Foundations of Time-Frequency Analysis (Applied and Numerical Harmonic Analysis)

By Karlheinz Gröchenig

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Time-frequency analysis is a modern branch of harmonic analysis. It com prises all those parts of mathematics and its applications that use the struc ture of translations and modulations (or time-frequency shifts) for the anal ysis of functions and operators. Time-frequency analysis is a form of local Fourier analysis that treats time and frequency simultaneously and sym metrically. My goal is a systematic exposition of the foundations of time-frequency analysis, whence the title of the book. The topics range from the elemen tary theory of the short-time Fourier transform and classical results about the Wigner distribution via the recent theory of Gabor frames to quantita tive methods in time-frequency analysis and the theory of pseudodifferential operators. This book is motivated by applications in signal analysis and quantum mechanics, but it is not about these applications. The main ori entation is toward the detailed mathematical investigation of the rich and elegant structures underlying time-frequency analysis. Time-frequency analysis originates in the early development of quantum mechanics by H. Weyl, E. Wigner, and J. von Neumann around 1930, and in the theoretical foundation of information theory and signal analysis by D.

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Editorial Review

Review

"*Foundations of Time-Frequency Analysis* provides a clear and thorough exposition of some of the fundamental results in the theory and gives some important perspectives on a rapidly growing field . . . An important feature of the book is complete, detailed proofs of all claims and extensive motivation of topics . . . The author has chosen topics that illuminate a path toward some of the most interesting and challenging research areas in mathematical time-frequency analysis. A graduate student or researcher seeking research problems in this area can come to no better source . . . The book is definitely suitable for a graduate-level course in mathematical time-frequency analysis. It assumes a background in real analysis, Fourier analysis and Hilbert spaces. It is also suitable for self-study, as the exposition is superb."   **?Mathematical Reviews**

"This book is written by one of the leading experts in Gabor analysis and deserves considerable interest. It gives a unified approach to most of the modern theory for time-frequency analysis from a mathematician's point of view, with new proofs of many recent results."   **?Zentralblatt Math**

"In contrast with the crowded market for wavelet expositions, this book has no up-to-date competitors in its niche, the rigorous mathematical theory. Groechenig makes contact with representation theory, operator algebra theory, and concludes with applications to pseudodifferential operators. But elsewhere he develops inequalities with implications for numerical analysis that should interest signal-processing engineers. He also explains how foundational investigations of quantum theory provided the subject with some of its original impetus.... Throughout, the author displays generosity to his readers as well as fastidious attention to mathematical detail. Of potential interest to graduate students and faculty in mathematics, physics, electrical engineering, and computer science."   **?Choice**

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