
Contents

Preface.....	xvii
Acknowledgments	xix
Organization of this Book	xxi
Author Biography	xxiii
1. Introduction to the Computer	1
1.1 Introduction	1
1.2 Definition and Characteristics of a Computer System	1
1.3 History of the Computer.....	2
1.4 Basic Computer Organization.....	4
1.4.1 Input Devices.....	5
1.4.2 Memory	6
1.4.3 Central Processing Unit	6
1.4.4 Output Devices.....	7
1.5 Computer Memory	7
1.5.1 Registers	8
1.5.2 Cache Memory	8
1.5.3 Primary Memory.....	8
1.5.4 Random Access Memory	10
1.5.5 Read Only Memory	10
1.5.6 Secondary Memory.....	10
1.5.7 Hard Disk Drive.....	10
1.5.8 Solid State Drive.....	11
1.6 Introduction to the Operating System	12
1.6.1 Hardware and Software.....	12
1.6.2 Operating System.....	12
1.6.3 Functions of an Operating System	13
1.7 Review Questions	14
1.7.1 Long Answers.....	14
1.7.2 Short Answers	14
1.7.3 Practical Exercises.....	15
References	16
2. Number Systems.....	17
2.1 Introduction	17
2.1.1 Non-positional Number System.....	17
2.1.2 Positional Number System	17
2.2 Positional Number Systems	18
2.2.1 Decimal Number System.....	18
2.2.2 Binary Number System.....	20
2.2.3 Hexadecimal Number System	21
2.2.4 Octal Number System	22

2.3	Number Conversion	23
2.3.1	Binary to Decimal	23
2.3.1.1	Approach 1	24
2.3.1.2	Approach 2	24
2.3.2	Binary Fraction to Decimal Conversion	25
2.3.3	Binary to Decimal Conversion	26
2.3.4	Decimal Fraction to Binary Fraction	27
2.3.5	Decimal to Octal Conversion	28
2.3.6	Octal to Decimal Conversion	29
2.3.7	Octal to Binary Conversion	29
2.3.7.1	Procedure 1	29
2.3.7.2	Procedure 2	30
2.3.8	Binary to Octal Conversion	30
2.3.8.1	Procedure 1	30
2.3.8.2	Procedure 2	31
2.3.9	Decimal to Hexadecimal Conversion	32
2.3.10	Hexadecimal to Decimal Conversion	33
2.3.11	Hexadecimal to Binary Conversion	33
2.3.11.1	Procedure 1	33
2.3.11.2	Procedure 2	34
2.3.12	Binary to Hexadecimal Conversion	34
2.3.12.1	Procedure 1	34
2.3.12.2	Procedure 2	35
2.4	Review Questions	36
2.4.1	Conversion Questions	36
3.	Problem Solving through Flowcharts and Algorithms	39
3.1	Introduction	39
3.2	Problem-solving Approach	40
3.3	Algorithm Design	41
3.3.1	Characteristics of an Algorithm	42
3.4	Basics of an Algorithm	43
3.4.1	Advantages of Using an Algorithm	44
3.4.2	Example: Write an Algorithm to Add Two Numbers and Produce the Sum	44
3.4.3	Algorithm 3.1	45
3.5	Flowcharts	45
3.5.1	Advantages of Using a Flowchart	45
3.5.2	Flowchart Symbols	46
3.5.3	Flowchart Drawing Guidelines	46
3.6	Example Problems	48
3.7	Basics of a Programming Language	53
3.7.1	Low-level Languages	53
3.7.1.1	Machine-level Languages	54
3.7.1.2	Assembly-level Languages	54
3.7.2	High-level Languages	55
3.7.2.1	Compiler vs. Interpreter	57
3.7.2.2	Advantages	57

3.8	Review Questions	57
3.8.1	Objective Type Questions	57
3.8.2	Practice Problems.....	57
3.8.3	Subjective Questions.....	58
	Reference	59
4.	Introduction to C Programming.....	61
4.1	Introduction	61
4.2	History of C.....	62
4.3	Executing a C Program.....	64
4.3.1	Editing	64
4.3.2	Compiling	64
4.3.3	Linking	65
4.3.4	Executing.....	65
4.4	Structure of a C Program	65
4.4.1	Documentation.....	65
4.4.2	Header Files	65
4.4.3	Global Variables	66
4.4.4	main() Function	66
4.4.5	Subprograms	67
4.4.6	Your First C Program.....	67
4.5	Compilers and Editors for Executing C Programs.....	69
4.5.1	Editors.....	69
4.5.2	Compilers	69
4.5.3	Executing Your First C Program	71
4.5.3.1	Mac	71
4.5.3.2	Windows.....	72
4.5.3.3	Linux	72
4.6	Review Questions	73
4.6.1	Objective Questions.....	73
4.6.2	Short Answer Questions	73
4.6.3	Programming Questions.....	73
4.6.4	Long Questions	75
	References	75
5.	Constants, Variables, and Data Types.....	77
5.1	Introduction	77
5.2	C Character Sets	77
5.3	Keywords	78
5.4	Variables and Identifiers	79
5.5	Data Types.....	80
5.5.1	Primary Data Types	81
5.5.2	Integer Data Types.....	81
5.5.3	Floating Point Types.....	82
5.5.4	Character Data Types	83
5.5.5	Void Types.....	83
5.6	Declaration of Variables	84
5.7	Constants.....	86
5.7.1	Integer Constants	86

5.7.2	Real Constants	87
5.7.3	Fractional Form	87
5.7.4	Exponential Form.....	87
5.7.5	Character Constants	87
5.7.6	String Constants	87
5.8	Learn to Code Examples	88
5.9	Escape Sequences	91
5.10	Review Questions	92
5.10.1	Objective Questions.....	92
5.10.2	Programming Questions.....	92
5.10.3	Subjective Questions.....	94
6.	Operators and Expressions	95
6.1	Introduction	95
6.2	Arithmetic Operators.....	96
6.3	Relational Operators.....	97
6.4	Assignment Operators	98
6.5	Logical Operators.....	99
6.6	Increment and Decrement Operators.....	100
6.7	Conditional Operators.....	103
6.7.1	Nested Conditional Operators.....	105
6.8	Bitwise Operators.....	105
6.8.1	Bitwise AND, OR, XOR.....	106
6.8.2	One's Complement (~) Operator.....	107
6.8.3	Two's Complement Representation	107
6.8.4	Left Shift Operator (<<) and Right Shift Operator (>>)	109
6.9	Special Operators	112
6.9.1	The Comma Operator	112
6.9.2	The sizeof Operator	113
6.10	Expressions	113
6.10.1	Evaluation of Expressions	114
6.10.2	Rules for Evaluation of Expressions.....	114
6.11	Type Conversion	115
6.11.1	Implicit Type Casting	115
6.11.2	Explicit Type Conversion.....	116
6.12	Operator Precedence and Associativity.....	116
6.13	Review Questions	118
6.13.1	Objective Type Questions	118
6.13.2	Programming Questions.....	119
6.13.3	Subjective Type Questions.....	120
7.	Basic Input/Output.....	123
7.1	Introduction	123
7.2	Unformatted Functions.....	124
7.2.1	getchar () and putchar ()	124
7.2.2	gets () and puts ()	125
7.2.3	getch () and getche ()	126
7.2.4	putch ().....	127

7.3	Formatted Functions.....	128
7.3.1	printf() Function.....	128
7.3.2	Formatting with printf()	129
7.3.3	scanf() Function	134
7.3.4	Formatting with scanf	134
7.4	Review Questions	137
7.4.1	Short Answer Questions	137
7.4.2	Programming Questions.....	138
7.4.3	Subjective Questions.....	139
8.	Control Structures.....	141
8.1	Introduction	141
8.2	Selection with if Statements.....	143
8.2.1	Some Points to Remember.....	145
8.3	if-else Statement	146
8.3.1	Write a Program to Check Whether a Number Entered by the User is Zero or Nonzero	148
8.3.2	Write a Program to Calculate the Travel Fare of a Person	149
8.4	Nested if-else Statements	150
8.4.1	Write a Program to Find the Biggest Among Three Numbers	151
8.5	if-else-if Ladders.....	151
8.5.1	Write a Program to Perform as a Four-Function Calculator.....	152
8.6	Compound Statements.....	154
8.7	Multiway Selection with Switch Statements.....	155
8.7.1	Some Points to Remember.....	157
8.8	goto Statement.....	159
8.8.1	Notes on goto.....	159
8.9	Introduction to Loops.....	160
8.10	while Loops.....	161
8.11	do-while Loops.....	164
8.11.1	Difference Between while and do-while Loops.....	166
8.12	for Loops.....	167
8.12.1	Some Solved Problems (Printing Patterns)	171
8.13	Unconditional Branching: Break and Continue.....	173
8.13.1	break Statements	173
8.13.2	continue Statements.....	174
8.14	Review Questions	176
8.14.1	Short Questions	176
8.14.2	Long Questions	176
9.	Functions	179
9.1	Introduction	179
9.2	The Need for Functions.....	181
9.3	Types of Function	182
9.4	User-defined Functions	182
9.5	Components and Working of a Function	186
9.5.1	Calling Function.....	186
9.5.2	Called Function	186
9.5.3	Function Prototype	187

9.5.4	Function Definition.....	187
9.5.5	Function Call	188
9.5.6	Actual Arguments.....	188
9.5.7	Formal Arguments.....	188
9.5.8	Return Type	188
9.6	Categories of a Function	191
9.6.1	A Function Without Arguments and Without Return Types.....	191
9.6.2	A Function Without Arguments and With Return Types	191
9.6.3	A Function With Arguments and Without Return Types	193
9.6.4	A Function With Arguments and With Return Types	193
9.7	Recursion.....	195
9.7.1	Example: Find the Value of x^y	198
9.7.2	Programming Examples	201
9.8	Storage Classes	204
9.8.1	Automatic Storage Class.....	205
9.8.2	Register Storage Class	206
9.8.3	Static Storage Class	206
9.8.4	External Storage Class.....	207
9.9	Review Question	209
9.9.1	Objective Questions.....	209
9.9.2	Subjective Questions.....	210
9.9.3	Programming Questions.....	210
10.	Arrays and Strings	213
10.1	Introduction	213
10.2	Need for Arrays.....	214
10.3	Types of Arrays.....	214
10.4	1D Arrays	215
10.4.1	Declaration of 1D Arrays	215
10.4.2	Initialization of Arrays	216
10.4.3	Accessing Array Elements.....	217
10.4.4	Characteristics of an Array	218
10.4.5	Entering Data in an Array	219
10.4.6	Displaying the Content of an Array	220
10.4.7	Programming Examples	221
10.4.7.1	Write a Program to Create an Array of N Elements and Write the Code to Find the Biggest Number and the Smallest Number Present in the Array	221
10.4.7.2	Write a Program to Search for an Element Present in the Array, the Number of Times the Element is Present, and Print the Element's Positions	222
10.4.7.3	Write a Program to Print the Binary Equivalent of a Decimal Number Using an Array	223
10.4.8	Points to Note	224
10.5	2D Arrays	225
10.5.1	Introducing Matrices	225
10.5.2	Declaration of a 2D Array	226
10.5.3	Representation of a 2D Array in Memory	226
10.5.3.1	Row Major Order	227

10.5.3.2	Column Major Order	227
10.5.4	Initialization of 2D Array	228
10.5.5	Accessing the Elements of a 2D Array	229
10.5.6	Entering Data in a 2D Array	231
10.5.7	Exploration of a 2D Matrix	234
10.5.8	Programming Examples	235
10.5.8.1	Write a Program to Add All the Elements Present in the Main Diagonal of a 2D Matrix	235
10.5.8.2	Write a Program to Add the Elements of Each Column and Print it in the Following Format	236
10.5.8.3	Write a Program to Add Two Matrices	238
10.5.8.4	Write a Program to Multiply Two Matrices	240
10.6	Multidimensional Arrays	242
10.6.1	Declaration and Representation of 3D Arrays	242
10.6.1.1	Write a Program to Declare a 3D Array, Input Some Numbers, and Display the 3D Array	244
10.7	Character Arrays: Strings	245
10.7.1	Declaration of a String	245
10.7.2	Initialization of a String	245
10.7.3	Reading a String	246
10.7.3.1	Disadvantages of the <code>scanf ()</code> Function	246
10.7.3.2	Reading Strings with the <code>gets ()</code> Function	247
10.7.4	Displaying the String	247
10.7.5	Programming Examples	249
10.7.5.1	Find the Length of a String	249
10.7.5.2	Count the Number of Words Present in a String	249
10.7.5.3	Reverse the String	250
10.7.5.4	Check Whether the String is a Palindrome or Not	251
10.8	String Functions	252
10.8.1	<code>strcpy (Destination, Source)</code>	253
10.8.2	<code>strcat (Destination, Source)</code>	253
10.8.3	<code>strcmp (First, Second)</code>	253
10.8.4	Programming Examples Using String Functions	254
10.9	Review Questions	255
10.9.1	Objective Questions	255
10.9.2	Subjective Questions	255
10.9.3	Programming Exercises	256
11.	Pointers	259
11.1	Introduction	259
11.2	Basic Knowledge	260
11.3	Pointer Variables	261
11.3.1	Declaration of Pointer Variables	261
11.3.2	Working with Pointers	261
11.3.3	Workout	263
11.4	Pointer to Pointer (Double Pointer)	265
11.5	Void Pointers	266
11.6	Null Pointers	268
11.6.1	What is the Meaning of NULL?	268

11.7	Constant Pointers.....	268
11.7.1	Pointers to Constants.....	272
11.8	Pointer Arithmetic.....	272
11.9	Pointers and Functions.....	276
11.9.1	Pass by Value.....	276
11.9.2	Pass by Reference or Address.....	277
11.9.2.1	Problem: Write a Program to Swap Two Numbers Using Functions.....	280
11.10	Pointers and Arrays.....	282
11.11	Passing Arrays to Functions.....	285
11.11.1	Write a Program to Pass an Array to a Function and Find the Largest and Smallest Numbers Present in that Array.....	290
11.12	Pointers and 2D Arrays.....	291
11.13	Pointers and Strings.....	293
11.13.1	Passing a String to a Function.....	294
11.13.2	Write a Program to Reverse a String Using a Function.....	294
11.14	An Array of Pointers.....	295
11.15	Pointers to Functions.....	297
11.16	Review Questions.....	300
11.16.1	Objective Questions.....	300
11.16.2	Subjective Questions.....	302
11.16.3	Programming Exercises.....	302
12.	Structures and Unions.....	305
12.1	Introduction.....	305
12.2	Declaring a Structure.....	307
12.2.1	Tagged Structure Declaration.....	307
12.2.2	Structure Declaration Using typedef.....	308
12.2.3	Declaring Structure Variables.....	308
12.2.3.1	Declaring Structure Variables Using the Structure Name.....	308
12.2.3.2	Declaring Structure Variables after the Closing Braces.....	309
12.3	Initializing a Structure.....	311
12.4	Accessing Structure Members.....	312
12.4.1	Accessing Members Using the dot (.) Operator.....	313
12.5	Learn to Code Examples.....	315
12.6	Arrays of Structures.....	316
12.7	Structures within Structures (Nested Structures).....	318
12.7.1	Declaration of Nested Structures.....	318
12.7.1.1	Declare the Structure with One Declaration.....	319
12.7.1.2	Declare the Structure Separately.....	319
12.7.2	Accessing the Members of a Nested Structure.....	319
12.7.3	Nested Structure Initialization.....	320
12.8	User-defined Data Type: <i>typedef</i>	321
12.8.1	Uses of typedef.....	322
12.9	Pointers and Structures.....	323
12.9.1	Accessing Structure Members Using a Pointer.....	323
12.9.2	A Pointer as a Member of a Structure.....	324
12.9.3	Self-referential Structures.....	324
12.10	Structures and Functions.....	328

12.10.1	Passing Individual Members of a Structure.....	328
12.10.2	Passing the Whole Structure Using the Pass by Value Concept	330
12.10.3	Passing the Whole Structure Using the Pass by Address Concept.....	332
12.11	Unions.....	333
12.11.1	Declaration of a Union	333
12.11.2	Member Accessing.....	336
12.12	Structures vs. Unions.....	336
12.12.1	Size of Unions and Structures	337
12.12.2	Sharing Memory and Member Accessing	337
12.13	Bitfields.....	338
12.13.1	Declaration of a Bitfield	340
12.13.2	Uses of Bitfields	342
12.14	Enumeration	343
12.15	Review Questions	346
12.15.1	Objective Questions.....	346
12.15.2	Subjective Questions.....	346
12.15.3	Programming Exercises	346
13.	Dynamic Memory Allocation	349
13.1	Introduction	349
13.1.1	Process of Memory Allocation	350
13.1.1.1	Text Segments	351
13.1.1.2	Data Segments	351
13.1.1.3	Stack Segments	351
13.1.1.4	Heap Segments	351
13.2	Types of Memory Allocation	351
13.2.1	Static Memory Allocation	351
13.2.2	Dynamic Memory Allocation.....	351
13.3	Dynamic Memory Allocation Process.....	352
13.3.1	The malloc() Function.....	353
13.3.2	The calloc() Function.....	356
13.3.3	The realloc() Function	356
13.3.4	The free() Function.....	360
13.4	Review Questions	361
14.	File Handling.....	365
14.1	Introduction	365
14.1.1	Difference between Console I/O and File I/O.....	366
14.2	Basics of File I/O.....	367
14.2.1	What is a File?.....	367
14.2.2	File Handling Process Flow	367
14.3	Opening a File.....	368
14.4	Closing a File	370
14.5	File Functions with Examples	371
14.5.1	The fprintf() and fscanf() Functions.....	371
14.5.1.1	Writing and Reading an Integer Using fprintf() and fscanf()	372
14.5.2	The putw() and getw() Functions.....	374

14.5.2.1	Writing and Reading More than One Integer Using the <code>putw()</code> and <code>getw()</code> Functions.....	374
14.5.2.2	Reading Numbers from a File and Checking Them for Even or Odd.....	375
14.5.3	The <code>fputc()</code> and <code>fgetc()</code> Functions.....	377
14.5.3.1	Writing and Reading a Character Using <code>fputc()</code> and <code>fgetc()</code>	378
14.5.3.2	Writing and Reading Multiple Characters Using <code>fputc()</code> and <code>fgetc()</code>	379
14.5.3.3	Count Number of Characters, Lines, Tabs, and Blank Spaces Present in a File.....	380
14.5.4	The <code>fputs()</code> and <code>fgets()</code> Functions.....	381
14.5.4.1	Writing and Reading a String Using <code>fputs()</code> and <code>fgets()</code>	382
14.6	Other Programming Examples	383
14.7	Review Questions	386
15.	The Preprocessor.....	389
15.1	Introduction	389
15.2	Preprocessor Directives	389
15.3	Macro-substitutions	390
15.3.1	Writing Macros with Arguments.....	392
15.3.2	Removing a Macro.....	392
15.4	The <code>#include</code> Preprocessor.....	392
15.5	Conditional Preprocessors	395
15.5.1	The <code>#ifdef</code> and <code>#endif</code> Preprocessor Directives	395
15.5.2	The <code>#ifndef</code> and <code>#endif</code> Directives	396
15.5.3	The <code>#if</code> and <code>#endif</code> Directives	396
15.6	Other Preprocessor Directives.....	396
15.6.1	<code>#line</code> Directives.....	397
15.6.2	<code>#error</code> Directives.....	398
15.6.3	<code>#pragma</code> Directives.....	400
15.7	Review Questions	400
16.	Command Line Arguments.....	403
16.1	Introduction	403
16.1.1	The Code::Block IDE.....	404
16.2	Executing a Program Using a Command Prompt.....	405
16.2.1	Installing the minGW Compiler	405
16.2.2	Compiling and Executing a Program	407
16.3	Fundamentals of the Command Line Argument	410
16.4	Using Command Line Arguments	411
16.5	Review Questions	413
	Appendix A: ASCII Character Table	415
	Appendix B: Integer Representation.....	417
	Index	423