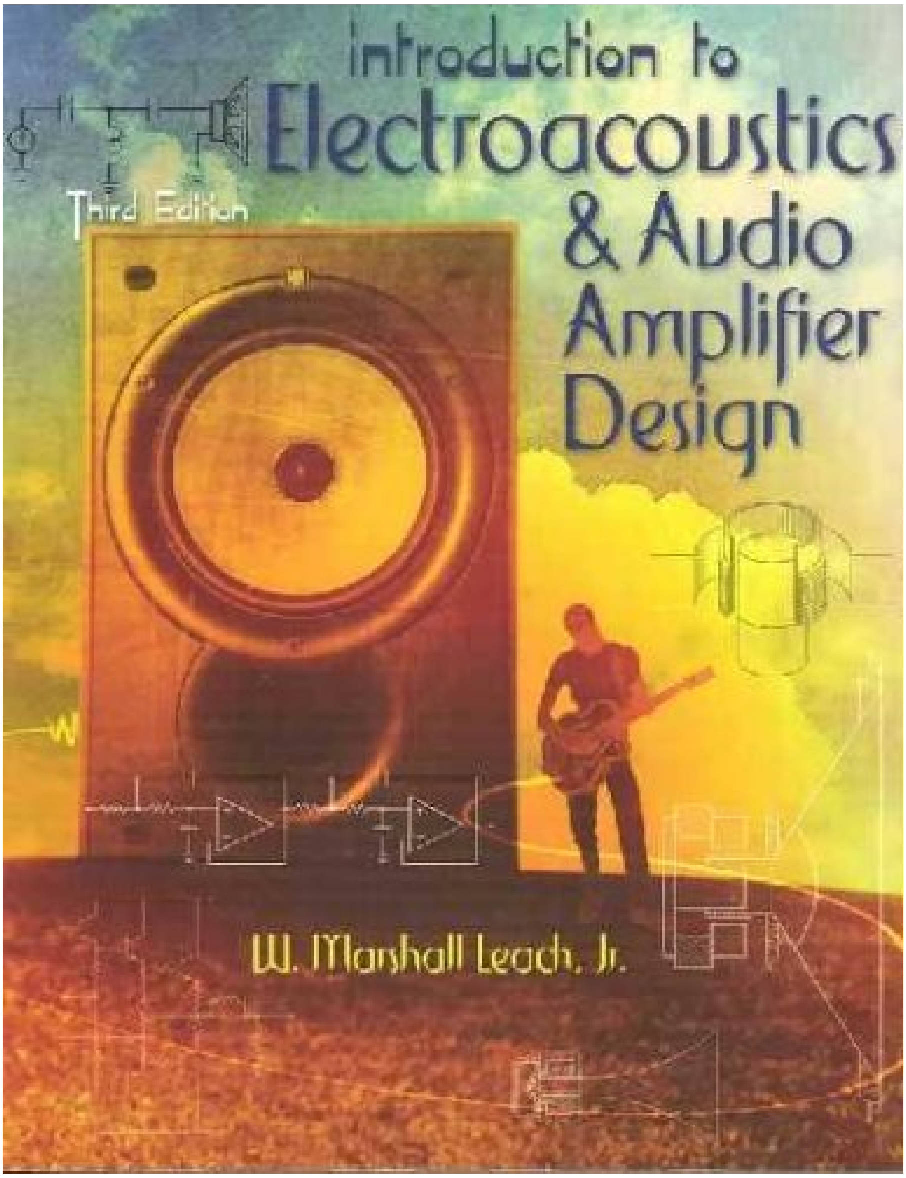
introduction to
Electroacoustics
& Audio
Amplifier
Design
Third Edition
W. Marshall Leach, Jr.

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Most helpful customer reviews

14 of 14 people found the following review helpful.
Excellent book on a very specialized subject
By calvinnme
Electroacoustics is that part of acoustics that pertains to the modeling of acoustical systems with electric circuits. This book is an outgrowth of a senior elective course in audio engineering taught at Georgia Tech by the electrical engineering department. The first part of the book teaches basic acoustics as it pertains to audio engineering. The remainder of the book concerns the application of the tools of electroacoustics to the analysis and synthesis of microphones, loudspeakers, crossover networks, and acoustic horns. The book concludes with a chapter on the basic theory of audio amplifier design. Because most acoustic devices have a mechanical part, the modeling of mechanical systems with electrical ones is also part of electroacoustics, and is also covered in this book. This book is therefore aimed at electrical engineers that are interested in the analysis and design of acoustic systems. This book is not for recording engineers looking for studio construction techniques. The table of contents is:

1. Basic Principles of Sound

2. Fundamentals of Acoustics

3. Analagous Circuits of Acoustical Systems

4. Analogous Circuits of Mechanical Systems

5. Microphones

6. Moving-Coil Loudspeakers

7. Closed-Box Loudspeaker Systems

8. Vented-Box Loudspeaker Systems

9. Acoustic Horns

10. Crossover Networks

11. A Loudspeaker Potpourri

12. Audio Power Amplifiers

2 of 2 people found the following review helpful.
Review of fourth, and sadly final, edition
By Daniel L. Schwartz
Writing this book review for Introduction to Electroacoustics & Audio Amplifier Design, 4th and final edition [ISBN 978-0-7575-7286-9] is a bittersweet task, as the author was the very popular Georgia Tech Electrical Engineering Professor W Marshall Leach Jr, who was taken from us at just 70 in November 2010.[1]

Electroacoustics is the part of of acoustics that pertains to the conversion of sound waves into electrical signals, such as with microphones, phono pickup cartridges and vibration sensors; and electric signals into sound waves, such as in loudspeakers and hearing aids. The beauty of electroacoustics is that the electrical, mechanical and acoustical portions are modeled together using straightforward electrical circuit techniques, very often with just linear "lumped" elements (resistors, inductors, capacitors and transformers), where the entire system behavior can be accurately designed or analyzed.

The Table of Contents shows comprehensive coverage of the material, and when followed in sequence, is quite an impressive audio engineering textbook.

1. Basic Principles of Sound
2. Fundamentals of Acoustics
3. Analogous Circuits of Acoustical Systems
4. Analogous Circuits of Mechanical Systems
5. Microphones
6. Moving-Coil Loudspeakers
7. Closed-Box Loudspeaker Systems
8. Vented-Box Loudspeaker Systems
9. Acoustic Horns
10. Crossover Networks
11. A Loudspeaker Potpourri ???This chapter alone is worth the price of the book
12. Audio Power Amplifiers

The first chapter on Basic Principles of Sound is rather straightforward, covering what sound is, how it's generated, it's characteristics; plus it also goes into human hearing, introducing equal loudness contours and a basic loudness compensation volume control using a tapped potentiometer circuit.

The second chapter adequately discusses the fundamentals of acoustics, assuming the reader has knowledge of partial differential equations and surface & volume integrals; while the 3rd & 4th chapters cover analogous acoustical & mechanical systems (i.e. mass, resistance & compliance), tying everything together into relatively simple electrical circuit models that can be easily solved to accurately predict the properties.

Chapter 8 goes into the details of vented box analysis & synthesis; and presents the 4th order Butterworth & Chebyshev and the 3rd order quasi-Butterworth QB3 alignments, basically expanding on Neville Thiele's 1971 seminal papers on the subject. However, the reader needs to go to section 5 in Chapter 11 to find out about the very handy 6th order assisted vented-box alignment, which uses a 2nd order high-pass filter in the amplifier circuit, which is used to lower the cutoff frequency while containing voice coil motion below that point.

One minor disappointment is in chapter 9 and elsewhere: The lack of the use of a gyrator model for the voice coil, which "eliminates the confusing parallel-element mobility and admittance circuits from the analysis." Go to figure 2 of Leach's 1979 seminal paper On the Specification of Moving-Coil Drivers for Low-Frequency Horn-Loaded Loudspeakers and you'll see the gyrator with a gyration resistance of Bl between the electrical and mechanical network segments.[3] Although introduced for horn-loaded loudspeakers, in fact it has broad use across electroacoustics, including for conventional piston loudspeakers of all varieties, and also for hearing aids. In this final edition before his death in November 2010, Dr Leach did not include his groundbreaking use of the gyrator, because parallel reactive network elements are now easily handled in SPICE; however we believe it should have been included, as it makes pencil & paper calculations much easier when SPICE is not available. Interestingly, in chapter 4′s problem #4 (p.65) the gyrator is introduced; but it's not even mentioned in the index.

Chapter 11, A Loudspeaker Potpourri, is worth the price of the book alone: Oftentimes in both acoustics and (especially) audio engineering you'll see all sorts of "cookbook recipes" that have significant errors; but here you'll find the correct information for your loudspeaker designs, including step-by-step instructions on measuring the Thiele-Small electroacoustic parameters of any moving coil loudspeaker driver in sections 11.7 & 11.8. Section 11.5.3 has the recipe for the valuable 6th-order Butterworth and Chebyshev assisted vented box alignment using a second order active high pass filter in the preamp, the latter being this author's EE3900 Junior Design Project.[2]

One minor nit this author and former student has, however, is in section 11.4 on passive radiator ("drone-cone") systems. Although passive radiators look sexy, in fact they are no more than performance-sapping decorations that compensate for the laziness of the designer. Specifically, the compliance C(ap) and resistance R(ap) of the passive radiator are non-zero, and have a negative impact on the performance. Also, although equation 11.60 is correct, the value for ωs derived in equation 11.61 is not, as M(ac) is not approximately the same as M(as), i.e. the acoustic mass of the diaphragm and its air load is not the same as for an infinite baffle. Although it's readily apparent from the equations that using a passive radiator would sap performance, this author believes it should be explicitly stated in section 11.4.1.

We were also a bit disappointed that transmission line loudspeakers were not covered, especially since when you go to Dr Leach's Amplifier and Speaker Projects page we find the following:
An Electroacoustic Analysis of Transmission Line Loudspeakers - This is Allen Robinson's 2007 thesis on transmission-line loudspeaker systems; and also it should be noted that Dr Leach was Robinson's advisor. The upshot of all this is that if you want to design & build a transmission line loudspeaker -- and are willing to wade through 150 pages -- then this thesis is for you.

NOTE: This review is excerpted from my review in The Hearing Blog at TheHearingBlog dot com/archives/648

Footnotes:

1) Dr Leach was my professor for Audio Engineering (EE4026) in Spring 1981, Low-Noise Amplifiers (EE4084) in Fall 1982, and was my faculty advisor for my Junior Design Project (EE3900) of a subwoofer system. It is in memory of my former Professor and Mentor to whom I dedicate this book review.

2) My EE3900 Junior Design Project subwoofer system consisted of an Electro-Voice EVM-18B 18 inch driver in an 18 ft^3 vented cabinet, and included an active VCVS (non-inverting left channel) and MFB (inverting right channel) 2nd order Chebyshev response bandpass crossover network. When I put this all together, I achieved a 6th order Chebyshev high-pass response with a lower -3dB (cut-off) frequency response of 24.5 Hz with a 36dB/octave rolloff & upper cutoff of 85Hz. If you go to §11.3 (pp 206-211) in the Loudspeaker Potpourri section, you'll see the entire design rationale for the 2nd order high pass auxiliary filtering. The theory of operation, and reason for the voltage-controlled voltage source (VCVS) and multiple feedback (MFB) topologies is that (a) the sound in both channels of a stereo recording below ≈100 Hz is the same, and (b) by having non-inverted & inverted signals fed into the two channels of my BGW 750B (class AB1) amplifier, and floating the outputs in a bridged mono configuration, I was able to squeeze 800 watts RMS out of it, which, in the days before class D PWM amplifiers were commonplace, was a lot of power.

3) On the Specification of Moving-Coil Drivers for Low-Frequency Horn-Loaded Loudspeakers (Journal of the Audio Engineering Society, vol. 27, no. 12, pp. 950-959, December 1979); also posted here on the Georgia Tech website. A gyrator is a passive, linear, lossless, two-port electrical network element proposed by by Bernard DH Tellegen in his 1948 paper The gyrator, a new electric network element by Bernard DH Tellegen (click for the mirror copy here on The Hearing Blog). as a hypothetical fifth linear element after the resistor, capacitor, inductor and ideal transformer. Unlike the four conventional elements, the gyrator is non-reciprocal. An important property of a gyrator is that it inverts the current-voltage characteristic of an electrical component or network; and in the case of linear elements, the impedance is also inverted; or in other words, a gyrator can make a capacitive circuit behave inductively, a series LC circuit behave like a parallel LC circuit, and so on. Gyrators permit network realizations of two-(or-more)-port devices which cannot be realized with just the conventional four elements. Unlike Tellegin's then-hypothetical circuit element, gyrators today make possible network realizations of isolators and circulators; and is primarily used in active filter design and miniaturization today, including in audio filters such as equalizers and analog hearing aids, replacing bulky inductors with small precision capacitors. Gyrators do not, however, change the range of one-port devices that can be realized: Although Tellegen conceived it as a fifth linear element, its adoption makes both the ideal transformer and either the capacitor or inductor redundant; thus the number of necessary linear elements is in fact reduced to three.

6 of 7 people found the following review helpful.
Simply the Best!
By M. Valerio
Introduction ... is not an introduction! It's a complete book to correctly design speakers systems and gives good hints for audio amplifiers design.

It makes you back to school, with problems and tricky questions. It is well written but you need some mathematics skills to read (study!) it without stops.

I own many books about the subject (Electroacoustics) but this is simply the Best!

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