



# Harmonic Analysis: From Fourier to Wavelets (Student Mathematical Library)

By *María Cristina Pereyra, Lesley A. Ward*



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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.

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### Editorial Review

#### Review

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 Society

A 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 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 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

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