Detailed Contents I

Chapters 1-10 begin with a discussion of one of the ten outstanding achievements and a reference to an application section that solves a related problem. Chapter 1 also contains a list of references to more information on these outstanding achievements. Each chapter begins with an introduction and ends with a summary. In addition, chapters also include the following:

- keywords
- debugging aids
- style/technique guides
- programming problems
- FORTRAN statement summaries

■ 1 An Introduction to Problem Solving with FORTRAN 77 1

1-1 Engineering and Scientific Achievements 2
Moon Landing 2
Application Satellites 2
Microprocessors 3
Computer-Aided Design and Manufacturing 3
CAT Scan 4
Advanced Composite Materials 4
Jumbo Jets 4
Lasers 5
Fiber-Optic Communications 5
Genetically Engineered Products 5

1 - 2 Engineering and Scientific Challenges 6
Prediction of Weather, Climate, and Global Change 6
Speech Recognition and Understanding 6
Machine Vision 6
Vehicle Performance 7
Superconductivity 7
Enhanced Oil and Gas Recovery 7
Nuclear Fusion 7

I- 3 Computer Hardware 8

		Computer Software 14 Computer Languages 14 Software Tools 17 Operating Systems 18
		Executing a Computer Program 19
	1-6	A Five-Step Problem Solving Process 21
2	Arith	metic Computations 29
	2-1	Constants and Variables 30 Variable Names 30 Data Types 31 Scientific and Exponential Notation 33 Magnitude Limitations 33
	2-2	Arithmetic Operations 35 Simple Arithmetic 35 Evaluating an Arithmetic Expression 36 Truncation and Mixed-Mode Operations 39 Underflow and Overflow 41
	2-3	Intrinsic Functions 42
	2-4	Simple Input and Output 45 FORTRAN Statement Format 46 List-Directed Output 47 List-Directed Input 49 Formatted Output 50 Literal Specification 52 X Specification 54 I Specification 55 F Specification 57 E Specification 58
		Complete Programs 61
	2-6	Application — Bacteria Growth (Biology) 64
	2-7	Application — Atmospheric Measurements (Remote Sensing) 66
	2-8	Application — Equipment Reliability (Electrical Engineering) 69
	2-9	Application — Stride Estimation (Mechanical Engineering) 72
	2 – 10	Additional Formatting Features 75 Repetition 75 Slash 76 Tab Specification 76 Number of Specifications 77

■ 5 Array Processing 197

- 5 1 One-Dimensional Arrays 198 Storage and Initialization 198 Input and Output 200
- 5 2 DATA Statement 205
- 5-3 Application Speech Processing (Digital Signal Processing) 207
- 5 4 Sorting Algorithms 211 Selection Sort 212 Bubble Sort 214 Insertion Sort 216
- 5-5 Application Earthquake Measurements (Civil Engineering) 219
- 5 6 Two-Dimensional Arrays 223 Storage and Initialization 224 Input and Output 227
- 5-7 Application Power Plant Data Analysis (Power Engineering) 230
- 5 8 Application -Terrain Navigation (Aerospace Engineering) 235
- 5 9 Multidimensional Arrays 238

■ 6 Function Subprograms 251

- 6 1 Intrinsic Functions 252
- 6 2 Statement Functions 253
- 6 3 Application Fluid Flow Analysis (Mechanical Engineering) 257
- 6 4 Modular Programming 261
- 6 5 User-Defined Functions 262
- 6-6 Application Oil Well Production (Petroleum Engineering) 276
- 6-7 Application Stability Analysis (Robotic Engineering) 282
 Roots of Equations 283
 Incremental-Search Method 284
 Bisection Method 285
 Robot Stability 287
- 6-8 Functions for Search Algorithms 294 Unordered List 294 Ordered List 298

■ 7 Subroutine Subprograms 313

- 7 1 User-Defined Subroutines 314
- 7 2 Subroutine for Generating Random Numbers 321
- 7 3 Application Equipment Reliability (Quality Control Engineering) 323
- 7 4 Application -Waste Water Treatment (Chemical Engineering) 328
- 7 5 Subroutines for Inserting and Deleting 335
 Inserting in an Ordered List 335
 Deleting from an Ordered List 339
- 7 6 Application Composite Materials (Mechanical Engineering) 345
- 7 7 Common Blocks 351

■ 8 Additional Data Types 365

8-1 Character Data 366

Character I/O 368

Character Operations 370

Assign Values 370

Compare Values 371

Extract Substrings 372

Combine Strings 374

Character Intrinsic Functions 374

INDEX 375

LEN 375

CHAR, ICHAR 377

LGE, LGT, LLE, LLT 378

- 8-2 Application Protein Molecular Weights (Genetic Engineering) 380
- 8-3 Double-Precision Data 385

Double-Precision I/O 386

Double-Precision Operations 387

Double-Precision Intrinsic Functions 387

- 8-4 Application Global Positioning System (GPS) (Navigational Engineering) 389
- 8 5 Complex Data 394

Complex I/O 394

Complex Operations 395

Complex Intrinsic Functions 395

8-6 Application — Electric Circuit Model (Electrical Engineering) 397

9 Additional File Handling 413

- 9-1 Formatted READ Statements 414
 - X Specification 415
 - I Specification 415
 - F Specification 416
 - E Specification 417
 - A Specification 418
- 9 2 Internal Files 420
- 9-3 Sequential Files 421

OPEN Statement 421

UNIT 421

FILE 421

ACCESS 422

STATUS 422

FORM 422

IOSTAT 422

RECL 422

BLANK 422

ERR 422

CLOSE Statement 423

REWIND Statement 423

BACKSPACE Statement 423

ENDFILE Statement 423

- 9 4 Application -Voyager Spacecraft Data Analysis (Electrical Engineering) 424
- 9-5 Application Data Filters (Software Engineering) 431
- 9 6 Direct-Access Files 434
- 9 7 Application CAT Scan Database (Biomedical Engineering) 435
- 9 8 INQUIRE Statement 440

Numerical Applications 453

- 10 1 Least-Squares Methods 454
 - Linear Models 454

Polynomial Models 457

Nonlinear Models 458

- 10 2 Application Ozone Model (Remote Sensing) 459
- 10-3 Matrix Operations 465
- 10 4 Gauss Elimination 472

- 10 5 Application Deformable Mirrors (Optical Engineering) 476
- 10 6 Numerical Integration and Differentiation 486 Integration Using the Trapezoidal Rule 486 Differentiation Using Central Differences 489
- 10 7 Application Sounding Rocket Trajectory (Aerospace Engineering)
 492

■ 11 FORTRAN 77 Extensions 509

- 11 1 Extensions to the Character Set and Source Format 511
 Source Format Extensions 511
 Symbolic Names Extensions 511
 Comments 511
 Constants 512
 Variables 513
 Operations 513
- 11 2 Extensions to the Intrinsic and Derived Data Types 513

 Extensions to Intrinsic Data Types 514

 Derived Data Types 516
- 11-3 Statement Extensions 520
- 11 4 Subprogram (Subroutine and Function) Extensions 531
 Subroutine and Function Extensions 531
 Standard Function Extensions 535
- 11 5 Extensions to Input/Output Formats 537
 Suppressing Carriage Returns 538
 Hollerith Edit Descriptor 538
 Hexadecimal Output Descriptor 538
 Radix Control Edit Descriptor 538
 Remaining Characters Edit Descriptor 539
 Variable Expressions in Formats 540
 Direct I/O and Internal Files 540

■ 12 The Fortran 90 Standard 543

12 – 1 Expanded Character Set and Source Format 544
Fortran Character Set 544
Variable Names 544
Relational Operators 545
Free and Fixed Source Form 546
INCLUDE Line 546

- 12 2 Intrinsic and Derived Data Types 546
 Intrinsic Data Types 546
 Type Declarations 547
 Derived Data Types 547
 Attributes 547
- 12 3 Array Enhancements 548
 Array Computations 548
 New Array Functions 548
 Masked Array Assignment 548
 Dynamic Array Allocation 549
- 12 4 Control Statements 550 CASE Construct 550 DO Construct 551
- 12 5 Intrinsic and User-Defined Procedures 552

 New Intrinsic Procedures 552

 Internal and External Procedures 553

 Modules 553

 Recursive Procedures 553
- 12 6 Pointer Variables 555
 Linked Lists 556
 Additional Linked Structures 559
 Circularly Linked List 559
 Doubly Linked List 559
 Stack 560
 Queue 560
 Binary Tree 561

Appendix A FORTRAN 77 Intrinsic Functions 563
Appendix B Additional FORTRAN 77 Topics 567
Glossary of Key Words 578
Answers to Self-Tests 586
Index 598