

Prolate Spheroidal Wave Functions Of Order Zero Mathematical Tools For Bandlimited Approximation Applied Mathematical Sciences

Prolate Spheroidal Wave Functions (PSWFs) are the eigenfunctions of the bandlimited operator in one dimension. As such, they play an important role in signal processing, Fourier analysis, and approximation theory. While historically the numerical evaluation of PSWFs presented serious difficulties, the developments of the last fifteen years or so made them as computationally tractable as any other class of special functions. As a result, PSWFs have been becoming a popular computational tool. The present book serves as a complete, self-contained resource for both theory and computation. It will be of interest to a wide range of scientists and engineers, from mathematicians interested in PSWFs as an analytical tool to electrical engineers designing filters and antennas.

The volume is one of a series of six volumes published by the Naval Research Laboratory containing tabulation of explicit values of radial spheroidal wave functions of both oblate and prolate kinds over extended ranges of parameters. It is designed to provide the mathematical physicist and research engineer with accurate values of important but not easily calculated functions needed to solve boundary value problems of radiation, scattering, and propagation of scalar or vector waves in spheroidal coordinates. This series vastly extends the scope and accuracy of existing tabulations of radial spheroidal wave functions. The presence of many of the entries was made possible only through adoption of calculation techniques involving extreme precision. This was particularly true in the calculation of the characteristic values for the radial equation resulting from separation of the Helmholtz wave equation in spheroidal coordinates, a knowledge of which is essential in the calculation of spheroidal angle functions. The present document consists of Volume 1-prolate $m=0$. (Author).

A set of tables of spheroidal wave functions designed to simplify the computation of acoustic and electromagnetic scattering from spheroids. The tables were computed to five-place accuracy on the Whirlwind digital computer, and automatically tabulated. An introduction discusses the mathematical properties of the functions and describes some of their applications.

This book gathers the peer-reviewed proceedings of the 14th International Symposium, PRADS 2019, held in Yokohama, Japan, in September 2019. It brings together naval architects, engineers, academic researchers and professionals who are involved in ships and other floating structures to share the latest research advances in the field. The contents cover a broad range of topics, including design synthesis for ships and floating systems, production, hydrodynamics, and structures and materials. Reflecting the latest advances, the book will be of interest to researchers and practitioners alike.

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The theory of prolate spheroidal wave functions is briefly reviewed. Formulas useful for the numerical calculation of prolate radial function of the first and second type, together with their first derivatives, are derived and explained. A step-by-step procedure of computation is then outlined together with an indication of precision achieved and method of checking. Finally a computer-printout tabulation of 66,600 entries comprising prolate radial functions and their first derivatives of both types is reproduced. The range of parameters m , l , h , and ξ covered in these tables is $m=0$ and 1 , $l=m(1)18$, $h=0.1(0.1)1(0.2)8$, and $\xi=1.01(0.01) 1.10$. (Author). The thoroughly revised and updated second edition of Ultra Wideband Signals and Systems in Communication Engineering features new standards, developments and applications. It addresses not only recent developments in UWB communication systems, but also related IEEE standards such as IEEE 802.15 wireless personal area network (WPAN). Examples and problems are included in each chapter to aid understanding. Enhanced with new chapters and several sections including Standardization, advanced topics in UWB Communications and more applications, this book is essential reading for senior undergraduates and postgraduate students interested in studying UWB. The emphasis on UWB development for commercial consumer communications products means that any communication engineer or manager cannot afford to be without it! New material included in the second edition: Two new chapters covering new regulatory issues for UWB systems and new systems such as ad-hoc and sensor networks, MAC protocols and space-time coding for UWB systems IEEE proposals for channel models and their specifications Interference and coexistence of UWB with other systems UWB antennas and arrays, and new types of antennas for UWB systems such as printed bow-tie antennas Coverage of new companies working on UWB such as Artimi and UBISense UWB potential for use in medicine, including cardiology, respiratory medicine, obstetrics and gynaecology, emergency room and acute care, assistance for disabled people, and throat and vocals Companion website features a solutions manual, Matlab programs and electronic versions of all figures.

This monograph records progress in approximation theory and harmonic analysis on balls and spheres, and presents contemporary material that will be useful to analysts in this area. While the first part of the book contains mainstream material on the subject, the second and the third parts deal with more specialized topics, such as analysis in weight spaces with reflection invariant weight functions, and analysis on balls and simplexes. The last part of the book features several applications, including cubature formulas, distribution of points on the sphere, and the reconstruction algorithm in computerized tomography. This book is directed at researchers and advanced graduate students in analysis. Mathematicians who are familiar with Fourier analysis and harmonic analysis will understand many of the concepts that appear in this manuscript: spherical harmonics, the Hardy-Littlewood maximal function, the Marcinkiewicz multiplier theorem, the Riesz transform, and doubling weights are all familiar tools to researchers in this area.

If the electric field intensity in the Fraunhofer region of a one-dimensional radiating source can be represented as a finite Fourier transform of the source current, then the source current can be reconstructed exactly by using prolate spheroidal wave functions and a segment of either the far field or the diffraction-limited image for the noise-free case. An example of the image enhancement

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of this process is given for the case of two equal point sources, which are unresolved in the Rayleigh sense. The point response function of this process shows that the resolution cell extent can be readily reduced to less than 10% of the Rayleigh cell with only 20 degrees of enhancement processing. A method of generating the Legendre polynomial and power series expansions of the prolate spheroidal angle functions of the first kind and order zero was worked out in detail. The Legendre polynomial expansion coefficients for degrees $n = 0(1)40$ and the power series expansion coefficients for degrees $n = 0(1)36$ are tabulated for $c = 2$. (Author).

This book addresses coding, a new solution to the major challenge of communicating more bits of information in the same radio spectrum. Explores concepts and new transmission methods that have arisen in the last 15 years Discusses the method of faster than Nyquist signaling Provides self-education resources by including design parameters and short MATLAB routines Bandwidth Efficient Coding takes a fresh look at classical information theory and introduces a different point of view for research and development engineers and graduate students in communication engineering and wireless communication.

Gaussian quadrature is a powerful technique for numerical integration that falls under the broad category of spectral methods. The purpose of this work is to provide an introduction to the theory and practice of Gaussian quadrature. We study the approximation theory of trigonometric and orthogonal polynomials and related functions and examine the analytical framework of Gaussian quadrature. We discuss Gaussian quadrature for bandlimited functions, a topic inspired by some recent developments in the analysis of prolate spheroidal wave functions. Algorithms for the computation of the quadrature nodes and weights are described. Several applications of Gaussian quadrature are given, ranging from the evaluation of special functions to pseudospectral methods for solving differential equations. Software realization of select algorithms is provided. Table of Contents: Introduction / Approximating with Polynomials and Related Functions / Gaussian Quadrature / Applications / Links to Mathematical Software "Tabulation of explicit values of radial spheroidal wave functions of both oblate and prolate kinds over extended ranges of parameters. It is designed to provide the mathematical physicist and research engineer with accurate values of important but not easily calculated functions needed to solve boundary value problems of radiation, scattering and propagation of scalar or vector waves in spheroidal coordinates."--Foreword.

The solutions of the Helmholtz wave equation in prolate spheroidal coordinates can be obtained by separation of variables. The subject of this report is a Fortran computer program called PRAD which calculates numerical values to the solutions of the resulting ordinary differential equation for the 'radial' coordinate. The printed output of PRAD consists of radial functions of the first and second types, their first derivatives, the separation constants or eigenvalues, and an accuracy check. The report describes the computer program PRAD and briefly reviews the theory of prolate spheroidal wave functions. A computer listing of PRAD along with some sample output is included in an appendix. (Author).

The flagship monograph addressing the spheroidal wave function and its pertinence to computational electromagnetics Spheroidal Wave Functions in Electromagnetic Theory presents in detail the theory of spheroidal wave functions,

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its applications to the analysis of electromagnetic fields in various spheroidal structures, and provides comprehensive programming codes for those computations. The topics covered in this monograph include: Spheroidal coordinates and wave functions Dyadic Green's functions in spheroidal systems EM scattering by a conducting spheroid EM scattering by a coated dielectric spheroid Spheroid antennas SAR distributions in a spheroidal head model The programming codes and their applications are provided online and are written in Mathematica 3.0 or 4.0. Readers can also develop their own codes according to the theory or routine described in the book to find subsequent solutions of complicated structures. Spheroidal Wave Functions in Electromagnetic Theory is a fundamental reference for scientists, engineers, and graduate students practicing modern computational electromagnetics or applied physics.

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During the last three decades geosciences and geo-engineering were influenced by two essential scenarios: First, the technological progress has changed completely the observational and measurement techniques. Modern high speed computers and satellite based techniques are entering more and more all geodisciplines. Second, there is a growing public concern about the future of our planet, its climate, its environment, and about an expected shortage of natural resources. Obviously, both aspects, viz. efficient strategies of protection against threats of a changing Earth and the exceptional situation of getting terrestrial, airborne as well as spaceborne data of better and better quality explain the strong need of new mathematical structures, tools, and methods. Mathematics concerned with geoscientific problems, i.e., Geomathematics, is becoming increasingly important. The 'Handbook Geomathematics' as a central reference work in this area comprises the following scientific fields: (I) observational and measurement key technologies (II) modelling of the system Earth (geosphere, cryosphere, hydrosphere, atmosphere, biosphere) (III) analytic, algebraic, and operator-theoretic methods (IV) statistical and stochastic methods (V) computational and numerical analysis methods (VI) historical background and future perspectives.

This volume facilitates the use and calculation of spheroidal wave functions with a detailed and unified account of the properties of these functions and helpful tables.

Innovative developments in science and technology require a thorough knowledge of applied mathematics, particularly in the field of differential equations and special functions. These are relevant in modeling and computing applications of electromagnetic theory and quantum theory, e.g. in photonics and nanotechnology. The problem of solving partial differential equations remains an important topic that is taught at both the undergraduate and graduate level. Separable Boundary-Value Problems in Physics is an accessible and comprehensive treatment of partial differential equations in

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mathematical physics in a variety of coordinate systems and geometry and their solutions, including a differential geometric formulation, using the method of separation of variables. With problems and modern examples from the fields of nano-technology and other areas of physics. The fluency of the text and the high quality of graphics make the topic easy accessible. The organization of the content by coordinate systems rather than by equation types is unique and offers an easy access. The authors consider recent research results which have led to a much increased pedagogical understanding of not just this topic but of many other related topics in mathematical physics, and which like the explicit discussion on differential geometry shows - yet have not been treated in the older texts. To the benefit of the reader, a summary presents a convenient overview on all special functions covered. Homework problems are included as well as numerical algorithms for computing special functions. Thus this book can serve as a reference text for advanced undergraduate students, as a textbook for graduate level courses, and as a self-study book and reference manual for physicists, theoretically oriented engineers and traditional mathematicians.

Growing request for wideband communications requires innovation in power efficiency and signal processing. Without the use of any peak to average power ratio (PAPR) reduction technique, the efficiency of power consumption at the transmitter end becomes very poor. PAPR reduction in this work is accomplished based on using a unique class of functions, prolate spheroidal wave functions (PSWFs). The difficulty arises from the fact that these pulses do not belong to the Nyquist family. A zero forcing equalizer (ZFE) is designed to compensate intersymbol interference (ISI), and its performance is studied under the presence of AWGN. Considering PAPR and ISI as the constraints of communication systems, based on the properties of PSWF, a set of pulses with minimum ISI with respect to a specific amount of PAPR is achieved by defining an optimization problem. The desired level of PAPR is considered to be moved to the constraint set to convert the multi-objective problem into a single objective problem. The results of the numerical optimization of both ISI and PAPR are presented along with a couple of examples of comparison between the resultant pulse and the conventional square root raised cosine. It is shown that by achieving the same level of PAPR of the SRRC, the obtained pulse is a close approximation of SRRC. An implementation based on state variable filters is introduced to realize PSWF for high speed applications. An example based on this approach is presented to compare the finite pole approximation result with the original pulse.

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