

Contents

Chapter 1 Introduction	1
1.1 The Problem: Bugs	1
1.2 The Cleanroom Method	3
1.3 About This Book	6
Notes	8
Chapter 2 The Functions Computed by Programs	11
2.1 Computations: States and Functions	11
2.2 Representation of Functions: Concurrent Assignments	12
2.3 Conditional Concurrent Assignments	15
2.4 Local Variables	17
2.5 Specification Using Intended Functions	18
2.6 Other Notation Conventions	20
2.7 Writing Intended Functions	23
Exercises	27
Notes	29
Chapter 3 Verification	31
3.1 The Structured Control Constructs	31
3.2 Placement of Intended Functions	33
3.3 The Substitution Principle	36
3.4 Sequences of Statements	38
3.5 Trace Tables	41

3.6	If-statements	42
3.7	Conditional Trace Tables	47
	Exercises	51
	Notes	52

Chapter 4 Verification of Iterations 53

4.1	While-statements	53
4.2	Proving Termination	55
4.3	Initialized Loops	57
4.4	Writing Intended Functions for Loops in Isolation	59
4.5	Other Forms of Indefinite Iteration	63
	Exercises	66
	Notes	67

Chapter 5 Programming with Intended Functions 69

5.1	A Pascal Program: Length of the Longest Line	69
5.2	A C Program: Counting Letters and Digits	77
5.3	An Icon Routine: Uncompressing a String	83
5.4	A Study in Abstraction: The Registrar's Program	90
5.5	Keeping Things Simple	96
	Exercises	100
	Notes	102

Chapter 6 Verification Reviews 103

6.1	Why Verification Reviews Are Necessary	103
6.2	Verification Reviews in the Cleanroom Process	104
6.3	How Verification Reviews Are Done	105
6.4	Example: Another Routine from the Registrar's Programs	108
6.5	Example: A Routine from a Test-data Generator	111
6.6	Discussion of the Examples	117
	Exercises	119
	Notes	119

Chapter 7 Definite Iteration	121
7.1 Definite Iteration Over Sequences	121
7.2 Sequence Variables	124
7.3 Other Sequence Expressions	127
7.4 Ranges of Integers	131
7.5 Other Data Structures	133
7.6 The Iteration Mechanisms	136
7.7 Sets and Sequences in Program Design	142
Exercises	145
Notes	147
Chapter 8 Data Abstraction and Object-oriented Programs	149
8.1 Data Abstraction and Encapsulation	149
8.2 The Abstraction Function	152
8.3 Data Invariants	155
8.4 Object-oriented Programs	161
Exercises	166
Notes	166
Chapter 9 Recursion and Functional Languages	169
9.1 Recursive Routines	169
9.2 Termination	174
9.3 Mutual Recursion	176
9.4 Functional Languages	178
Exercises	184
Notes	185
Chapter 10 Testing	187
10.1 The Role of Testing	187
10.2 Usage-based Testing	190
10.3 Test-data Generators	191

10.4 Other Forms of Testing	196
Exercises	197
Notes	198

Chapter 11 Incremental Development **199**

11.1 Developing a Program in Increments	199
11.2 Planning and Carrying Out the Process	201
11.3 Example: Rehearsal Scheduling	203
Exercises	207
Notes	208

Chapter 12 Where Do We Go From Here? **209**

12.1 Other Parts of the Cleanroom Process	209
12.2 Other Formal Methods	212
12.3 What Have We Accomplished?	216
12.4 Prospects for the Future	219
Notes	222
Hints for Selected Exercises	225
References	227
Index	235