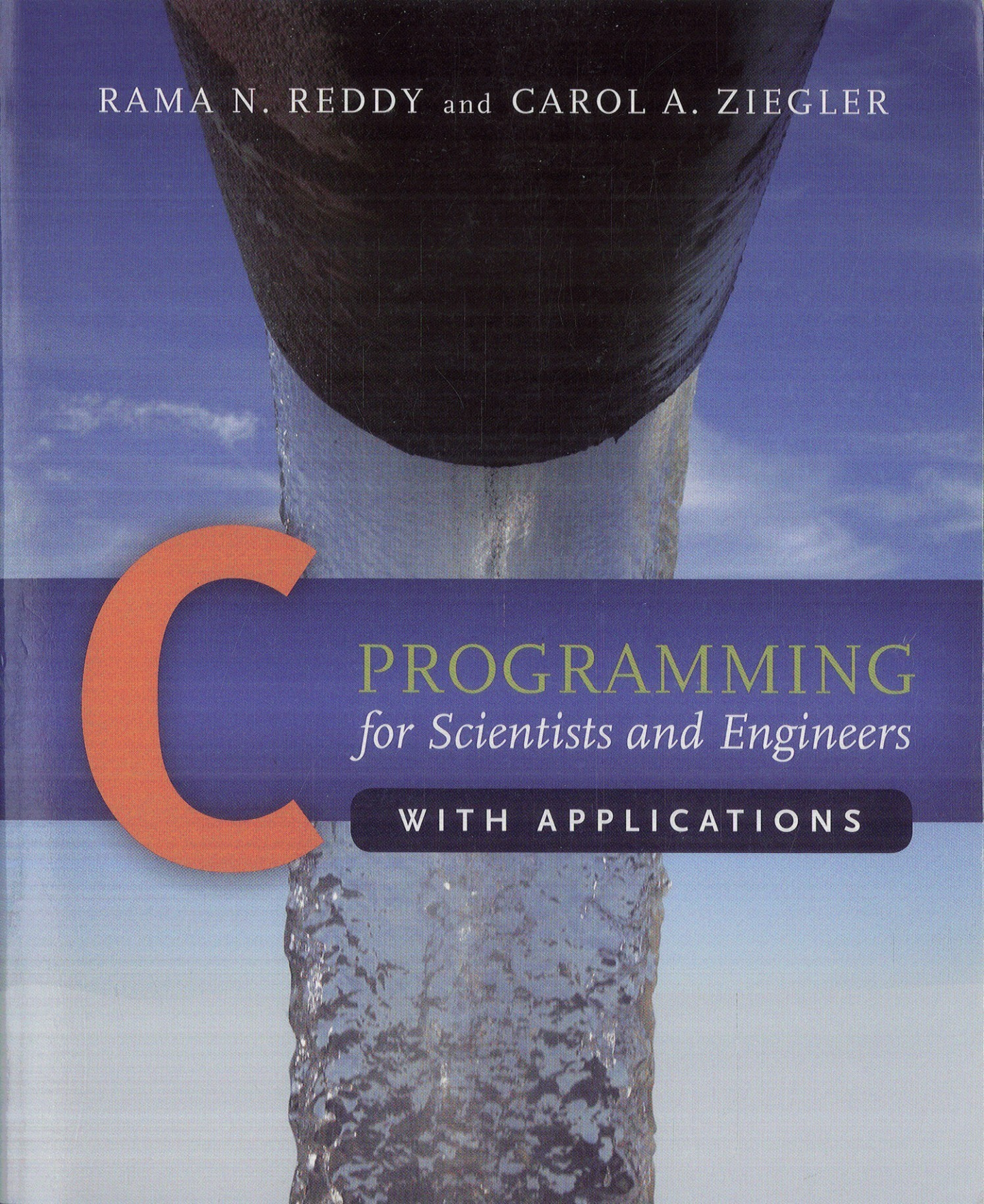


The background of the book cover is a photograph of a dark, cylindrical object, possibly a rocket nozzle or a large pipe, with a bright blue sky and white clouds in the background. A large, stylized orange letter 'C' is positioned on the left side of the cover, partially overlapping the title text.

RAMA N. REDDY and CAROL A. ZIEGLER

C PROGRAMMING
for Scientists and Engineers

WITH APPLICATIONS

Contents

Preface xv

Chapter 1 Introduction to Computers and Programming 1

- 1.1 Concept of Computers and Computer Systems 2
 - 1.1.1 Hardware Components and Functions 4
 - 1.1.2 Software Components and Functions 6
 - 1.1.3 Integration of Hardware and Software 9
 - 1.1.4 Review Questions 9
- 1.2 Modular Programming 10
 - 1.2.1 Modular Design 10
 - 1.2.2 Structure Charts 11
 - 1.2.3 Functional Modules 12
 - 1.2.4 Review Questions 12
- 1.3 Algorithms and Program Development 12
 - 1.3.1 Concept of an Algorithm 13
 - 1.3.2 Concept of Programs and Data 14
 - 1.3.3 Procedure for Problem Analysis 18
 - 1.3.4 Solution Design Methodology 19
 - 1.3.5 Concept of Structured Programming 30
 - 1.3.6 Review Questions 35
- 1.4 Program Processing 35
 - 1.4.1 Program Coding 36
 - 1.4.2 Program Compilation 38

1.4.3	Program Execution	38
1.4.4	Program Testing	39
1.4.5	Program Documentation	41
1.4.6	Review Questions	42
1.5	Program Processing Environment	42
1.5.1	Computer System Environment	42
1.5.2	Programming Environment	43
1.5.3	Review Questions	44
1.6	Samples of Algorithms	45
1.6.1	Resistance and Voltage of a Parallel Circuit	45
1.6.2	Volume of a Sphere	47
1.6.3	Square Root Approximation	51
1.6.4	Total Pressure of Gaseous Mixture	54
1.6.5	Mass Flow Rate of Air Through Pipes	57
	Chapter Summary	60
	Exercises	61

Chapter 2 Basic Elements of the C Programming Language 65

2.1	Introduction to C	66
2.1.1	Structured Language	67
2.1.2	Procedural Language	69
2.1.3	Statically Typed Language	72
2.1.4	Review Questions	72
2.2	Constants and Variables	73
2.2.1	Character Set	73
2.2.2	Identifiers	74
2.2.3	Built-in Data Types	76
2.2.4	Derived Data Types	81
2.2.5	Pointer and Pointer Variables	82
2.2.6	Review Questions	85
2.3	Arithmetic Operations and Expressions	86
2.3.1	Arithmetic Operators and Operations	86
2.3.2	Arithmetic Expressions	90
2.3.3	Assignment Statement	90
2.3.4	Order of Evaluations	92
2.3.5	Use of Parentheses	95

2.3.6	Special Operators	96
2.3.7	Accuracy of Computation	101
2.3.8	C Libraries and Functions	103
2.3.9	Review Questions	103
2.4	Overview of Implementation	106
2.4.1	Formatting of Statements	106
2.4.2	Formatting of a Program	107
2.4.3	Data Design	109
2.4.4	Review Questions	110
2.5	First Complete Programs	110
2.5.1	Sample C Program	111
2.5.2	Slope of a Straight Line	112
2.5.3	Compression Stress in a Steel Column	115
2.5.4	Set of Simultaneous Equations	118
2.5.5	Area of a Scalene Triangle	120
2.5.6	Volume of a Sphere	123
	Chapter Summary	125
	Exercises	126

Chapter 3 Input and Output 129

3.1	Input and Output Functions	130
3.1.1	Formatted Input and Output Functions	130
3.1.2	Standard Input Function	131
3.1.3	Standard Output Function	134
3.1.4	Review Questions	138
3.2	File Input and Output	139
3.2.1	Declaration of File Pointers	139
3.2.2	open and close Statements	140
3.2.3	Input from a Data File	143
3.2.4	Output to a Data File	145
3.2.5	Review Questions	149
3.3	Field Width Specification	151
3.3.1	Input Field Width Specification	151
3.3.2	Output Field Width Specification	153
3.3.3	Review Questions	155
3.4	Input and Output of Characters	157
3.4.1	Standard Input and Output	158

3.4.2	File Input and Output	159
3.4.3	Unformatted Input and Output	160
3.4.4	Review Questions	163
3.5	Sample Programs	163
3.5.1	Conversion from Polar to Cartesian Coordinates	164
3.5.2	Cost of a Steel Cage	166
3.5.3	Convection Heat Transfer	170
3.5.4	Air Conditioners Sales Report	173
3.5.5	Wavelength of an Electron	176
	Chapter Summary	179
	Exercises	183

Chapter 4 Control Structures 187

4.1	Relational and Logical Operations	190
4.1.1	Relational Operators and Relational Expressions	190
4.1.2	Logical Operators and Logical Expressions	193
4.1.3	Review Questions	196
4.2	Selection Structures	198
4.2.1	Two-Way Selection Structures	198
4.2.2	Compound Conditions	206
4.2.3	Multiway Structures	210
4.2.4	Review Questions	215
4.3	Repetition Structures	217
4.3.1	Iterative Loops	218
4.3.2	Nested Iterative Loops	220
4.3.3	Conditional Loops	222
4.3.4	Review Questions	228
4.4	Stacking and Nesting of Control Structures	229
4.4.1	Control Structure Stacking	230
4.4.2	Nested Control Structures	231
4.4.3	Review Questions	237
4.5	Sample Problems and Programs	237
4.5.1	Impedance and Inductance of an Electrical Coil	237
4.5.2	Altitude of a Projectile	241
4.5.3	Shear Stress of a Metallic Member	244
4.5.4	Table of Periods of a Pendulum	248
4.5.5	Compression Stress and Strain in Steel Rods	251

4.5.6 Types of Triangles 254

Chapter Summary 259

Exercises 260

Chapter 5 Modular Design and Function 265

5.1 Introduction to Modular Programming 266

5.1.1 Design of Modular Programs 266

5.1.2 Functional Modules in C 270

5.1.3 Review Questions 271

5.2 Functions 272

5.2.1 Function Declaration 272

5.2.2 Function Definition 274

5.2.3 Scope of Names 278

5.2.4 return Statement 284

5.2.5 Review Questions 285

5.3 Computation Functions 288

5.3.1 Passing Arguments by Value 288

5.3.2 Passing Arguments by Pointer 291

5.3.3 Review Questions 300

5.4 Input and Output Functions 302

5.4.1 Input Using Functions 302

5.4.2 Output Using Functions 307

5.4.3 Review Questions 311

5.5 Recursive Functions 312

5.5.1 Concept of Recursion 312

5.5.2 Relationship Between Iteration and Recursion 315

5.5.3 Review Questions 317

5.6 Sample Programs 317

5.6.1 Rocket Motor Thrust 317

5.6.2 Current in Series Circuit 322

5.6.3 Square Root Function 328

Chapter Summary 332

Exercises 334

Chapter 6 Storage Classes 341

6.1 Scope of Variables 342

6.1.1 Block Structure 342

6.1.2	Global Scope and Block Scope	344
6.1.3	Scope of Access	347
6.1.4	Review Questions	349
6.2	Storage Classes in a Single File	351
6.2.1	Storage Class <code>auto</code>	352
6.2.2	Storage Class <code>extern</code>	353
6.2.3	Storage Class <code>static</code>	359
6.2.4	Storage Class <code>register</code>	363
6.2.5	Review Questions	364
6.3	Storage Classes in Multiple Files	367
6.3.1	Storage Class <code>Extern</code>	367
6.3.2	Review Questions	371
6.4	Sample Programs	373
6.4.1	Flow Through Pipes	373
6.4.2	Water Pressure	379
	Chapter Summary	386
	Exercises	388

Chapter 7 One-Dimensional Arrays 389

7.1	One-Dimensional Arrays	390
7.1.1	Subscripts and Subscripted Variables	391
7.1.2	Declaration of Arrays	393
7.1.3	Initialization of Arrays	395
7.1.4	Review Questions	397
7.2	Input of One-Dimensional Arrays	398
7.2.1	Array Input	398
7.2.2	Input of Parallel Arrays	400
7.2.3	Review Questions	401
7.3	Output of One-Dimensional Arrays	402
7.3.1	Array Output	402
7.3.2	Output of Parallel Arrays	404
7.3.3	Review Questions	405
7.4	Manipulation of Arrays	407
7.4.1	Array Assignment	407
7.4.2	Array Arithmetic	411
7.4.3	Review Questions	413
7.5	Passing Arrays to Functions	414

7.5.1	Passing Fixed-Size Arrays	414
7.5.2	Passing Array Elements	418
7.5.3	Review Questions	419
7.6	Sample Programs	420
7.6.1	Reynolds Numbers	420
7.6.2	Stress and Strain	423
7.6.3	Standard Deviation	426
7.6.4	Maximum and Minimum Values	431
7.6.5	Sorting	434
7.6.6	Searching	448
7.6.7	Inventory of an Engineering Sales Company	456
	Chapter Summary	464
	Exercises	466

Chapter 8 Multidimensional Arrays 469

8.1	Introduction to Two-Dimensional Arrays	470
8.1.1	Declaration Statement	472
8.1.2	Storage Allocation	473
8.1.3	Array Initialization	474
8.1.4	Review Questions	477
8.2	Input of Two-Dimensional Arrays	478
8.2.1	Standard Input	478
8.2.2	Input from a Data File	479
8.2.3	Review Questions	480
8.3	Output of Two-Dimensional Arrays	481
8.3.1	Standard Output	481
8.3.2	Output to a Data File	482
8.3.3	Review Questions	483
8.4	Manipulation of Arrays	484
8.4.1	Array Assignment	484
8.4.2	Array Arithmetic	486
8.4.3	Matrix Operations	487
8.4.4	Review Questions	491
8.5	Passing Arrays to Functions	493
8.5.1	Passing Fixed Size Arrays	493
8.5.2	Passing Array Elements	495
8.5.3	Review Questions	496

8.6	Higher-Dimensional Arrays	497
8.6.1	Declaration and Storage Allocation	497
8.6.2	Input of Three-Dimensional Arrays	500
8.6.3	Output of Three-Dimensional Arrays	501
8.6.4	Manipulation of Three-Dimensional Arrays	501
8.6.5	Review Questions	504
8.7	Sample Programs	504
8.7.1	Drag Force	504
8.7.2	Saddle Point	509
8.7.3	Computation of Pressure	513
8.7.4	Geometric Transformations	519
8.7.5	Inventory of Cars in the XYZ Dealership	536
	Chapter Summary	549
	Exercises	549

Chapter 9 Characters and Strings 553

9.1	Introduction to Character Data	554
9.1.1	Declaration of Character Data	554
9.1.2	Initialization of Character Data	555
9.1.3	Input/Output of Character Data	557
9.1.4	Review Questions	559
9.2	Introduction to Strings	560
9.2.1	Declaration and Initialization of Strings	561
9.2.2	Storage of String Arrays	565
9.2.3	Input/Output of Character Strings	567
9.2.4	Review Questions	578
9.3	Strings and Functions	580
9.3.1	Passing Strings to Functions	580
9.3.2	Review Questions	582
9.4	String Library Functions	583
9.4.1	String Assignment	583
9.4.2	String Copy (strcpy)	583
9.4.3	String Concatenation (strcat)	586
9.4.4	String Comparison	589
9.4.5	String Length (strlen) and Other String Functions (strstr, strchr, and strrchr)	592
9.4.6	Review Questions	594

9.5	Sample Programs	595
9.5.1	Creating a List of Names from a File	596
9.5.2	Sorting a List of Names	599
9.5.3	Sequential Search of Parts List	605
	Chapter Summary	609
	Exercises	611

Chapter 10 Pointers and Dynamic Storage 613

10.1	Concept of a Pointer	614
10.1.1	Pointers and Pointer Variables	615
10.1.2	One Level and Multilevel Indirection	619
10.1.3	Review Questions	622
10.2	Address and Pointer Arithmetic	623
10.2.1	Arithmetic Operations on Pointers	623
10.2.2	Dereferencing of Pointers	624
10.2.3	Review Questions	625
10.3	Pointers and Arrays	626
10.3.1	One-Dimensional Arrays	626
10.3.2	Increment and Decrement Operations	633
10.3.3	Two-Dimensional Arrays	634
10.3.4	Review Questions	640
10.4	Dynamic Storage and Arrays	640
10.4.1	One-Dimensional Arrays	641
10.4.2	Two-Dimensional Arrays	645
10.4.3	Review Questions	649
10.5	Character Strings and Pointers	650
10.5.1	Dynamic Storage of Character Strings	650
10.5.2	Passing Strings to Functions as Dynamic Arrays	652
10.5.3	Review Questions	655
10.6	Sample Programs	655
10.6.1	Tensile Stress	655
10.6.2	<i>Days of Above Average Temperature</i>	658
10.6.3	Sorting Dynamically Stored Character Strings	662
	Chapter Summary	668
	Exercises	670

Chapter 11 Structures 673

- 11.1 Structures and Structure Variables 674
 - 11.1.1 Declaration of Structures and Variables 674
 - 11.1.2 Declaration of Arrays of Structure Variables 677
 - 11.1.3 Structure Member and Pointer Operators 679
 - 11.1.4 Definition of Structure Variables 686
 - 11.1.5 Review Questions 689
 - 11.2 Manipulation of Structures 691
 - 11.2.1 Input/Output of Structure Variables 691
 - 11.2.2 Arithmetic on Structure Variables 698
 - 11.2.3 The `typedef` Statement and its Usage 699
 - 11.2.4 Review Questions 700
 - 11.3 Structures and Functions 701
 - 11.3.1 Passing Structure Variables by Value 701
 - 11.3.2 Returning Structure Variables 705
 - 11.3.3 Passing Structure Variables by Pointer 706
 - 11.3.4 Review Questions 710
 - 11.4 Nested and Self-Referential Structures 711
 - 11.4.1 Nested Structures 711
 - 11.4.2 Self-Referential Structures 715
 - 11.4.3 Review Questions 717
 - 11.5 *Union and Enumeration Data Types* 717
 - 11.5.1 Declaration of Union and Union Variables 717
 - 11.5.2 Operations on Unions 718
 - 11.5.3 Enumeration Data Type 720
 - 11.5.4 Review Questions 721
 - 11.6 Sample Programs 721
 - 11.6.1 Parts Table 721
 - Chapter Summary 730
 - Exercises 732
-
- Appendix A 735
 - Appendix B 741
 - Appendix C 747
 - Appendix D 799
 - Index 801