Methods of Applied Mathematics with a MATLAB Overview

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This book aims at presenting different applications of the Fourier analysis including classical applications in partial differential equations and boundary value problems, as well as concepts and methods associated to the Laplace, Fourier and discrete transforms. The book has nine chapters, three annexes and an index. A list of references is included at the end of each chapter.

The topics covered are useful both in traditional continuum mechanics and mathematical physics areas, as well as in applied mathematics domain such as control and communications. The book provides in a clear and distinct manner the fundamental concepts and techniques of this area and a wide variety of problems in which these methods are useful. Both the theoretical and the computational aspects are emphasized.

The material of the book is a mixture of analytical results, computational techniques and applications illustrating the power of these methods. Some aspects of model formulations and analysis are also included.

The second chapter covers the Fourier Series Analysis including their convergence, summation methods, properties and periodic solutions of differential equations. The third chapter presents the elementary boundary value problem as an application of the Fourier series results of the previous chapter. Here, some derivations of the standard models of boundary value problem and a discussion of discrete boundary value problem for analogue systems are presented. The fourth chapter considers the higher-dimensional, non-rectangular boundary value problems, as well as the theory of Sturm-Liouville expansions. The chapter includes some aspects of series solutions and Bessel equations, as well as inhomogeneous boundary value problem. Since all these methods and techniques are based on the complex variables functions theory, Chapter five refers to the theory of functions of complex variables. The fundamental results including Cauchy's integral formula and the Residue Theorem, the principle of argument and conformal mappings are included. The sixth chapter introduces the Laplace transform method and its inversion. Applications include the solution of ordinary differential equations, the transient circuit analysis and the input-output analysis of linear systems. Continuous time Fourier transform appears in Chapter seven. The basic Fourier transforms, the formal properties of Fourier transforms, the convolution and Parseval's Theorem, Fourier inversion by contour integration are considered in this chapter. Applications of Fourier transforms are made to ordinary differential equations, integral equations, linear systems, communications problems, impedance analysis and partial differential equations. The subject of the eighth chapter is discrete variable transforms (z transforms). The z-transforms, discrete Fourier transforms, properties of these transforms, finite and fast Fourier transforms and their properties including computing the FFT are included. The last chapter contains some additional topics and provides an examination of wavelets, Walsh functions, short-time Fourier analysis and geometrically-based transforms. Annex A contains an overview of Linear Algebra. Annex B discusses the Software resources including computational and visualization software with MATLAB. Annex C presents the Laplace transforms, the Fourier transforms, Z-transforms and the discrete Fourier transforms.

Davis's book has many novel features being quite different from most other textbooks on applied mathematics. Besides a nice treatment of all these topics, I mentioned above, it also contains a very deep treatment of MATLAB implementations of methods and algorithms. Mainly it has a clear and consistent exposition with a strong focus on mathematical fundamentals and useful techniques. It has numerous extensive examples, illustrations, comments and a very modern graphical presentation of results. A variety of problems of wide-ranging difficulty together with their solutions are presented. Plenty of MATLAB routines and exercises are also provided.

The book has style. Every theorem and mathematical result has a wonderful appealing comment. While the author does not purposely go out of his way to be rigorous and very technical, he illustrates all these results by numerical examples implemented and solved in the MATLAB environment. However, the book sometimes has an engineer's feel for proofs. There are many instances where the proof is illustrated via an example. Often the examples are of an academic style and there are no interests to get down at the physical significance of the variables and parameters of the model. In fact, this book is on applied mathematics, and if the existence is inexhaustible and not a random chaos, then we see that its mathematical description by boundary value problems, as it is done in this book, is also inexhaustible. This gives beauty to the book, its nice features.

All in all, I greatly enjoyed reviewing this book and I recommend it without any hesitation as a textbook for advanced graduate or master's level course in engineering

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