



Table of Contents

Chapter 1: Basics of C	1
Introduction to Programming Languages.....	2
First Generation Programming Languages	2
Second Generation Programming Languages	3
Third Generation Programming Languages	3
Fourth Generation Programming Languages	3
Fifth Generation Programming Languages.....	3
Brief History of C	4
C as a Middle Level Language.....	4
C as a Structured Language	4
Writing your First C Program.....	5
Character Set in C.....	6
C Tokens	6
Keywords.....	6
Identifiers.....	7
Data Types.....	7
Additional Data Types in C	9
Constants	9
Floating Point Constant	10
Character Constants	11
Variables in C.....	13
Arithmetic Operators in C.....	14
Expressions in C.....	18
Statements in C	19
Decision Making.....	19
The IF Statement	19
Different Types of the IF Expression	21

Table of Contents

Multiple IF Statements	21
The if-else Statement	22
Nesting If-Else Statements	24
Logical Operators	26
The else-if Statement	29
The Conditional Operators	30
Switch Case Paradigm in C	31
Nested Switch	36
Block Statements	38
Looping in C	39
The while Loop	39
Nesting of the while Loop	41
The for Loop	41
The Do-While Loop	45
Jump Statements	46
The Return Statement	46
The GOTO Statement	47
The BREAK Statement	48
The Continue Statement	49
Summary	50
Quick Revise	50
Multiple Choice Question	50
Subjective Questions	52
Chapter 2: Functions in C	55
A Brief Overview of Functions	56
Defining a Function	57
Calling Convention of a Function	59
Call by Value	60
Call by Reference	61
Passing Arguments to the main() Method	62
Function Prototypes	63
Old Style Function Declaration	66
Standard Library Function Prototypes	67
Variable Length Parameter List	67
The Implicit Int Rule in C	68
Recursion in C	69
Stack in Recursion	71

Storage Class Specification in C	73
Auto Storage Class	73
Register Storage Class	75
Extern Storage Class.....	76
Static Storage Class.....	80
Static Local Variables	80
Static Global Variables	81
Static Functions	82
Summary	82
Quick Revise	82
Multiple Choice Questions	82
Subjective Questions	84
Chapter 3: String Manipulation in C	85
Strings.....	86
Standard String Library Functions	88
Summary	94
Quick Revise	94
Multiple Choice Questions	94
Subjective Questions	94
Chapter 4: Pointers and Function Pointers in C.....	95
Pointers.....	96
Multiple Indirection in Pointers.....	97
Pointer Handling	97
Single Dimensional Arrays using Pointers	98
Two-Dimensional Arrays using Pointers.....	100
Exploring Pointer Arithmetic in Two-Dimensional Array.....	101
Passing Two-Dimensional Array to a Function.....	103
Returning a Two-Dimensional Array from a Function.....	105
Three-Dimensional Arrays using Pointers.....	106
Passing Three-Dimensional Array to a Function.....	108
Returning Three-Dimensional Array from a Function	110
Array of Pointers	114
Function Pointers	116
Passing a Function Pointer as an Argument	118
Returning a Function Pointer from a Function.....	119
Exploring Array of Function Pointers.....	120
Callbacks	120

Table of Contents

Callback to a C++ Member Function using a Function Pointer.....	121
Callback to a C++ Member Function using a Global Variable.....	122
Functors.....	123
Complex Examples of Pointers and Function Pointers.....	125
Summary.....	127
Quick Revise.....	127
Subjective Questions.....	128
Chapter 5: Advanced Concepts on C.....	129
Structures.....	130
Declaring a Structure.....	131
Accessing Structure Elements.....	132
Nesting of Structure.....	134
Exploring Array of Structures.....	136
Assigning a Structure Variable to Another.....	139
Exploring Structures and Pointers.....	140
Passing Structures to Functions.....	143
Returning a Structure from Function.....	145
Exploring Self-Referential Structure.....	145
Unions.....	148
File Management in C.....	150
Opening a File.....	151
Closing a File.....	152
Binary Files.....	160
File Management Functions.....	166
fclose().....	166
feof().....	167
ferror().....	167
fgetpos().....	168
freopen().....	168
ftell().....	168
Bitwise Operators.....	169
One's Complement Operator.....	169
Bitwise Logical Operators.....	169
Bitwise AND Operator.....	170
Bitwise OR Operator.....	171
Bitwise XOR Operation.....	172
Right Shift Operator.....	173

Left Shift Operator	175
Type Qualifiers	176
Const	176
volatile.....	177
restrict	178
Memory Segmentation in C	178
Summary	179
Quick Revise	179
Multiple Choice Questions	179
Subjective Questions	180
Chapter 6: Interrupts in C	181
Interrupt Handling in C	182
Calling Subroutines from Interrupt Handlers	183
Re-Entrant Interrupt Handlers	184
Some Useful Signals.....	185
Registering a Common Handler.....	186
Blocking Signals.....	187
Interrupt Service Routine	188
Case Study on ARM Architecture	188
Handling Processor Exceptions	189
Summary	191
Quick Revise	191
Multiple Choice Questions	191
Subjective Questions	192
Chapter 7: Preprocessor in C	193
Stages of Compilation.....	194
Preprocessor Directives	194
Macro Definition.....	195
File Inclusion	199
Summary	203
Quick Revise	203
Multiple Choice Questions	203
Subjective Questions	204

Chapter 8: Standard Library Functions in C.....	205
Mathematical Functions	206
acos()	207
acosh()	207
cos()	207
cosh()	208
asin()	208
asinh()	208
sin()	209
sinh()	209
atan()	209
atanh()	210
tan()	210
tanh()	211
cbrt()	211
sqrt()	212
pow()	212
exp()	212
fabs()	213
ceil()	213
floor()	214
remainder()	214
Time Functions	214
asctime()	215
ctime()	215
difftime()	216
gmtime()	216
localtime()	217
mktime()	217
time()	218
Dynamic Allocation Functions	218
calloc()	218
free()	219
malloc()	219
realloc()	220
Utility Functions	221
abort()	221
abs()	222

atoi()	222
atof()	223
atol()	223
div()	224
exit()	224
bsearch().....	225
qsort()	226
rand().....	227
srand()	227
strtod().....	228
String Functions.....	229
isalnum()	229
isalpha()	230
iscntrl()	230
isblank()	231
isdigit()	231
ispunct()	232
Summary	233
Quick Revise	233
Multiple Choice Questions	233
Subjective Questions	234
Chapter 9: Kernel Programming in C.....	235
Overview of the Linux Operating System.....	236
Monolithic or Microkernels - What Linux Chooses?.....	237
Linux Kernel Modules	238
Hello World - The First Kernel Module	238
Compilation of Kernel Modules	239
The module_init() and module_exit() Macros	240
The __init and __exit Macros	241
Licensing and Documentation for Kernel Modules	241
Compilation of a Module Spanning Multiple Files	242
Kernel Modules vs. C User-Space Programs.....	243
Library Functions for Modules	244
Character Device Files	244
Exploring the File Structure	244
Registering a Device.....	245
Unregistering a Device.....	245

Table of Contents

Device Drivers	245
System Calls	246
Task Scheduling	246
Interrupt Handlers	247
Summary	247
Quick Revise	247
Multiple Choice Questions	247
Subjective Questions	248
Chapter 10: Parallel Programming in C	249
POSIX Threads.....	250
Thread Programming using the POSIX Library	250
Thread Attributes	255
Thread Cancellation and Modes.....	257
Cleanup Handlers	259
Synchronization Problem	261
Mutex.....	262
Semaphore.....	266
Conditional Variables	271
Deadlocks	273
Summary	273
Quick Revise	273
Multiple Choice Questions	273
Subjective Questions	274
Chapter 11: Cross Compilation in C	275
Compiling C Code in Linux Environment.....	276
Cross Compilation.....	277
Summary	278
Quick Revise	278
Multiple Choice Questions	278
Subjective Questions	278
Chapter 12: An Introduction to C++	279
Structure of a C++ Program.....	280
Data Types	281
Declaration of Variables	286
Expressions, Operators, and Operator Precedence.....	286
Expressions.....	287

Operators	288
Operator Precedence	290
Evaluation of Expressions in C++	292
Type Conversions.....	293
Implicit Type Conversions	294
Explicit Type Conversions.....	295
Static Casting.....	295
Dynamic Casting	295
Reinterpret Casting	296
Const Casting	296
Arrays, Strings, Structures, and References	296
Arrays.....	296
Strings	298
Structures.....	300
References.....	302
Flow Control Statements.....	303
Decision Statements	303
Loops.....	306
Jump Statements	309
Functions	311
Parameter Passing in Functions.....	313
Default Arguments in Function.....	315
Inline Functions	316
Recursive Functions	317
Dynamic Memory Allocation and Deallocation Operators	318
Preprocessor Directives	321
#include	322
#define	323
Predefined Macro Names.....	323
Summary	324
Quick Revise	324
Multiple Choice Questions.....	324
Subjective Questions	326
Chapter 13: OOP Principles, Classes and Data Abstraction.....	327
Different Paradigms for Problem Solving.....	328
Imperative Programming Paradigm.....	328
Logical Programming Paradigm	329

Table of Contents

Functional Programming Paradigm.....	329
Differences between OOP and Procedural Programming	330
The Concept of Abstraction	331
Overview of OOP Principles.....	332
Encapsulation	332
Inheritance.....	333
Polymorphism	334
Genesis of C++	335
OOP, Objects, and Classes.....	335
Constructors.....	339
Copy Constructors	339
Public, Private, and Protected Constructors.....	341
Destructors	342
Class Members.....	342
Definition of Member Functions and Access controls	343
Messages to Objects	343
Objects	343
Encapsulation - Access Control to the Members and External Users.....	344
Relationships between Classes	345
Association	347
Dependency.....	351
Aggregation.....	351
Composition.....	353
Generalization.....	357
Include	357
Extend	357
Data Abstraction and Information Hiding.....	358
Summary	359
Quick Revise	360
Multiple Choice Questions	360
Subjective Questions	361
Chapter 14: Polymorphism and Inheritance.....	365
Polymorphism and Inheritance.....	365
Polymorphism	366
Function Overloading	366
Ambiguity in Function Overloading.....	368
Steps for Function Overloading.....	370

Overloading Constructor Functions.....	371
Operator Overloading.....	372
The operator keyword	373
Operator Arguments	373
Operator Return Values	373
Member Operator Functions	373
Overloading Unary Operators.....	374
Overloading Binary Operators	378
Operator Overloading Restrictions	383
Overloading Some Special Operators.....	383
Benefits of the Friend Function in Operator Overloading	387
Inheritance.....	390
Defining the Base and Derived Classes	390
Protected Access Specifier.....	393
Disadvantages of Protected Access Specifier.....	394
Access Specifier Combinations in C++	395
When are Constructor and Destructor Functions Called?	396
Passing Parameters to Base Class Constructors	397
Overriding Member Functions	399
Multi-Level Inheritance	402
Multiple Inheritance.....	404
Ambiguities in Multiple Inheritance.....	405
Virtual Base Classes	407
Virtual Functions.....	408
Virtual Functions and Polymorphism - Early Binding and Late Binding	409
Calling Mechanism of Virtual Functions.....	409
Base and Derived Virtual Functions	412
Rules for Virtual Functions	414
Pure Virtual Functions.....	415
Abstract Classes.....	416
Virtual Destructors.....	416
Summary	418
Quick Revise	418
Multiple Choice Questions	418
Subjective Questions	420

Table of Contents

Chapter 15: C++ I/O and Exception Handling	421
I/O Streams.....	422
The Stream Class Hierarchy.....	423
Standard Output Streams.....	423
Stream Insertions and Extraction.....	424
Integer and Floating-Point Extraction.....	424
Character Extraction.....	425
Implicit File Opening and Closing.....	425
Extraction and Insertion of Fundamental Data Types.....	425
File I/O Using Objects.....	426
Binary I/O.....	427
The read() and write() Functions.....	428
Explicit File Opening and Closing.....	430
Disk I/O Using Member Functions.....	431
The Stream Status Bits.....	433
Member Functions for Accessing Stream Status Bits.....	433
Random Access.....	434
Example of Random Access.....	435
Formatted I/O - ios Format Functions.....	435
The setf() Function.....	436
The unsetf() Function.....	437
The width() Function.....	437
The fill() Function.....	438
The precision() Function.....	438
Manipulators.....	439
Exception Handling.....	441
Error Handling in C and C++.....	441
Exception Handling - Mechanics.....	445
Exceptions - Stack.....	446
Stack Unwinding.....	448
Uncaught Exceptions.....	449
Catch - All Handlers.....	450
Restricting Exception.....	451
Catching any Exception.....	452
Re-throwing an Exception.....	452
Handling Derived Class Exceptions.....	453
Standard Library Exception Hierarchy.....	454
bad_alloc ().....	455

bad_cast ().....	456
bad_exception ().....	456
bad_typeid ()	457
logic_error ().....	457
domain_error ().....	457
invalid_argument ().....	458
length_error ()	458
runtime_error ()	459
range_error()	459
overflow_error().....	459
underflow_error ().....	460
ios_base :: failure.....	460
Summary	460
Quick Revise	460
Multiple Choice Questions.....	460
Subjective Questions	462
Chapter 16: An Introduction to C# and .NET Architecture	463
An Introduction to C# and .NET Architecture.....	463
Introduction to .NET Architecture	464
CLR.....	465
Class Library	468
Assemblies in C#	471
Assembly Manifest.....	472
Type Metadata	474
MSIL/CIL Information.....	475
Resource File	475
Global Assembly Cache.....	476
Memory Management in C# Programming	476
Introduction to C# Programming Language	478
C# Evolution.....	480
Summary	481
Quick Revise	481
Multiple Choice Questions.....	481
Subjective Questions	482

Table of Contents

Chapter 17: Basic of C#	483
C# Hello World Program	484
Data Type	487
Built-In Data Types.....	487
User-Defined Data Types	489
Anonymous Type	489
Declaration of Variables	489
Expression, Operators, and Operator Precedence	490
Type Casting	492
Arrays	494
Single Dimensional Array	494
Multidimensional Array	495
Jagged Array	496
Strings	498
Declaration of a String	498
String Comparison	498
String Concatenation.....	499
String Copy.....	501
CopyTo Operation.....	501
Remove Operation.....	502
Replace Operation	502
Split Operation	503
Substring Operation	504
Structure	505
Collection	508
ArrayList.....	508
Stack	509
Queue	510
SortedList.....	511
Hash Table.....	512
Reference Type	513
Value Type	515
Flow Control Statements	516
The if-else Statement	516
The switch Statement	517
The while Loop	518
The do-while Loop	519
The for Loop.....	520

The foreach Loop	522
The continue-break Statement	523
The goto Statement	524
Scope of Variables	525
Class-Level Scope	525
Method-Level Scope	526
Nested Scope	526
Parameter Passing	527
Passing values	527
Passing a Reference using the ref Keyword	528
Passing a Reference using the out Keyword	529
Passing Parameters Key using the params Keyword	530
Named and Optional Arguments	530
Named Arguments	531
Optional Arguments	531
Namespace	532
Summary	536
Quick Revise	537
Multiple Choice Questions	537
Subjective Questions	539
Chapter 18: Implementation of OOP in C#.....	541
Classes in C#	542
Implementing Classes in C#	543
Defining Properties	547
Defining Constructors	548
Defining Destructors	552
Defining Partial Classes and Methods	553
Defining Shared Members	554
Defining Indexers	554
Defining Delegates	558
Defining Events.....	561
Implementing Nested Classes.....	562
Concept of Inheritance, Generalization, and Specialization	563
Polymorphism	564
Function Overloading	564
Function Overriding.....	566

Table of Contents

Operator Overloading	569
Types of Object in C#.....	572
Access Modifiers	573
Public.....	573
Private	574
Protected.....	575
Internal.....	575
Protected Internal	576
Interfaces	577
Implicit Interface.....	577
Explicit Interface	578
Enumerators.....	579
Generics	583
Summary	584
Quick Revise	585
Multiple Choice Questions.....	585
Subjective Questions	586
Chapter 19: Advanced Concept of C#	587
LINQ	588
Anonymous Method.....	588
Lambda Expression.....	589
LINQ Queries.....	590
Comprehensive Queries	590
Lambda Queries.....	592
Deferred and Immediate Executions.....	593
Usage of LINQ.....	594
LINQ to Object.....	595
LINQ to XML	596
LINQ to ADO.NET.....	598
Expression Tree in LINQ.....	611
Executing an Expression Tree for a Lambda Expression.....	611
Building an Expression Tree for a Lambda Expression.....	612
Standard LINQ Operators.....	614
Filtering Operators	615
ProjectingOperators.....	616
Joining Operators.....	619
Ordering Operators	625

Grouping Operators	626
Set Operators	629
Conversion Operators	630
Partitioning Operators	633
Equality Operator	634
Element Operators.....	635
Aggregation Operators	636
Quantifiers	637
Error Handling	638
Summary	640
Quick Revise	640
Multiple Choice Questions	640
Subjective Questions	642
Chapter 20: XML in C#	643
XML in C#	643
Introduction to XML	644
Elements.....	645
Tags	645
Attributes	645
Document Type Definition.....	646
Creating XML Files using Visual Studio 2008	647
XML Namespaces.....	648
XML Classes.....	649
XmlTextReader	649
XmlTextWriter	652
XmlDocument.....	654
Application of XML Classes.....	657
The OnLoad Event	657
The Create XML using XmlTextWriter Button	659
The Create XML using XML Document Button	666
XSD	669
XSLT.....	672
Converting an XmlDocument into HTML.....	672
XPath.....	674
ADO.NET and XML.....	675

Table of Contents

Summary	676
Quick Revise	676
Multiple Choice Questions	676
Subjective Questions	678
Chapter 21: File System and I/O Operations Using C#.....	679
Exploring the File System Architecture.....	680
Understanding Risks Concerning File Systems in a Web Application.....	681
Describing File System Classes.....	681
The FileStream Class	682
The StreamReader Class	683
The StreamWriter Class	684
Exploring the Classes for File and Directory Operations	685
The Directory Class	685
The DirectoryInfo Class	687
The File Class	688
The FileInfo Class	691
Creating a File System Application using C#	693
Describing the Page Load Event	693
Selecting a Tree View Node	696
Clicking the Modify selected file Button	697
Clicking the Append Text Button.....	701
Clicking the Upload File Button	703
Introducing the File Compression Technique	706
Creating an Application on File Compression.....	707
Describing the Isolated Storage	713
Writing an Email Script	715
Writing an Email.....	715
Writing an Email with Attachment	717
Writing an Email with the HTML Body	719
Writing a System Generated Email	719
Summary	720
Quick Revise	720
Multiple Choice Questions	720
Subjective Questions	722

Chapter 22: An Introduction to Network and Socket Programming.....	723
Socket Address Structure	724
Generic Socket Address Structures	725
IPv6 Socket Address Structure	726
Byte Ordering Functions	726
Byte Manipulation Functions.....	727
Address Conversion Functions	728
Elementary Socket Functions.....	728
socket Function	729
connect Function.....	730
bind Function.....	731
listen Function.....	732
accept Function	733
close Function.....	733
Client-Server Implementation in C	734
I/O Multiplexing.....	738
Blocking I/O Model	739
Non-Blocking I/O Model	739
I/O Multiplexing Model	740
select Function	740
Advanced I/O Handling.....	743
recv and recvfrom Functions.....	744
send and sendto Functions.....	744
readv and writev Functions	745
recvmsg and sendmsg Functions.....	745
Summary	746
Quick Revise	746
Chapter 23: Object-Oriented Design, Analysis, and Programming.....	747
Object-Oriented Notion – The Shift in Paradigm	748
Various Definitions of Object-Oriented Programming	749
Object-Oriented Design	750
Unified Modeling Language.....	750
Use of UML and Its Support for Database Design Specifications	751
Object Modeling Notations and Basic Concepts.....	751
Object-Oriented Analysis	752
Classifier	753
Object Modeling Notations and Basic Concepts	754
Class	754

Table of Contents

Attribute.....	754
Operation.....	755
Interface	755
Signal.....	755
Component.....	755
Node	756
Package	756
Subsystem.....	756
Object	756
Collaboration.....	757
Relationships	757
Object Allocation	759
Static versus Instance Variables.....	760
Structural Diagrams	760
Class Diagrams	760
Object Diagrams	760
Component Diagram.....	761
Deployment Diagram.....	761
Behavioral Diagrams.....	762
Use-Case Diagram	762
Interaction Diagram	762
Activity Diagram	764
Statechart Diagram.....	765
Case Study - Hotel Management Systems.....	765
Identify the Users and Their Goals.....	766
Goals of Each Actor	766
Use-Case Template for Case Study	767
Sequence Diagram.....	768
Summary	774
Quick Revise	775
Multiple Choice Question.....	775
Subjective Questions	776
Chapter 24: Data Structures and Algorithms	777
Data Structures	778
Abstract Data Type	779
Infix, Prefix, and Postfix Notations	780
Complexity of an Algorithm.....	781

Big “Oh” Notation.....	781
Big “omega” Notation.....	782
Big Theta Notation	782
Small “Oh” Notation.....	782
Small “omega” Notation.....	782
Algorithm Case Analysis.....	783
Linked List	783
Circular Linked List	788
Doubly Linked List.....	793
Stack.....	798
Queues	801
Circular Queues	808
Dequeues	816
Priority Queues	820
Tree	821
Binary Tree	822
Binary Search Tree.....	823
Threaded Binary Tree.....	826
AVL Tree.....	827
Expression Trees	828
Sorting Techniques.....	828
Bubble Sort	829
Insertion Sort.....	832
Quick Sort.....	836
Merge Sort	842
Count Sort.....	846
Radix Sort	849
Heap Sort.....	852
Graph Sort	861
Binary Search	869
Algorithm Analysis	872
Comparison on Sequential Search and Binary Search	872
Hashing	873
Separate Chaining	874
Open Addressing.....	875
Separate Chaining vs. Open Addressing.....	877
Graphs	878
Spanning Tree Algorithms	879
BFS.....	879
DFS	881

Table of Contents

Minimum Spanning Tree	883
Prim's Algorithm	883
Kruskal's Algorithm.....	884
Dijkstra's Algorithm	886
All Pairs Shortest Path Algorithm	888
Summary	890
Quick Revise	891
Multiple Choice Questions.....	891
Subjective Questions	892
Appendix A: Some Important Concepts of C++	895
Appendix B: Some Important Programs in C++	905
Bibliography	923
Index.....	925
Online Resource Available with the Book	941