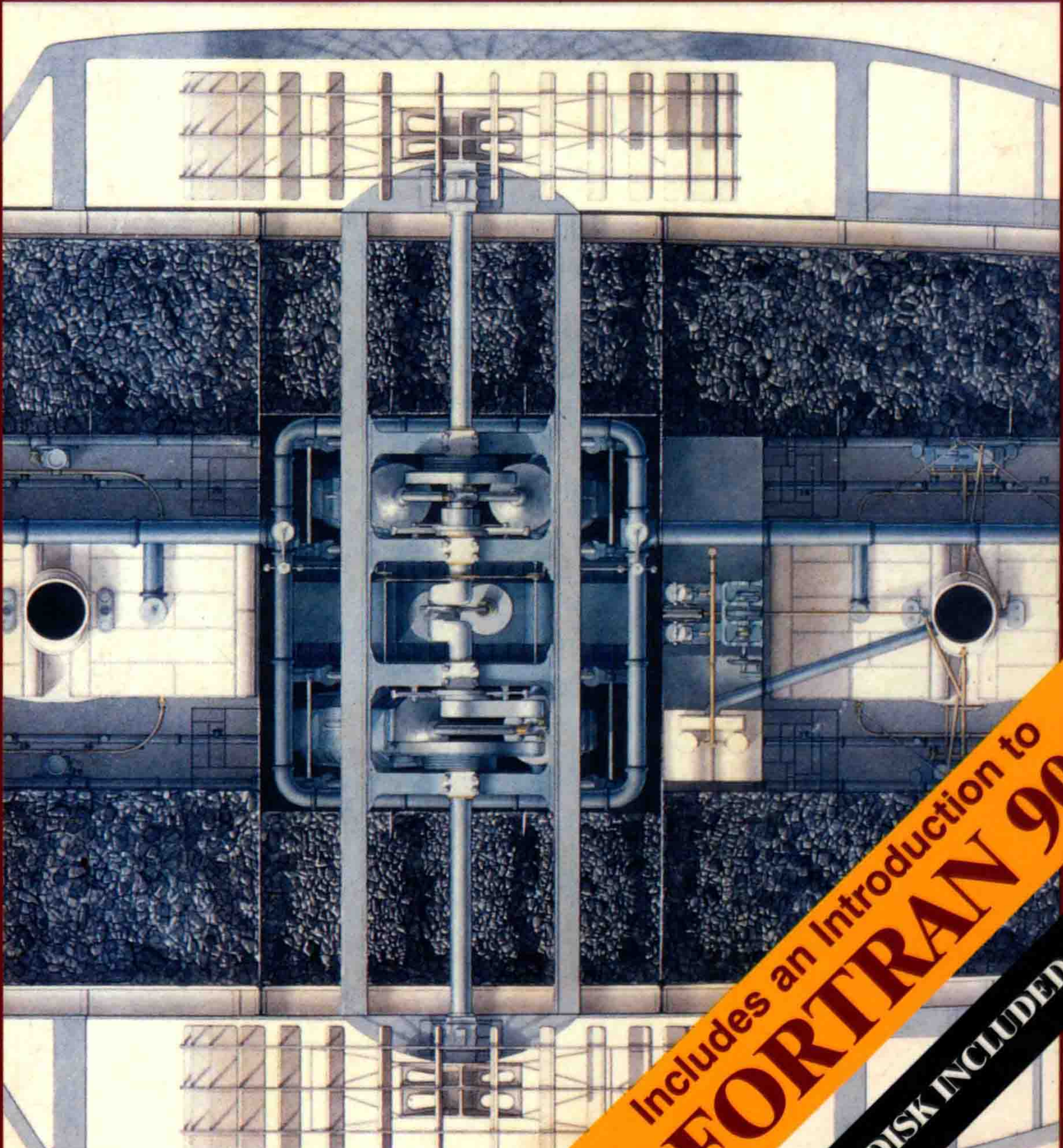
LARRY NYHOFF • SANFORD LEESTMA

FORTRAN 77

and Numerical Methods for Engineers and Scientists



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DISK INCLUDED

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Dedicated to the memory of

DAVID JOHNSTONE

who is missed by all of us who knew and admired this sincere, kind, and gentle man. We thank God for him and for the opportunity of working with him and for his friendship.

PREFACE

FORTRAN, now 40 years old, is a language that is used throughout the world to write programs for solving problems in science and engineering. Since its creation in the late 1950s, it has undergone a number of modifications that have made it a very powerful yet easy-to-use language. These modifications, however, led to a proliferation of different dialects of FORTRAN, which hindered program portability. Since some uniformity was desirable, the American National Standards Institute (ANSI) published the first FORTRAN standard in 1966. In the years following, extensions to this standard version of FORTRAN were developed, some of which came into common use. It became apparent that many of these features should be incorporated into a new standard. This updated ANSI FORTRAN standard (ANSI X3.9-1978), popularly known as FORTRAN 77, is the basis for this text. A new standard has recently been finalized, and the version of FORTRAN—FORTRAN 90—specified by this standard has many new features. At the end of each chapter and in Chapter 14 we describe some of these additions to FORTRAN.

FORTRAN is one of the most widely used programming languages for solving problems in science and engineering. This text describes these applications in the examples and exercises. It contains more than 60 complete examples and over 400 exercises, both written and programming exercises, chosen from areas that are relevant to science and engineering students. Copies of all programs and subprograms marked in the text with a disk icon are on the data disk that accompanies this text.

A special feature of this text is its emphasis on numerical methods. These methods are highlighted in 15 special NUMERICAL METHODS sections, which we have marked with a special icon. These sections contain descriptions of and programs for a variety of methods that are particularly useful in solving science and engineering problems. These include the following:

- Least squares approximations.
- Root finding: Bisection method, Newton's method, false position, secant method, fixed-point iteration.
- Linear systems: Matrices, Gaussian elimination, Jacobi iteration, Gauss-Seidel iteration.
- Derivatives and differences: First and second differences.
- Numerical integration: Rectangle method, trapezoidal method, Simpson's rule, Romberg integration, Gaussian quadrature.

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- Differential equations: Euler's method, Runge-Kutta method, multistep methods, predictor-corrector methods.
- Interpolation: Linear, quadratic, cubic, Lagrange, and piecewise.
- Function approximation: Method of undetermined coefficients, cubic splines, Taylor polynomials.

Although this book gives a complete presentation of FORTRAN 77, it is more than just a programming manual. The main reason for learning a programming language is to use the computer to solve problems. Consequently, the basic steps in problem solving and program development are discussed and illustrated: (1) problem analysis and specification, (2) algorithm development, (3) program coding, (4) program execution and testing, and (5) program maintenance. We also feel that an intelligent user of the computer must have some elementary understanding of the manner in which a computer operates, how it stores information, how it processes data, and what some of its capabilities and limitations are. For this reason the text also contains a brief sketch of the history of computers and a simple description of a computer system, including techniques for representing data and machine instructions in binary form.

The text also emphasizes the importance of good structure and style in programs. In addition to describing these concepts in general, it contains a large number of complete examples. Each of these consists of a description of the algorithm using pseudocode and/or flowcharts together with a program and sample run. These are intended to demonstrate good algorithm design and programming style. At the end of each chapter a Programming Pointers section summarizes the main points regarding structure and style as well as language features presented and potential problems that beginning programmers may experience.

Supplementary Materials

There are two supplementary materials available to instructors who adopt this text:

- A solutions manual.
- Disks containing solutions to programming exercises.

Acknowledgments

We express our sincere appreciation to all who helped in any way in the preparation of this text, especially our editors, Betsy Jones at Macmillan and Alan Apt at Prentice Hall. We also thank Ferenc Szidarovszky for contributing engineering exercises that are solved using numerical methods. And, of course, we must once again thank our wives, Shar and Marge, whose love and understanding have kept us going through another year of textbook writing, and to our kids and grandkids, Jeff and Dawn, Jim, Julie, Joan, Rebecca, Michelle and Paul, Sandy and Lori, and Michael, for not complaining about the times that their needs and wants were slighted because of our busyness. Above all, we give thanks to God for giving us the opportunity, ability, and stamina to prepare this text.

L. N.
S. L.

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