Book Review:

Numerical Methods for Engineers (Fifth Edition)

Steven Chapra and Raymond Canale
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With this book, the same as in previous editions, Chapra and Canale intend to provide a solid training in numerical methods by means of a pleasant and attractive approach that motivates the reader to study the subject and enjoy while doing it. The authors use programming as a powerful tool to implement models and experiment with them, generating a greater enthusiasm on the reader and, as a consequence, a better understanding of the problems developed, which are applied to Engineering and Physics.

Chapra and Canale divide the contents of their book in eight sections, each if which is presented through motivation followed by the necessary mathematical background to help understand the contents. Then, the authors provide a schematic representation to guide the reader through the topics analyzed in each of the sections. At the end of each section, the authors include abundant references and examples of the use of software packages such as Excel, MATLAB and IMSL routines, as well as the algorithms in pseudo-code for the methods included.

A brief summary of each of the sections of this book follows.

In the first section, the authors show the importance of mathematical problems solved by numerical methods in Engineering. They highlight the impact of the use of computers on the search for a solution to these problems. They also emphasize, in a very effective way, the importance of the errors that arise from the application of these techniques, as well as the effects caused both by the errors and the instability of the calculations and the uncertainty of the data in approximated results.

In this section, the authors present the software packages that will be used to discuss each of the topics, highlighting the importance of programming when these packages do not allow obtaining a solution. One of the chapters includes an introduction to structured programming, using pseudo-code and Excel VBA for coding the algorithms.

The second section is devoted to the study of methods for calculating equation roots. The topic is divided into two areas of problems - those dealing with the determination of real roots of algebraic and transcendental equations, and those dealing with the determination of all real and complex roots of a polynomial. The last chapter in this section includes examples applied to engineering developed in a clear and pedagogical way, the same as every section of the book. The examples selected are molar volume calculation, open channel flow, design of an electric circuit, and vibration analysis.

The third section deals with methods to solve linear algebraic equations and their use in Engineering, highlighting the consequences of the difficulties caused by problems with poorly presented conditions and rounding errors when writing the algorithms. Programming is focused to the use of packages that are specially designed to solve equations. The application problems developed are: analysis of the stationary state of a reactor system, analysis of a statically determined armor, currents and voltages in circuits with resistors and mass-spring system.

The fourth section deals with optimization methods, and mainly focuses on linear programming and software packages specially devoted to this kind of problems. The application problems developed are: design of a tank with the lowest possible cost, minimum cost for the treatment of waste waters, maximum power transfer in a circuit and design of a mountain bike.

The fifth section delves into the topic of curve adjustment, including linear and non-linear regression, interpolation and Fourier's approximation. In this section, the authors include numerous graphics and develop examples to support a better understanding. While showing how to use libraries and software packages to solve curve-adjustment problems, they present the contents in a very successful and

pedagogical manner. The application problems developed are: linear regression and population models, use of canonicals to estimate heat transfer, Fourier analysis and analysis of experimental data.

Section six presents and develops differentiation and integration methods, showing the advantages and disadvantages of selecting them. The authors provide algorithms for most of the methods treated and propose that the reader be able to master general use software packages that are commonly available. The application problems developed are: determination of the total amount of heat, effective force on the mast of a sailboat, mean square root of electric current and calculation of work.

The seventh section is used to develop methods for solving ordinary differential equations, and section eight deals with methods for the solution of partial differential equations, with a special subsection on the finite elements method with numerous graphics and presentation of examples implemented with software packages. The application problems that are presented in these two sections are: analysis of the transient response of a reactor, pray-predator model, simulation of transient current in an electrical circuit, and the oscillating pendulum in section seven. One-dimensional mass balance in a reactor, plate bending, two-dimensional electrostatic field problems, and solution by finite elements of a springs series in section eight.

Given its clarity and readability, this is an excellent textbook for a course on Programming and Numerical methods for Engineers, and a suitable book for any reader interested in learning about this subject.

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