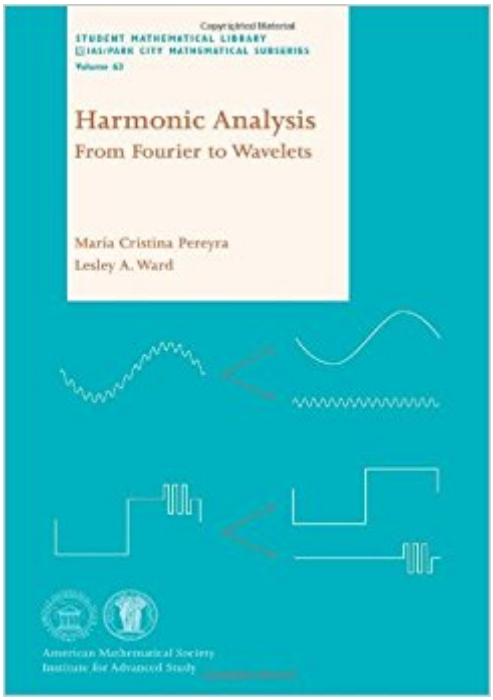
Harmonic Analysis: From Fourier To Wavelets (Student Mathematical Library)



Synopsis

In the last 200 years, harmonic analysis has been one of the most influential bodies of mathematical ideas, having been exceptionally significant both in its theoretical implications and in its enormous range of applicability throughout mathematics, science, and engineering. In this book, the authors convey the remarkable beauty and applicability of the ideas that have grown from Fourier theory. They present for an advanced undergraduate and beginning graduate student audience the basics of harmonic analysis, from Fourier's study of the heat equation, and the decomposition of functions into sums of cosines and sines (frequency analysis), to dyadic harmonic analysis, and the decomposition of functions into a Haar basis (time localization). While concentrating on the Fourier and Haar cases, the book touches on aspects of the world that lies between these two different ways of decomposing functions: time-frequency analysis (wavelets). Both finite and continuous perspectives are presented, allowing for the introduction of discrete Fourier and Haar transforms and fast algorithms, such as the Fast Fourier Transform (FFT) and its wavelet analogues. The approach combines rigorous proof, inviting motivation, and numerous applications. Over 250 exercises are included in the text. Each chapter ends with ideas for projects in harmonic analysis that students can work on independently. This book is published in cooperation with IAS/Park City Mathematics Institute.

Book Information

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Customer Reviews

This is a gentle introduction to Fourier analysis and wavelet theory that requires little background but still manages to explain some of the applications of Fourier and wavelet methods and touch on

several current research topics. ... The authors have taken care to be accessible to undergraduate mathematicians. ... Compared to standard texts, this book is characterised by more personal and historical information, including footnotes. ... It comes with many projects for interested students, and lists a number of open-ended problems that suggest further developments and should engage interested students. ... In summary, this is a well-written and lively introduction to harmonic analysis that is accessible and stimulating for undergraduates and instructive and amusing for the more sophisticated reader. It could also be argued that the material herein should be part of the knowledge of most undergraduates in mathematics, given that the modern world relies more and more on data compression. It is therefore timely as well. It has certainly earned my enthusiastic recommendation. --Michael Cowling, Gazette of the Australian Mathematical SocietyA wonderful introduction to harmonic analysis and applications. The book is intended for advanced undergraduate and beginning graduate students and it is right on target. Pereyra and Ward present in a captivating style a substantial amount of classical Fourier analysis as well as techniques and ideas leading to current research. ... It is a great achievement to be able to present material at this level with only a minimal prerequisite of advanced calculus and linear algebra and a set of Useful Tools included in the appendix. I recommend this excellent book with enthusiasm and I encourage every student majoring in math to take a look. --Florin Catrina, MAA ReviewsThis is a gentle introduction to Fourier analysis and wavelet theory that requires little background but still manages to explain some of the applications of Fourier and wavelet methods and touch on several current research topics. ... The authors have taken care to be accessible to undergraduate mathematicians. ... Compared to standard texts, this book is characterised by more personal and historical information, including footnotes. ... It comes with many projects for interested students, and lists a number of open-ended problems that suggest further developments and should engage interested students. ... In summary, this is a well-written and lively introduction to harmonic analysis that is accessible and stimulating for undergraduates and instructive and amusing for the more sophisticated reader. It could also be argued that the material herein should be part of the knowledge of most undergraduates in mathematics, given that the modern world relies more and more on data compression. It is therefore timely as well. It has certainly earned my enthusiastic recommendation. --Michael Cowling, Gazette of the Australian Mathematical Society[T]he panorama of harmonic analysis presented in the book includes very recent achievements like the connection of the dyadic shift operator with the Hilbert transform. This gives to an interested reader a good chance to see concrete examples of contemporary research problems in harmonic analysis. I highly recommend this book as a good source for undergraduate and graduate courses as well as

for individual studies. --Krzysztof Stempak, Zentralblatt MATH

I have worked with HA for decades in array processing and MR Imaging. I always enjoy authors who take a "specialty" area, then go really deep and broad to explore both the body and frontiers. The problem with handling HA this way is that the field, and Fourier transforms in general, has become SO broad and diverse that the math itself is all over the board in complexity, from "relatively" simple partial differential equations for continuous signal processing waveforms, to extremely difficult Hilbert space translations between pure and general functional analysis and HA, including rotational invariance of the Fourier tools and decompositions.Far from just thermodynamics and Newtonian physics, the dynamical systems and advanced Fourier applications have broadened HA to Neurology, Electronics, Quantum Physics, sound and musical eigenvalue applications, and many others. These don’t even begin to scratch the surface of the REALLY advanced research in pure math such as topology, duality and other very abstract research areas. Note also that this book is about the Fourier aspects of non-musical applications (though they are covered and mentioned as examples), NOT the strictly "other" form of HA in music. I’m sure you know this, but I have many music oriented buddies who frown at my (and this book’s) broad view of HA!The bottom line is that, even though the problems are very well presented and the book is brilliantly written, I’d take exception to the publisher’s "undergraduate" statement. If you’re a high level mathematician and perhaps a Senior at a really good technical school, maybe, but engineers like me, or even physics majors, will find much of this material challenging, and the author does not write it at a "slow general explain it from many angles" pedagogic level-- the pace is pure graduate style, with many assumptions that you will already know why that sine or radial/ spherical component popped up. I’d even venture to say that a previous Fourier course would probably be a requisite. When you start breaking functions into trig components, you better really know your trig both in calculus and linear algebra.Underneath it all, a transform is a transform, and the inverse, always the tougher little beast, isn’t really very intuitive until some advanced analysis courses show you that a MAJORITY of problems are not amenable to the "relatively" easy solutions presented in mosts texts. Once you see how nasty many of the nonlinear, discontinuous functions can be in the advanced areas, like me, you might say... "Oh, yeah, good old heat dynamics and the superpositioning of nice tame waves..." Might even make you look longingly AT the music side...It might not be all that helpful to point out how diverse Fourier topics have become, but HA now even includes spherical harmonics, Bessel functions, Laplacian eigenvectors and even graph theory! The authors do a great job of covering the entire field, with very current leading edge ideas as well as

centuries old applications and in between but still very important ideas like oscillatory integrals. If you’re going into either applied engineering in areas like signal processing or imaging, or math research at the graduate level, there is no book more recent and complete than this fine work. I just don’t want you to pick it up as an undergrad and find many of the author’s relatively fast paced decompositions leave you digging back through 5 other texts! If you’re already a pro using FT’s in any capacity in your work, this is a must have for your library, as ALL the most recent "named" algorithms are covered (you know, Paley-Weiner, Peter-Weyl, etc.).Library Picks reviews only for the benefit of shoppers and has nothing to do with , the authors, manufacturers or publishers of the items we review. We always buy the items we review for the sake of objectivity, and although we search for gems, are not shy about trashing an item if it’s a waste of time or money for shoppers. If the reviewer identifies herself, her job or her field, it is only as a point of reference to help you gauge the background and any biases.

Analysis) Stochastic Models, Information Theory, and Lie Groups, Volume 2: Analytic Methods and Modern Applications (Applied and Numerical Harmonic Analysis)