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BOOK REVIEW

ADVANCED MATHEMATICAL METHODS IN SCIENCE AND ENGINEERING,2001, by S. I. Hayek. New York: Marcel Dekker, xv + 734 pp. Price US$ 195.00. ISBN 0-8247-0466-5

The contents of this book have evolved from a three-semester course in the application of mathematical methods to scientific and engineering problems. The first course, with emphasis on ordinary differential equations, is contained in chapters 1–4 and Appendix A. Chapter 1 briefly reviews methods of integration of ordinary differential equations in closed form. However, in many instances, it is not possible to obtain such solutions. This difficulty can be overcome by using series solutions, which is the topic of Chapter 2. Chapter 3 deals with ordinary differential equations that can be solved using Bessel, Legendre and related functions. The functions are covered in detail, including recurrence relations, series expansions and integrals. Chapter 4 covers the derivation and solution of linear boundary value problems for physical systems in one spatial dimension such as vibration and waves of strings, bars, beams and acoustic horns. The concepts of eigenfunctions, orthogonality and eigenfunction expansions are introduced. The chapter concludes with methods of solution of non-homogeneous boundary value problems. The convergence of infinite series, used in Chapters 2–4, is dealt with in Appendix A and plots of Bessel functions are shown in Appendix E.

The second semester course, with emphasis on partial differential equations, is contained in Chapters 5–7. Chapter 5 contains functions of a complex variable and integration in the complex plane. Chapter 6 deals with the derivation and solution of partial differential equations in mathematical physics and engineering. The types of equations treated include the wave equations in acoustics, beams, membranes and plates among others. Solutions are obtained by the methods of separation of variables and eigenfunction expansions. Chapter 7 covers the derivation of integral transforms such as Fourier, Laplace and Hankel. Each transform includes applications to solution of partial differential equations for engineering and physical systems.

The material for the third semester is contained in Appendix D and Chapters 8 and 9. Appendix D involves the calculus of generalized functions such as the Dirac delta function in n-dimensional space. In Chapter 8, the solution of non-homogeneous ordinary and partial differential equations is obtained by an integral technique known as the Green function method. The system's response is sought for a point source, known as the Green function, so that the solution for a distributed source is obtained as an integral of this function over the source strength region. This method is applied to the same physical examples treated in Chapter 6. Chapter 9 covers asymptotic methods, the emphasis being on the asymptotic evaluation of integrals and the asymptotic solution of ordinary differential equations.

There are five appendices. In addition to the three already mentioned, Appendix B presents a compendium of special functions such as Beta, Gamma, Laguerre, Hermite, Hypergeometric, Tchebyshev and Fresnel. Also, Appendix C presents a compendium of formulae for spherical, cylindrical, ellipsoidal, oblate and prolate spheroidal co-ordinate systems.

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Each chapter of the book contains many solved examples and many problems with answers. In addition, references pertaining to each chapter are provided.

A knowledge of differential and integral calculus and an introductory level of ordinary differential equations is assumed. Thus, the book is intended for advanced senior and graduate students in engineering mechanics, engineering science, mechanical, civil and aeronautical engineering and physics and geology. It also provides suitable material for those wishing to specialize in vibration and acoustics. The only slight criticism one can make about this excellent book is that not all the chapters and appendices contain an introduction.

M. Petyt