

PEARSON

Computer Fundamentals

Anita Goel



Copyright © 2010 Dorling Kindersley (India) Pvt. Ltd

This book is sold subject to the condition that it shall not, by way of trade or otherwise, be lent, resold, hired out, or otherwise circulated without the publisher's prior written consent in any form of binding or cover other than that in which it is published and without a similar condition including this condition being imposed on the subsequent purchaser and without limiting the rights under copyright reserved above, no part of this publication may be reproduced, stored in or introduced into a retrieval system, or transmitted in any form or by any means (electronic, mechanical, photocopying, recording or otherwise), without the prior written permission of both the copyright owner and the above-mentioned publisher of this book.

ISBN 978-81-317-3309-7

10 9 8 7 6 5 4 3 2 1

Published by Dorling Kindersley (India) Pvt. Ltd., licensees of Pearson Education in South Asia

**Head Office: 7th Floor, Knowledge Boulevard, A-8 (A), Sector 62, NOIDA, 201 309, UP, India.
Registered Office: 11 Community Centre, Panchsheel Park, New Delhi 110 017, India**

Typeset by AcePro India Pvt. Ltd

Printed in India at Saurabh Printers Pvt. Ltd.

BRIEF CONTENTS

Preface	xxi
Acknowledgements	xxv

UNIT I BASICS OF COMPUTER

1. Introduction to Computer	1
2. The Computer System Hardware	19
3. Computer Memory	39
4. Input and Output Devices	61
5. Data Representation	87

UNIT II USER-COMPUTER INTERFACE

6. Interaction of User and Computer	115
7. Operating System	131
8. Computer Programming Fundamentals	150
9. Data Communication and Computer Network	163
10. The Internet and Internet Services	196

UNIT III APPLICATIONS AND SECURITY

11. Information Systems	219
12. Fundamentals of Database	236
13. Multimedia	256
14. Computer Security	284

UNIT IV COMPUTER PRACTICALS

15. Windows XP	307
16. MS-Word 2007	342
17. MS-Excel 2007	379
18. MS-PowerPoint 2007	422
19. MS-Access 2007	458
20. Network and Internet Connections	486
21. Using LaTeX	503
Appendix A	515
Appendix B	517
Appendix C	519
Appendix D	523
Index	541

CONTENTS

<i>Preface</i>	xxi
<i>Acknowledgements</i>	xxv

UNIT I BASICS OF COMPUTER **1**

1. Introduction to Computer **1**

1.1 Introduction	1
1.2 Digital and Analog Computers	2
1.3 Characteristics of Computer	2
1.4 History of Computer	3
1.5 Generations of Computer	4
1.5.1 First Generation (1940 to 1956): Using Vacuum Tubes	4
1.5.2 Second Generation (1956 to 1963): Using Transistors	5
1.5.3 Third Generation (1964 to 1971): Using Integrated Circuits	5
1.5.4 Fourth Generation (1971 to present): Using Microprocessors	6
1.5.5 Fifth Generation (Present and Next): Using Artificial Intelligence	6
1.6 Classification of Computer	7
1.6.1 Microcomputers	7
1.6.2 Minicomputers	9
1.6.3 Mainframe Computers	9
1.6.4 Supercomputers	9
1.7 The Computer System	10
1.7.1 The Input-Process-Output Concept	11
1.7.2 Components of Computer Hardware	12
1.8 Application of Computers	13
Summary	15
Keywords	16
Questions	17

2. The Computer System Hardware **19**

2.1 Introduction	19
2.2 Central Processing Unit	20
2.2.1 Arithmetic Logic Unit	20
2.2.2 Registers	21
2.2.3 Control Unit	22

2.3	Memory Unit	22
2.3.1	Cache Memory	22
2.3.2	<u>Primary Memory</u>	23
2.3.3	<i>Secondary Memory</i>	24
2.4	Instruction Format	24
2.5	Instruction Set	25
2.6	Instruction Cycle	25
2.7	<u>Microprocessor</u>	27
2.8	<u>Interconnecting the Units of a Computer</u>	27
2.8.1	<i>System Bus</i>	28
2.8.2	<i>Expansion Bus</i>	29
2.8.3	<i>External Ports</i>	29
2.9	Performance of a Computer	29
2.10	Inside a Computer Cabinet	31
2.10.1	<i>Motherboard</i>	31
2.10.2	<i>Ports and Interfaces</i>	32
2.10.3	<u><i>Expansion Slots</i></u>	33
2.10.4	<u><i>Ribbon Cables</i></u>	33
2.10.5	<i>Memory Chips</i>	34
2.10.6	<i>Storage Devices</i>	34
2.10.7	<i>Processor</i>	34
	Summary	35
	Keywords	36
	Questions	36
3.	Computer Memory	39
3.1	Introduction	39
3.2	Memory Representation	40
3.3	Memory Hierarchy	40
3.4	CPU Registers	42
3.5	Cache Memory	42
3.6	Primary Memory	43
3.6.1	<i>Random Access Memory</i>	43
3.6.2	<i>Read Only Memory</i>	44
3.7	Secondary Memory	46
3.8	Access Types of Storage Devices	46
3.8.1	<i>Sequential Access Devices</i>	46
3.8.2	<i>Direct Access Devices</i>	47
3.9	Magnetic Tape	47

3.10	Magnetic Disk	48
	3.10.1 <i>Floppy Disk</i>	50
	3.10.2 <i>Hard Disk</i>	51
	3.10.3 <i>Zip Disk</i>	52
3.11	Optical Disk	52
	3.11.1 <i>CD-ROM</i>	53
	3.11.2 <i>DVD-ROM</i>	53
	3.11.3 <i>Recordable Optical Disk</i>	55
3.12	Magneto-Optical Disk	55
3.13	Using the Computer Memory	56
	Summary	56
	Keywords	57
	Questions	58
4.	Input and Output Devices	61
	4.1 <i>Introduction</i>	61
	4.2 <i>Input-Output Unit</i>	62
	4.2.1 <i>Input Unit</i>	62
	4.2.2 <i>Output Unit</i>	62
	4.3 <i>Input Devices</i>	63
	4.4 <i>Human Data Entry Devices</i>	64
	4.4.1 <i>Keyboard</i>	64
	4.4.2 <i>Pointing Devices</i>	65
	4.4.2.1 <i>Mouse</i>	65
	4.4.2.2 <i>TrackBall</i>	66
	4.4.2.3 <i>Joystick</i>	66
	4.4.2.4 <i>Digitizing Tablet</i>	67
	4.4.3 <i>Pick Devices</i>	68
	4.4.3.1 <i>Light Pen</i>	68
	4.4.3.2 <i>Touch Screen</i>	68
	4.5 <i>Source Data Entry Devices</i>	69
	4.5.1 <i>Audio Input Device</i>	69
	4.5.2 <i>Video Input Device</i>	69
	4.5.3 <i>Optical Input Devices</i>	70
	4.5.3.1 <i>Scanner</i>	70
	4.5.3.2 <i>Optical Character Recognition (OCR)</i>	71
	4.5.3.3 <i>Magnetic Ink Character Recognition (MICR)</i>	72
	4.5.3.4 <i>Optical Mark Recognition (OMR)</i>	72
	4.5.3.5 <i>Barcode Reader</i>	72
	4.6 <i>Output Devices</i>	74
	4.6.1 <i>Hard Copy Devices</i>	74
	4.6.1.1 <i>Printer</i>	74
	4.6.1.2 <i>Plotter</i>	76
	4.6.1.3 <i>Computer Output on Microfilm</i>	77

4.6.2	<i>Soft Copy Devices</i>	77
4.6.2.1	Monitor	77
4.6.2.2	Visual Display Terminal	77
4.6.2.3	Video Output	78
4.6.2.4	Audio Response	78
4.7	I/O Port	80
4.8	Working of I/O System	81
	Summary	82
	Keywords	83
	Questions	84
5.	Data Representation	87
5.1	Introduction	87
5.2	Number System	88
5.2.1	<i>Decimal Number System</i>	88
5.2.2	<i>Binary Number System</i>	89
5.2.3	<i>Octal Number System</i>	89
5.2.4	<i>Hexadecimal Number System</i>	89
5.3	Conversion from Decimal to Binary, Octal, Hexadecimal	90
5.3.1	<i>Converting Decimal Integer to Binary, Octal, Hexadecimal</i>	90
5.3.2	<i>Converting Decimal Fraction to Binary, Octal, Hexadecimal</i>	92
5.3.3	<i>Converting Decimal Integer, Fraction to Binary, Octal, Hexadecimal</i>	94
5.4	Conversion of Binary, Octal, Hexadecimal to Decimal	95
5.5	Conversion of Binary to Octal, Hexadecimal	97
5.6	Conversion of Octal, Hexadecimal to Binary	97
5.7	Binary Arithmetic	98
5.7.1	<i>Binary Addition</i>	98
5.7.2	<i>Binary Subtraction</i>	100
5.8	Signed and Unsigned Numbers	102
5.8.1	<i>Complement of Binary Numbers</i>	102
5.9	Binary Data Representation	103
5.9.1	<i>Fixed Point Number Representation</i>	103
5.9.2	<i>Floating Point Number Representation</i>	105
5.10	Binary Coding Schemes	106
5.10.1	<i>EBCDIC</i>	106
5.10.2	<i>ASCII</i>	106
5.10.3	<i>Unicode</i>	107
5.11	<i>Logic Gates</i>	108
	Summary	110
	Keywords	110
	Questions	111
	Answers	113

UNIT II USER-COMPUTER INTERFACE	115
6. Interaction of User and Computer	115
6.1 Introduction	115
6.2 Types of Software	116
6.3 System Software	116
6.3.1 <i>Operating System</i>	117
6.3.2 <i>Device Driver</i>	117
6.3.3 <i>System Utilities</i>	118
6.3.4 <i>Programming Languages</i>	120
6.3.4.1 Machine Language	121
6.3.4.2 Assembly Language	121
6.3.4.3 High-level Language	122
6.3.4.4 Different Generations of Programming Languages	122
6.3.5 <i>Translator Software</i>	122
6.3.5.1 Assembler	124
6.3.5.2 Compiler	124
6.3.5.3 Interpreter	125
6.3.6 <i>Linker</i>	125
6.3.7 <i>Loader</i>	125
6.4 Application Software	126
6.5 Software Acquisition	127
Summary	128
Keywords	129
Questions	129
7. Operating System	131
7.1 Introduction	131
7.2 Objectives of Operating System	132
7.3 Types of OS	132
7.4 Functions of OS	134
7.5 Process Management	135
7.5.1 <i>CPU Scheduling</i>	136
7.5.2 <i>Process Synchronization</i>	136
7.5.3 <i>Deadlock</i>	137
7.6 Memory Management	138
7.6.1 <i>Memory Allocation</i>	138
7.6.2 <i>Virtual Memory</i>	139
7.7 File Management	140
7.8 Device Management	141
7.9 Protection and Security	142

7.10	User Interface	143
7.11	Examples of Operating Systems	144
	7.11.1 <i>MS-DOS</i>	144
	7.11.2 <i>Windows Family of OS</i>	145
	7.11.2.1 <i>Brief History of Windows OS</i>	146
	7.11.3 <i>Linux OS</i>	146
	Summary	147
	Keywords	147
	Questions	148
8.	Computer Programming Fundamentals	150
8.1	Introduction	150
8.2	Program Development Life Cycle	151
8.3	Algorithm	152
8.4	Control Structures	153
8.5	Flowchart	153
	8.5.1 <i>Flowchart Symbols</i>	153
	8.5.2 <i>Preparing a Flowchart</i>	153
8.6	Pseudo Code	156
	8.6.1 <i>Preparing a Pseudo Code</i>	156
8.7	Programming Paradigms	158
	8.7.1 <i>Structured Programming</i>	158
	8.7.2 <i>Object-Oriented Programming (OOP)</i>	159
	8.7.3 <i>Aspect-Oriented Programming</i>	160
	Summary	161
	Keywords	161
	Questions	162
9.	Data Communication and Computer Network	163
9.1	Introduction	163
9.2	Importance of Networking	164
9.3	Data Transmission Media	165
	9.3.1 <i>Twisted Pair</i>	165
	9.3.2 <i>Coaxial Cable</i>	166
	9.3.3 <i>Optical Fiber</i>	166
	9.3.4 <i>Radio Transmission</i>	167
	9.3.5 <i>Microwave Transmission</i>	168
	9.3.6 <i>Satellite Transmission</i>	168

9.4	Data Transmission Across Media	168
9.4.1	<i>Transmission Modes</i>	168
9.4.2	<i>Transmission Speed</i>	170
9.4.3	<i>Fundamentals of Transmission</i>	170
9.4.3.1	Analog and Digital Signals	171
9.4.3.2	Modulation and Demodulation	172
9.4.3.3	Multiplexing	174
9.4.3.4	Asynchronous and Synchronous Transmission	174
9.5	Data Transmission and Data Networking	175
9.5.1	<i>Switching</i>	176
9.5.1.1	Circuit Switching	177
9.5.1.2	Message Switching	177
9.5.1.3	Packet Switching	177
9.6	Computer Network	178
9.6.1	<i>Network Types</i>	178
9.6.1.1	Local Area Network	179
9.6.1.2	Metropolitan Area Network	179
9.6.1.3	Wide Area Network	180
9.6.2	<i>LAN Topologies</i>	180
9.6.2.1	Bus Topology	180
9.6.2.2	Ring Topology	181
9.6.2.3	Star Topology	181
9.6.3	<i>Communication Protocol</i>	181
9.6.4	<i>Network Devices</i>	184
9.6.4.1	Network Interface Card	184
9.6.4.2	Repeater	185
9.6.4.3	Bridge	186
9.6.4.4	Hub	186
9.6.4.5	Switch	187
9.6.4.6	Router	188
9.6.4.7	Gateway	188
9.7	Wireless Networking	189
9.7.1	<i>Bluetooth Technology</i>	189
9.7.2	<i>Wireless LAN</i>	190
9.7.3	<i>Wireless WAN</i>	191
	Summary	192
	Keywords	193
	Questions	193
10.	The Internet and Internet Services	196
10.1	Introduction	196
10.2	History of Internet	197
10.3	Internetworking Protocol	198
10.4	The Internet Architecture	198

10.5	Managing the Internet	199
10.6	Connecting to Internet	199
10.7	Internet Connections	200
	10.7.1 <i>Dial-up Access</i>	201
	10.7.2 <i>Leased Line</i>	201
	10.7.3 <i>Integrated Services Digital Network (ISDN)</i>	202
	10.7.4 <i>Digital Subscriber Line (DSL)</i>	202
	10.7.5 <i>Cable Modem</i>	203
10.8	Internet Address	203
10.9	Internet Services	204
	10.9.1 <i>World Wide Web (WWW)</i>	204
	10.9.1.1 Web Browser	206
	10.9.1.2 Uniform Resource Locator (URL)	207
	10.9.1.3 Internet Search Engines	207
	10.9.1.4 WWW Development Languages	209
	10.9.2 <i>Electronic Mail</i>	210
	10.9.2.1 E-mail Address	210
	10.9.2.2 E-mail Message Format	210
	10.9.2.3 E-mail Services	211
	10.9.2.4 How E-mail Works	211
	10.9.3 <i>File Transfer Protocol (FTP)</i>	212
	10.9.3.1 How FTP Works	213
	10.9.4 <i>Terminal Network (Telnet)</i>	213
	10.9.5 <i>News</i>	214
	10.9.6 <i>Internet Relay Chat (IRC)</i>	214
10.10	Uses of Internet	214
	Summary	215
	Keywords	216
	Questions	216
UNIT III APPLICATIONS AND SECURITY		219
11. Information Systems		219
11.1	Introduction	219
11.2	Data, Information and Knowledge	220
11.3	Characteristics of Information	221
11.4	Information System (IS)	221
11.5	Computer-Based Information System (CBIS)	223
11.6	Need for Efficient Information System	224
11.7	Categories of Information System	225

11.8	Operations Support System	226
	11.8.1 Transaction Processing System (TPS)	226
	11.8.2 Office Automation System (OAS)	227
11.9	Management Support System	228
	11.9.1 Management Information System (MIS)	228
	11.9.2 Decision Support System (DSS)	229
	11.9.3 Executive Information System (EIS)	230
11.10	Specialized Information System	230
	11.10.1 Expert Systems	230
	11.10.2 Enterprise Resource Planning (ERP)	231
	11.10.3 Electronic-Commerce (E-Commerce)	231
11.11	Careers in Information Systems	232
	Summary	233
	Keywords	234
	Questions	234

12. Fundamentals of Database **236**

12.1	Introduction	236
12.2	Database	237
	12.2.1 File-Oriented Approach and Database Approach	237
	12.2.2 Characteristics of Database Approach	239
	12.2.3 Data Models, Schema and Instances	240
	12.2.4 High-Level or Conceptual Data Model	240
	12.2.4.1 Entity	240
	12.2.4.2 Attribute	240
	12.2.4.3 Relationship	241
	12.2.4.4 Entity-Relationship (E-R) Model	241
	12.2.5 Representation or Implementation Data Model	242
	12.2.5.1 Relational Database Model	242
	12.2.5.2 Hierarchical Database Model	244
	12.2.5.3 Network Database Model	244
	12.2.6 Low-Level or Physical Data Model	245
12.3	Database System	245
	12.3.1 Components of Database System	245
	12.3.2 Architecture of Database System	246
12.4	Database Management System	247
	12.4.1 Data Independence	248
	12.4.2 Data Dictionary	248
	12.4.3 Database Administrator (DBA)	249
	12.4.4 Database Languages	249
	12.4.4.1 Data Definition Language (DDL)	249
	12.4.4.2 Data Manipulation Language (DML)	249

12.5 Database System Architectures	250
12.5.1 Centralized DBMS Architecture	250
12.5.2 Client-Server Architecture	250
12.5.3 Distributed Databases	251
12.6 Database Applications	251
Summary	252
Keywords	253
Questions	253
13. Multimedia	256
13.1 Introduction	256
13.2 Multimedia: Definition	257
13.3 Characteristics of Multimedia System	257
13.4 Elements of Multimedia	259
13.4.1 Text	259
13.4.2 Graphics	260
13.4.2.1 Bitmap Graphics	262
13.4.2.2 Vector Graphics	264
13.4.3 Audio	265
13.4.3.1 Audio from a CD to Web	266
13.4.4 Video	268
13.4.4.1 Video on Internet	269
13.4.5 Animation	271
13.5 Multimedia System	272
13.5.1 Desirable Features of Multimedia System	272
13.6 Multimedia Applications	273
13.6.1 In Education	273
13.6.2 In Entertainment	276
13.6.3 In Training	277
13.6.4 In Business	277
13.6.5 Virtual Reality	278
Summary	280
Keywords	280
Questions	281
14. Computer Security	284
14.1 Introduction	284
14.2 Security Threat and Security Attack	285
14.3 Malicious Software	286
14.3.1 Virus	287
14.3.2 Worms	287

14.3.3	<i>Trojan Horses</i>	287
14.3.4	<i>Javascrpts, Java Applets and ActiveX Controls</i>	288
14.4	Hacking	288
14.4.1	<i>Packet Sniffing</i>	289
14.4.2	<i>Password Cracking</i>	289
14.4.3	<i>E-mail Hacking</i>	289
14.5	Security Services	289
14.6	Security Mechanisms	290
14.7	Cryptography	290
14.7.1	<i>Secret Key Cryptography</i>	291
14.7.2	<i>Public-Key Cryptography</i>	291
14.7.3	<i>Hash Functions</i>	292
14.8	Digital Signature	292
14.9	Firewall	294
14.9.1	<i>Types of Firewall</i>	296
14.9.1.1	<i>Packet Filter Firewall</i>	296
14.9.1.2	<i>Circuit Filter Firewall</i>	296
14.9.1.3	<i>Application-Level Gateway</i>	297
14.10	Users Identification and Authentication	297
14.10.1	<i>User Name and Password</i>	298
14.10.2	<i>Smart Card</i>	299
14.10.3	<i>Biometric Techniques</i>	299
14.11	Other Security Measures	300
14.12	Security Awareness	301
14.13	Security Policy	302
14.13.1	<i>Formulating a Security Policy</i>	302
	Summary	303
	Keywords	304
	Questions	304
 UNIT IV COMPUTER PRACTICALS		 307
15. Windows XP		307
15.1	Introduction	307
15.2	Features of Windows XP	308
15.3	The Desktop	308
15.3.1	<i>The Task Bar</i>	309
15.3.2	<i>The Icons and Shortcuts</i>	311
15.4	Structure of Windows	313

15.5	Windows XP Explorer	314
15.5.1	<i>The Start</i>	314
15.5.2	<i>The Window</i>	315
15.5.3	<i>The View</i>	316
15.5.4	<i>Selecting Files</i>	317
15.5.5	<i>Working with Folders</i>	317
15.5.6	<i>Files and Folders Properties</i>	318
15.6	The Search	323
15.7	The Recycle Bin	323
15.8	Configuring the Screen	324
15.9	Configuring the Mouse	326
15.10	Adding or Removing Programs	328
15.11	Adding New Hardware	328
15.12	System Tools	330
15.13	The Scandisk	332
15.14	Windows XP Media Player	334
15.15	Windows XP Help	334
15.16	Windows Vista	334
15.17	Windows 7	337
	Questions	340
16.	MS-Word 2007	342
16.1	Introduction	342
16.2	Starting MS-Word	343
16.3	MS-Word Screen and Its Components	344
16.4	The Office Button	347
16.5	The Ribbon	350
16.5.1	<i>The Home Tab</i>	353
16.5.2	<i>The Insert Tab</i>	355
16.5.3	<i>The Page Layout Tab</i>	358
16.5.4	<i>The References Tab</i>	360
16.5.5	<i>The Mailings Tab</i>	360
16.5.6	<i>The Review Tab</i>	363
16.5.7	<i>The View Tab</i>	365
16.5.8	<i>The Help</i>	366
16.6	Solved Examples	366
	Exercises	375

17. MS-Excel 2007	379
17.1 Introduction	379
17.2 Start MS-Excel	380
17.3 Basics of Spreadsheet	381
17.4 MS-Excel Screen and Its Components	382
17.5 The Office Button	386
17.6 The Ribbon	390
17.6.1 <i>The Home Tab</i>	392
17.6.2 <i>The Insert Tab</i>	394
17.6.3 <i>The Page Layout Tab</i>	399
17.6.4 <i>The Formulas Tab</i>	400
17.6.5 <i>The Data Tab</i>	403
17.6.6 <i>The Review Tab</i>	405
17.6.7 <i>The View Tab</i>	406
17.6.8 <i>The Help</i>	408
17.7 Solved Examples	409
Exercises	417
18. MS-PowerPoint 2007	422
18.1 Introduction	422
18.2 Basics of PowerPoint	424
18.3 Start MS-PowerPoint	425
18.4 MS-PowerPoint Screen and Its Components	426
18.5 The Office Button	429
18.6 The Ribbon	434
18.6.1 <i>The Home Tab</i>	435
18.6.2 <i>The Insert Tab</i>	438
18.6.3 <i>The Design Tab</i>	440
18.6.4 <i>The Animations Tab</i>	442
18.6.5 <i>The Slide Show Tab</i>	443
18.6.6 <i>The Review Tab</i>	446
18.6.7 <i>The View Tab</i>	447
18.6.8 <i>The Help</i>	452
18.7 An Example	453
Exercises	456
19. MS-Access 2007	458
19.1 Introduction	458
19.2 Database Terminology	459
19.3 Start MS-Access	460

19.4	MS-Access Screen and Its Components	461
19.5	The Office Button	463
19.6	The Ribbon	467
	19.6.1 The Home Tab	468
	19.6.2 The Create Tab	472
	19.6.3 The External Data Tab	475
	19.6.4 The Database Tools Tab	476
	19.6.5 The Help	477
19.7	Solved Example	478
	Exercises	483
20.	Network and Internet Connections	486
20.1	Introduction	486
20.2	Start Network Connections	487
20.3	Create a New Connection	488
20.4	Manage a Network Connection	491
20.5	Network Setup	493
20.6	Windows Firewall	493
20.7	Sharing of Files	495
20.8	Wireless Network Setup	496
20.9	Connect using Virtual Private Network (VPN)	497
20.10	Set Up a Wired Network	498
20.11	Automatic Wireless Network Connections	498
20.12	Set up Internet Properties—Internet Options	501
20.13	Choose an Internet Connection	502
21.	Using LaTeX	503
21.1	Introduction	503
21.2	Create LaTeX Document	504
21.3	Components of a LaTeX Document	504
21.4	LaTeX Commands	504
21.5	Solved Examples	508
	Exercises	514
	Appendix A	515
	Appendix B	517
	Appendix C	519
	Appendix D	523
	Index	541

PREFACE

Computers play a key role in our everyday lives. In addition to communication media like television, radio and newspaper, we now have another communication medium, i.e. computers. We use computers to e-mail, to chat, for the Internet browsing, for teleconferencing, for video conferencing, etc. We also use them for e-learning, e-commerce, e-banking, e-governance, e-ticketing and for many more things. And the interesting part is, while we interact with the other media like television, radio, newspaper, etc. to merely get information, the interaction in computers is two ways—we can be a creator as well as a user. We may use a computer as a medium to get more information, as a tool to perform certain activities, or as an integral part of another component.

The fundamentals of computers are the stepping stones to computer science. Nowadays, all courses, related and unrelated to computer science, require using a computer. Knowledge of the basics of computers has become a fundamental requirement, in whatever area we choose to study or follow professionally. Computer fundamentals are also an introductory course to a more advanced study of computer science.

ABOUT THE BOOK

This book is written with the aim of introducing the fundamentals of computers to the reader. Attention has been paid to include chapters that are required by the students studying different courses. The book deals with both the theoretical concepts and the practicals. The unique features of this book are as follows:

⊙ *Style of Writing*

- The *language used* in the book is lucid, is easy to understand, and facilitates easy grasping of concepts.
- The chapters have been *logically arranged* in sequence.
- The book is written in a *reader-friendly* manner both for the students and the teachers.
- Most of the content presented in the book is in the form of bullets, organized sequentially. This form of presentation, rather than in a paragraph form, facilitates the reader to view, understand and remember the points better.
- The explanation is *supported by diagrams, pictures and images* wherever required.
- Sufficient *exercises* have been included for practice in addition to the *solved examples*.
- The questions at the end of the chapter are given section-wise. It is easier for the reader to find answers for the *section-wise questions* in a particular section rather than the whole book.

⊙ *Content of Book—Theory (Chapters 1–14)*

- Several *latest topics* have been included in the book. Some of these topics are
 - USB, Zip disk, Flash memory
 - Wireless networking
 - Notebook, Netbook, PDA, smartphones
 - Aspect Oriented Programming (AOP)
 - Imparting education via multimedia
 - Cryptography, Digital signature, Firewall, Biometrics
 - System clock, BIOS, CMOS, SIMM & DIMM memory module
- In the theory chapters (Chapters 1–14), the *theory is supported with the practical information* like, the name of supercomputer of India, how to create mp3 file from CD, what is a streaming video and understanding machine configuration.

- This book *does not discuss in detail the old technologies* that have become too common or are no longer used, like, about keys in a keyboard, magnetic tape, using mouse, drum printers and message switching.
- Several *colored inserts* in the book provide a colored view of the photographs.
- ⊙ **Content of Book—Practical (Chapters 15–21) and Appendix**
 - This book describes *MS-Office* with the latest commercially available version, version *2007*.
 - This book includes description of *Windows Vista and Windows 7* in addition to the detailed description of *Windows XP*.
 - The *solved examples* in the *MS-Office* chapters are described *step-wise*.
 - A *long list of practical exercises* is provided at the end of each chapter.
 - Some *chapters* contain topics that are new to a book on computers. These chapters are
 - Chapter 11—Information Systems
 - Chapter 12—Fundamentals of Database
 - Chapter 14—Computer Security
 - Chapter 19—MS-Access
 - Chapter 20—Network and Internet Connections
 - Chapter 21—Using LaTeX
 - Appendix D—Assembling a PC.

TARGET AUDIENCE

This book has been written keeping in mind the readers familiar and not-so familiar with computers. Several chapters have been included that cover the syllabi of different universities in India. The book is well suited for the following target audience:

- ⊙ *Computer science students* undergoing a course in computer science—DCA, MCA, BSc(Gen), BSc(Hons), MSc(IT), BSc(IT), BCA, DOEACC level courses.
- ⊙ *Engineering students* of first year—BTech, BE.
- ⊙ *Science students* pursuing BSc in physics, chemistry, botany, zoology and mathematics.
- ⊙ *Non-science students* pursuing BCom(P), BCom(Hons), BA(P), BDP, BBA, MBA, BBE
- ⊙ *Students enrolled in short-term courses on IT* in polytechnics, training institutes, Technical Institutes.
- ⊙ *Any learner* interested in computer science.

STRUCTURE OF THE TEXT

The book follows a structured and modular design, to facilitate the instructor in the teaching of the course and the students in the reading of the book. Figure 1 shows the design of the book. The following paragraphs present a brief review of the four units of the book.

Unit I comprises *five* chapters. This unit *introduces the reader to the computer as a machine*. Chapter 1 provides a brief introduction to computers—their evolution, types and applications. Chapter 2 discusses organization of the computer, different parts inside a computer case and their interaction. Chapter 3 provides an overview of the memory hierarchy, different kinds of memory of the computer and storage devices that are required for storing large quantities of data. The different devices that are used for providing input to the computer, and the presentation of output from the computer are discussed in Chapter 4. The computer uses the binary number system; Chapter 5 discusses binary coding schemes, logic gates, and the representation and conversion of numbers in the binary, octal and hexadecimal number system.

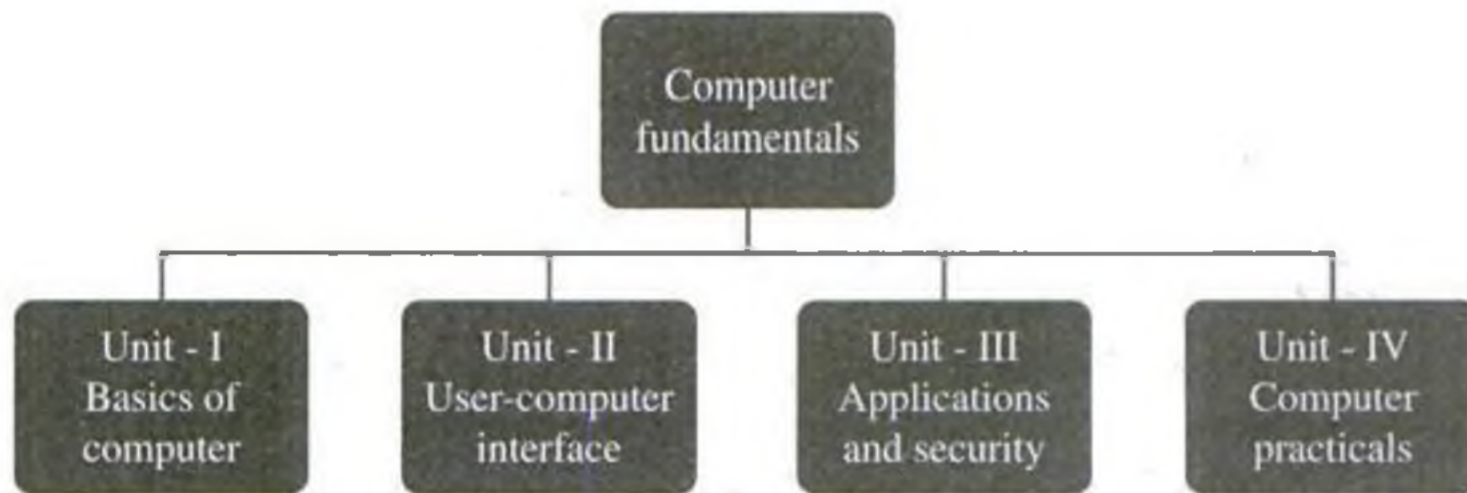


Figure 1 Modular structure of text

Unit II comprises *five* chapters. This unit *focuses on the interaction of user and computer, and the Internet*. Chapter 6 provides a description of the system software and the application software. Chapter 7 describes the operating system in detail. The writing of the programming logic and the different programming paradigms are discussed in Chapter 8. Chapters 9 and 10 relate to networking and the Internet. Chapter 9 discusses computer networks and the communication of data across the network. The Internet and its services are detailed in Chapter 10.

Unit III contains *four* chapters. This unit is *about applications and security*. Chapter 11 describes the information systems. This chapter is included bearing in mind the non-science courses. For teaching this paper in a science course, you may skip this chapter. The fundamentals of databases are discussed in Chapter 12. Chapter 13 describes the different elements of the multimedia system—text, audio, graphics, video and animation. Chapter 14 on computer security discusses the security attacks, and the way to handle them.

Unit IV consists of *seven* chapters. This unit is *designed for the computer practicals*. A detailed discussion on Windows XP is provided in Chapter 15, including a brief description about Windows Vista and Windows 7. Chapters 16 through 19 are about the four main components of MS-Office 2007, i.e. MS-Word, MS-Excel, MS-Powerpoint and MS-Access. Chapter 20 is about Network and the Internet connections. This chapter facilitates the reader in the creation and managing of computer network and the Internet connection. Chapter 21 is about using LaTeX which is used for the production of publication-quality typeset documents.

PEDAGOGICAL FEATURES

Pedagogy is the art and science of how something is taught and how students learn it. How the teaching occurs, the approach to teaching and learning, the way the content is delivered and what the students learn as a result of the process are all included in pedagogy. The following are the pedagogical features in this book:

- ⊙ **Start-of-Chapter Aids**
 - Contents—An overall view of the topics discussed in the chapter is provided, at the beginning of each chapter.
 - Why this chapter—It describes the need of including this chapter in computer fundamentals and why one should read it.
- ⊙ **In-Between Chapter Aids**
 - Visualization—“A picture is worth a thousand words” is a famous quote. This book supports the concepts with figures, diagrams and images to facilitate visualization.
 - Bulleted text—The book follows a bulleted approach of writing the text in contrast to the long paragraphs. The bulleted text approach is easier to read, understand and grasp.

⊙ ***End-of-Chapter Aids***

- **Summary**—It reviews the major concepts discussed in the chapter.
- **Keywords**—A list of keywords at the end of each chapter facilitates in locating a topic in the chapter.
- **Questions**—The questions at the end of each chapter are given section-wise. The reader has to search for the answers in this section, rather than the complete chapter.
- **Extra questions**—At the end of each chapter, the extra questions from the complete chapter are given in the form of short notes, abbreviations and differences.
- **Colored inserts**—A first initiative in a book on this topic, the colored inserts provide the reader with actual images in colour.

FEEDBACK

For interacting with the author, or for suggestions and comments on this book, please send your e-mails at goel.anita.book@gmail.com.

ACKNOWLEDGEMENTS

It took me almost 2 years to write this book. During my journey of book writing, I have been helped and supported by my family, friends and colleagues. I express my gratitude to one and all for their extensive support in this endeavour.

I am grateful to Dr. S. C. Gupta, Prof. S. K. Wasan and Dr. Mukul Sinha for encouraging me to write a book. I thank them for their valuable advice and for their encouragement to disseminate information. I also thank them for continually inspiring me to write a good book.

I thank Mr Neeraj Saxena, Ms Renu Saxena and Mr Rajendra for their extensive help in clicking the photographs in this book.

My special thanks go to all my students, Amit Jain in particular, who have always been eager to inform me the the expectations of the students of a book. Their suggestions and feedback have helped me write the book in a student-friendly manner.

Thanks to Mr Sachin Saxena and the team of Pearson Education for their extensive support. The book in its present form is a result of the long discussions and the brainstorming sessions with Sachin. I am grateful to Sachin for his ideas, suggestions and excellent support provided to me during the writing of this book.

I express my regards and love to my mother Urmila, and my father Amar Chand. Being their child makes me feel special, and I thank them both for guiding me through life. Through this book, I carry forward the legacy of book writing from my maternal grandfather late Mr C. S. Jain. I express my respect and thanks to my father-in-law Gopal Krishan for his motivation and cooperation, and for taking care of matters while I was busy writing the book. My thanks are due, in memory of my mother-in-law Pushpa who has always loved and supported me.

Thanks to my loving husband, Ajay, for standing by me in the difficult times during the course of writing this book. He is a bagful of innovative ideas and has contributed creatively to the writing of this book. My special thanks to my lovely and beautiful children, Anirudh and Ashima, who brilliantly contributed towards the creation and editing of this book. They are my greatest source of inspiration and motivation.

Since this is not the first book on this topic, I thank the authors of other books on similar topic, whose books have been a source of ideas for me.

I thank the Almighty without whose grace it would have been impossible for me to accomplish this task.

INTRODUCTION TO COMPUTER

1

- ⊙ Digital and analog computers
- ⊙ Characteristics of computer—Speed, accuracy, diligence, storage capability, versatility
- ⊙ History of computer—Calculating machines, Napier's bones, slide rule, Pascal's adding and subtraction machine, Leibniz's multiplication and dividing machine, punch card system, Babbage's analytical engine, Hollerith's punched card tabulating machine
- ⊙ Generations of computer
 - First generation (1940 to 1956): Using vacuum tubes
 - Second generation (1956 to 1963): Using transistors
 - Third generation (1964 to 1971): Using integrated circuits
 - Fourth generation (1971 to present): Using microprocessors
 - Fifth generation (present and next): Using artificial intelligence
- ⊙ Classification of computer—Micro-computers (desktop computer or Personal Computer (PC), notebook computers or laptop, netbook, tablet computer, handheld computer or Personal Digital Assistant (PDA), smart phones), minicomputers, mainframe computers, supercomputers
- ⊙ The computer system—Hardware, software, data, users
- ⊙ The Input-process-output concept
- ⊙ Components of computer hardware—Input/output unit, central processing unit, storage unit
- ⊙ Application of computers—Education, entertainment, sports, advertising, medicine, science and engineering, government, home



Why this chapter

Computers are an integral part of our lives. Wherever we are—sitting in our homes, working in the office, driving on roads, sitting in a movie hall, staying in a hotel, etc.—our lives are directly or indirectly affected by the computers. In this era of information, we are dependent on the storage, flow and processing of data and information, which can only be possible with the help of computers. The purpose of this chapter is to introduce you to the “computer”.

1.1 INTRODUCTION

Nowadays, computers are an integral part of our lives. They are used for the reservation of tickets for airplanes and railways, payment of telephone and electricity bills, deposit and withdrawal of money from banks, processing of business data, forecasting of weather conditions, diagnosis of diseases, searching

for information on the Internet, etc. Computers are also used extensively in schools, universities, organizations, music industry, movie industry, scientific research, law firms, fashion industry, etc.

The term computer is derived from the word *compute*. The word *compute* means *to calculate*. A *computer* is an electronic machine that accepts data from the user, processes the data by performing calculations and operations on it, and generates the desired output results. Computer performs both simple and complex operations, with speed and accuracy.

This chapter discusses the history and evolution of computer, the concept of input-process-output and the characteristics of computer. This chapter also discusses the classification of digital computers based on their size and type, and the application of computer in different domain areas.

1.2 DIGITAL AND ANALOG COMPUTERS

A *digital computer* uses distinct values to represent the data internally. All information are represented using the digits 0s and 1s. The computers that we use at our homes and offices are digital computers.

Analog computer is another kind of a computer that represents data as variable across a continuous range of values. The earliest computers were analog computers. Analog computers are used for measuring of parameters that vary continuously in real time, such as temperature, pressure and voltage. Analog computers may be more flexible but generally less precise than digital computers. Slide rule is an example of an analog computer.

This book deals only with the *digital computer* and uses the term *computer* for them.

1.3 CHARACTERISTICS OF COMPUTER

Speed, accuracy, diligence, storage capability and versatility are some of the key characteristics of a computer. A brief overview of these characteristics are—

- **Speed** The computer can process data very fast, at the rate of millions of instructions per second. Some calculations that would have taken hours and days to complete otherwise, can be completed in a few seconds using the computer. For example, calculation and generation of salary slips of thousands of employees of an organization, weather forecasting that requires analysis of a large amount of data related to temperature, pressure and humidity of various places, etc.
- **Accuracy** Computer provides a high degree of accuracy. For example, the computer can accurately give the result of division of any two numbers up to 10 decimal places.
- **Diligence** When used for a longer period of time, the computer does not get tired or fatigued. It can perform long and complex calculations with the same speed and accuracy from the start till the end.
- **Storage Capability** Large volumes of data and information can be stored in the computer and also retrieved whenever required. A limited amount of data can be stored, temporarily, in the primary memory. Secondary storage devices like floppy disk and compact disk can store a large amount of data permanently.
- **Versatility** Computer is versatile in nature. It can perform different types of tasks with the same ease. At one moment you can use the computer to prepare a letter document and in the next moment you may play music or print a document.

Computers have several limitations too. Computer can only perform tasks that it has been programmed to do. Computer cannot do any work without instructions from the user. It executes instructions as specified by the user and does not take its own decisions.

1.4 HISTORY OF COMPUTER

Until the development of the first generation computers based on vacuum tubes, there had been several developments in the computing technology related to the mechanical computing devices. The key developments that took place till the first computer was developed are as follows—

- ⊙ **Calculating Machines** ABACUS was the first mechanical calculating device for counting of large numbers. The word ABACUS means calculating board. It consists of bars in horizontal positions on which sets of beads are inserted. The horizontal bars have 10 beads each, representing units, tens, hundreds, etc. An abacus is shown in Figure 1.1
- ⊙ **Napier's Bones** was a mechanical device built for the purpose of multiplication in 1617 AD. by an English mathematician John Napier.
- ⊙ **Slide Rule** was developed by an English mathematician Edmund Gunter in the 16th century. Using the slide rule, one could perform operations like addition, subtraction, multiplication and division. It was used extensively till late 1970s. Figure 1.2 shows a slide rule.



Figure 1.1 Abacus



Figure 1.2 Slide rule

- ⊙ **Pascal's Adding and Subtraction Machine** was developed by Blaise Pascal. It could add and subtract. The machine consisted of wheels, gears and cylinders.
- ⊙ **Leibniz's Multiplication and Dividing Machine** was a mechanical device that could both multiply and divide. The German philosopher and mathematician Gottfried Leibniz built it around 1673.
- ⊙ **Punch Card System** was developed by Jacquard to control the power loom in 1801. He invented the punched card reader that could recognize the presence of hole in the punched card as binary one and the absence of the hole as binary zero. The 0s and 1s are the basis of the modern digital computer. A punched card is shown in Figure 1.3.



Figure 1.3 Punched card



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.

are able to store millions of components on a single chip. These computers have large memory requirements.

This generation of computers uses *parallel processing* that allows several instructions to be executed in parallel, instead of serial execution. Parallel processing results in faster processing speed. The Intel dual-core microprocessor uses parallel processing.

The fifth generation computers are based on *Artificial Intelligence (AI)*. They try to simulate the human way of thinking and reasoning. Artificial Intelligence includes areas like Expert System (ES), Natural Language Processing (NLP), speech recognition, voice recognition, robotics, etc.

1.6 CLASSIFICATION OF COMPUTER

The digital computers that are available nowadays vary in their sizes and types. The computers are broadly classified into four categories (Figure 1.8) based on their size and type—(1) Microcomputers, (2) Minicomputers, (3) Mainframe computers, and (4) Supercomputer.

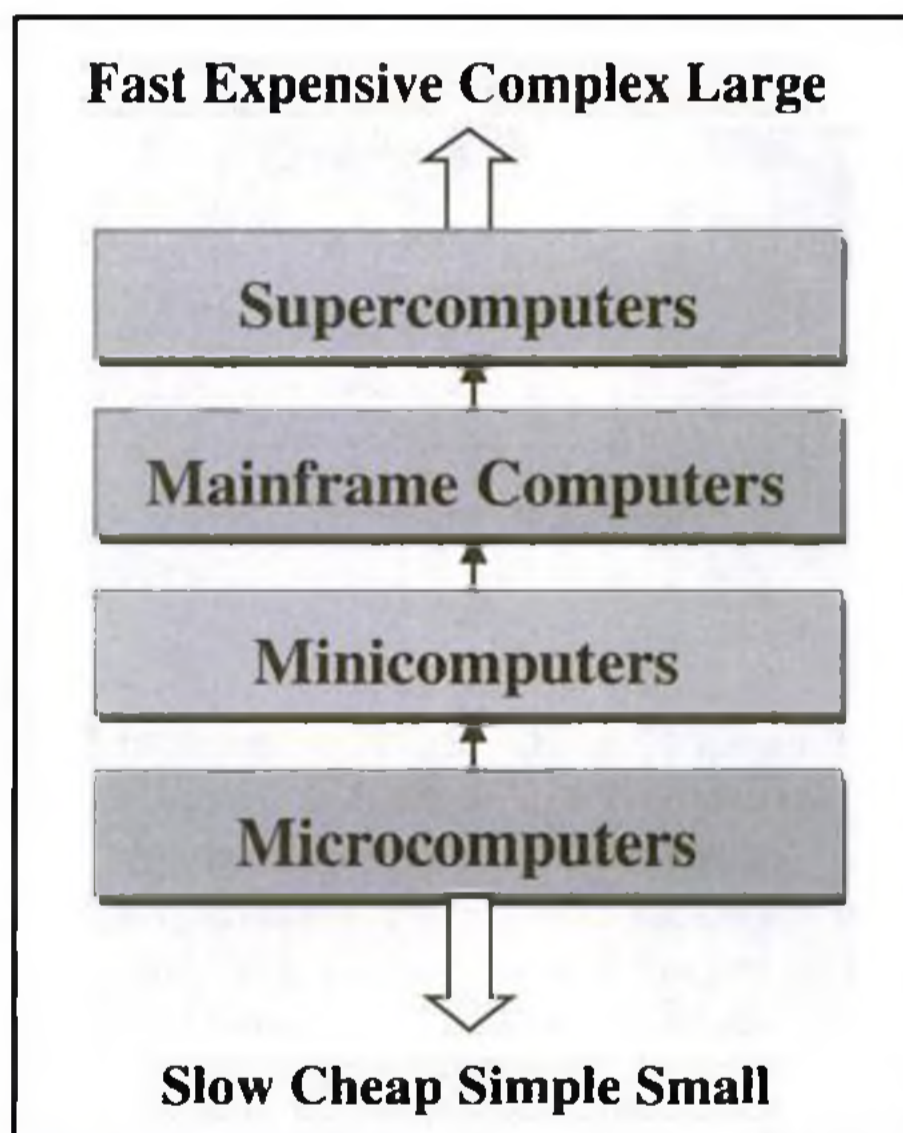


Figure 1.8 Classification of computers based on size and type

1.6.1 Microcomputers

Microcomputers are small, low-cost and single-user digital computer. They consist of CPU, input unit, output unit, storage unit and the software. Although microcomputers are stand-alone machines, they can be connected together to create a network of computers that can serve more than one user. IBM PC based on Pentium microprocessor and Apple Macintosh are some examples of microcomputers. Microcomputers include desktop computers, notebook computers or laptop, tablet computer, handheld computer, smart phones and netbook, as shown in Figure 1.9.

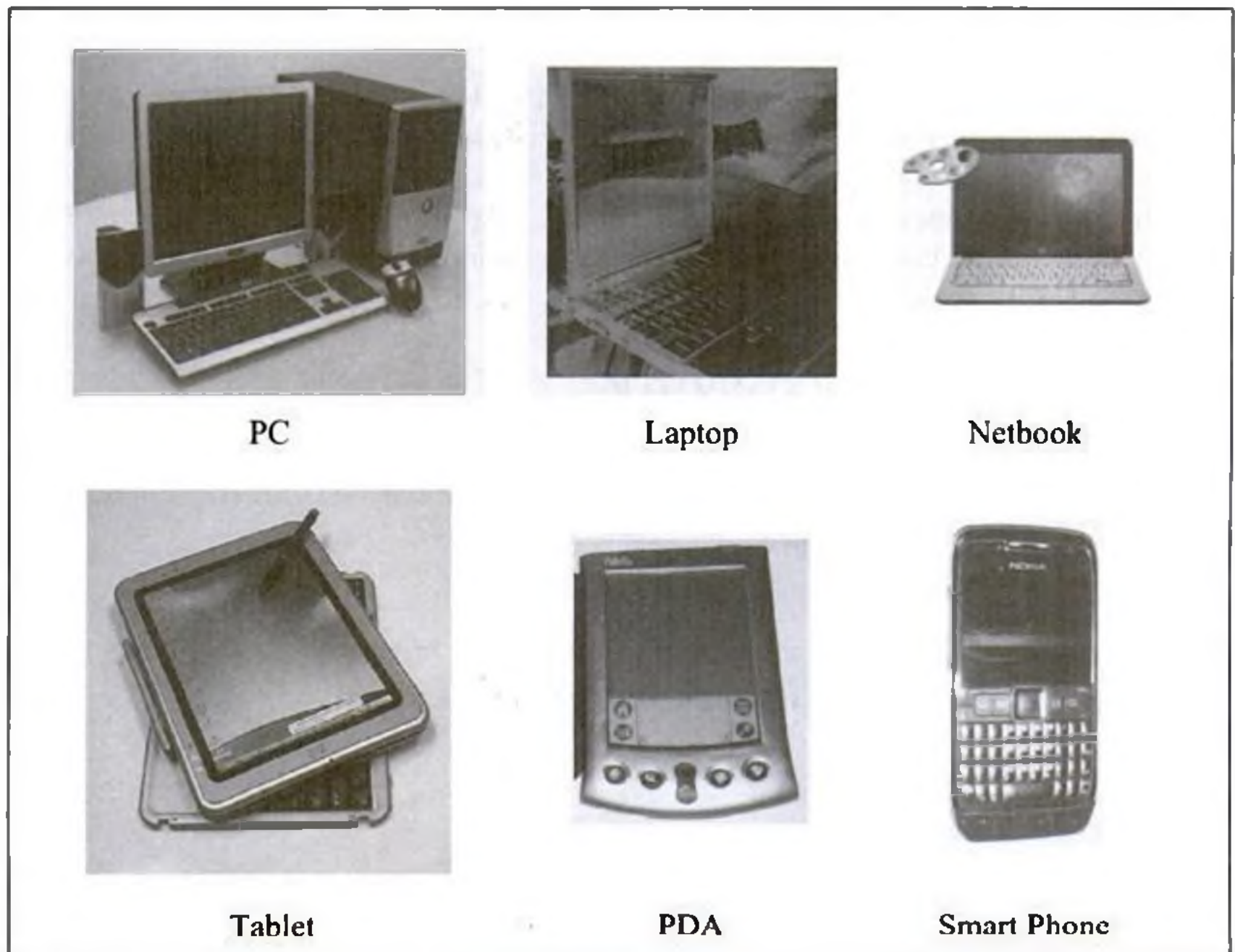


Figure 1.9 Microcomputers

- **Desktop Computer or Personal Computer (PC)** is the most common type of microcomputer. It is a stand-alone machine that can be placed on the desk. Externally, it consists of three units—keyboard, monitor, and a system unit containing the CPU, memory, hard disk drive, etc. It is not very expensive and is suited to the needs of a single user at home, small business units, and organizations. Apple, Microsoft, HP, Dell and Lenovo are some of the PC manufacturers.
- **Notebook Computers or Laptop** resemble a notebook. They are portable and have all the features of a desktop computer. The advantage of the laptop is that it is small in size (can be put inside a briefcase), can be carried anywhere, has a battery backup and has all the functionality of the desktop. Laptops can be placed on the lap while working (hence the name). Laptops are costlier than the desktop machines.
- **Netbook** These are smaller notebooks optimized for low weight and low cost, and are designed for accessing web-based applications. Starting with the earliest netbook in late 2007, they have gained significant popularity now. Netbooks deliver the performance needed to enjoy popular activities like streaming videos or music, emailing, Web surfing or instant messaging. The word *netbook* was created as a blend of *Internet* and *notebook*.
- **Tablet Computer** has features of the notebook computer but it can accept input from a stylus or a pen instead of the keyboard or mouse. It is a portable computer. Tablet computer are the new kind of PCs.

- ⊙ **Handheld Computer or Personal Digital Assistant (PDA)** is a small computer that can be held on the top of the palm. It is small in size. Instead of the keyboard, PDA uses a pen or a stylus for input. PDAs do not have a disk drive. They have a limited memory and are less powerful. PDAs can be connected to the Internet via a wireless connection. Casio and Apple are some of the manufacturers of PDA. Over the last few years, PDAs have merged into mobile phones to create smart phones.
- ⊙ **Smart Phones** are cellular phones that function both as a phone and as a small PC. They may use a stylus or a pen, or may have a small keyboard. They can be connected to the Internet wirelessly. They are used to access the electronic-mail, download music, play games, etc. Blackberry, Apple, HTC, Nokia and LG are some of the manufacturers of smart phones.

1.6.2 Minicomputers

Minicomputers (Figure 1.10) are digital computers, generally used in multi-user systems. They have high processing speed and high storage capacity than the microcomputers. Minicomputers can support 4–200 users simultaneously. The users can access the minicomputer through their PCs or terminal. They are used for real-time applications in industries, research centers, etc. PDP 11, IBM (8000 series) are some of the widely used minicomputers.



Figure 1.10 Minicomputer

1.6.3 Mainframe Computers

Mainframe computers (Figure 1.11) are multi-user, multi-programming and high performance computers. They operate at a very high speed, have very large storage capacity and can handle the workload of many users. Mainframe computers are large and powerful systems generally used in centralized databases. The user accesses the mainframe computer via a terminal that may be a dumb terminal, an intelligent terminal or a PC. A *dumb terminal* cannot store data or do processing of its own. It has the input and output device only. An *intelligent terminal* has the input and output device, can do processing, but, cannot store data of its own. The dumb and the intelligent terminal use the processing power and the storage facility of the mainframe computer. Mainframe computers are used in organizations like banks or companies, where many people require frequent access to the same data. Some examples of mainframes are CDC 6600 and IBM ES000 series.



Figure 1.11 Mainframe computer

1.6.4 Supercomputers

Supercomputers (Figure 1.12) are the fastest and the most expensive machines. They have high processing speed compared to other computers. The speed of a supercomputer is generally measured in FLOPS (Floating point Operations Per Second). Some of the faster supercomputers can perform trillions of calculations per second. Supercomputers are built by interconnecting thousands of processors that can work in parallel.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.

Hardware consists of the mechanical parts that make up the computer as a machine. The hardware consists of physical devices of the computer. The devices are required for input, output, storage and processing of the data. Keyboard, monitor, hard disk drive, floppy disk drive, printer, processor and motherboard are some of the hardware devices.



Figure 1.13 Parts of computer system

Software is a set of instructions that tells the computer about the tasks to be performed and how these tasks are to be performed. *Program* is a set of instructions, written in a language understood by the computer, to perform a specific task. A set of programs and documents are collectively called software. The hardware of the computer system cannot perform any task on its own. The hardware needs to be instructed about the task to be performed. Software instructs the computer about the task to be performed. The hardware carries out these tasks. Different software can be loaded on the same hardware to perform different kinds of tasks.

Data are isolated values or raw facts, which by themselves have no much significance. For example, the data like *29, January, and 1994* just represent values. The data is provided as input to the computer, which is processed to generate some meaningful information. For example, *29, January and 1994* are processed by the computer to give the date of birth of a person.

Users are people who write computer programs or interact with the computer. They are also known as *skinware, liveware, humanware or peopeware*. Programmers, data entry operators, system analyst and computer hardware engineers fall into this category.

1.7.1 The Input-Process-Output Concept

A computer is an electronic device that (1) accepts data, (2) processes data, (3) generates output, and (4) stores data. The concept of generating output information from the input data is also referred to as *input-process-output* concept.





You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.

relatives via Internet, for paying bills, for education and learning, etc. Microprocessors are embedded in house hold utilities like, washing machines, TVs, food processors, home theatres, security devices, etc.

The list of applications of computers is so long that it is not possible to discuss all of them here. In addition to the applications of the computers discussed above, computers have also proliferated into areas like banks, investments, stock trading, accounting, ticket reservation, military operations, meteorological predictions, social networking, business organizations, police department, video conferencing, telepresence, book publishing, web newspapers, and information sharing.

SUMMARY

- ⊙ *Computer* is an electronic device which accepts data as input, performs processing on the data, and gives the desired output. A computer may be *analog or digital computer*.
- ⊙ Speed, accuracy, diligence, storage capability and versatility are the main *characteristics of computer*.
- ⊙ The *computing devices* have evolved from simple mechanical machines, like ABACUS, Napier's bones, Slide Rule, Pascal's Adding and Subtraction Machine, Leibniz's Multiplication and Dividing Machine, Jacquard Punched Card System, Babbage's Analytical Engine and Hollerith's Tabulating Machine, to the first electronic computer.
- ⊙ Charles Babbage is called the father of computer.
- ⊙ The evolution of computers to their present state is divided into *five generations of computers*, based on the hardware and software they use, their physical appearance and their computing characteristics.
- ⊙ *First generation computers* were vacuum tubes based machines. These were large in size, expensive to operate and instructions were written in machine language. Their computation time was in milliseconds.
- ⊙ *Second generation computers* were transistor based machines. They used the stored program concept. Programs were written in assembly language. They were smaller in size, less expensive and required less maintenance than the first generation computers. The computation time was in microseconds.
- ⊙ *Third generation computers* were characterized by the use of IC. They consumed less power and required low maintenance compared to their predecessors. High-level languages were used for programming. The computation time was in nanoseconds. These computers were produced commercially.
- ⊙ *Fourth generation computers* used microprocessors which were designed using the LSI and VLSI technology. The computers became small, portable, reliable and cheap. The computation time is in picoseconds. They became available both to the home user and for commercial use.
- ⊙ *Fifth generation computers* are capable of learning and self organization. These computers use SLSI chips and have large memory requirements. They use parallel processing and are based on AI. The fifth generation computers are still being developed.
- ⊙ *Computers are broadly classified* as microcomputers, minicomputers, mainframe computers, and supercomputers, based on their sizes and types.
- ⊙ *Microcomputers* are small, low-cost stand-alone machines. Microcomputers include desktop computers, notebook computers or laptop, netbooks, tablet computer, handheld computer and smart phones.

- ⊙ *Minicomputers* are high processing speed machines having more storage capacity than the microcomputers. Minicomputers can support 4-200 users simultaneously.
- ⊙ *Mainframe computers* are multi-user, multi-programming and high performance computers. They have very high speed, very large storage capacity and can handle large workloads. Mainframe computers are generally used in centralized databases.
- ⊙ *Supercomputers* are the most expensive machines, having high processing speed capable of performing trillions of calculations per second. The speed of a supercomputer is measured in FLOPS. Supercomputers find applications in computing-intensive tasks.
- ⊙ *Computer* is an electronic device based on the input-process-output concept. Input/Output Unit, CPU and Memory unit are the three main *components of computer*.
- ⊙ *Input/Output Unit* consists of the Input unit which accepts data from the user and the Output unit that provides the processed data. *CPU* processes the input data, and, controls, coordinates and supervises the operations of the computer. CPU consists of ALU, CU and Registers. The memory unit stores programs, data and output, temporarily, during the processing. Additionally, storage unit or secondary memory is used for the storing of programs, data and output permanently.
- ⊙ Computers are used in various areas of our life. Education, entertainment, sports, advertising, medicine, science and engineering, government, office and home are some of the *application areas of the computers*.

KEYWORDS

ABACUS 3	Input/Output Unit 12	Process 12
Analog computer 2	Integrated Circuit (IC) 5	Program 11
Arithmetic Logic Unit (ALU) 13	Intelligent terminal 9	Punched cards 4
Assembly language 5	Jacquard's punch card 3	Second Generation Computer 5
Babbage's Analytical Engine 4	Large Scale Integration (LSI) 6	Slide Rule 3
Central Processing Unit (CPU) 6	Leibniz's Machine 3	Smart phones 9
Computer 2	Machine language 4	Software 11
Control Unit (CU) 13	Mainframe computers 9	Storage unit 6
Data 11	Memory 13	Supercomputer 9
Desktop computer 8	Microcomputers 7	Super Large Scale Integrated (SLSI) chips 6
Digital computer 2	Microprocessor 6	Tablet computer 8
Dumb terminal 9	Minicomputers 9	Third Generation Computer 5
Fifth Generation Computer 6	Napier's bones 3	Transistors 5
First Generation Computer 4	Netbook 8	Users 11
Floating point Operations Per Second (FLOPS) 9	Notebook computer 8	Vacuum Tubes 4
Fourth Generation Computer 6	Output 12	Very Large Scale Integration (VLSI) 6
Hardware 4	Parallel processing 7	
Hollerith's tabulator 4	Pascal's Machine 3	
Input 11	Personal Computer (PC) 8	
	Personal Digital Assistant (PDA) 9	

QUESTIONS

Section 1.2

1. Define an analog computer and a digital computer.
2. Give an example each of analog computer and digital computer.

Section 1.3

3. List the main characteristics of the computer.
4. Describe the characteristics of the computer.
5. List three significant limitations of the computer.

Section 1.4

6. Explain briefly the developments in computer technology starting from a simple calculating machine to the first computer.
7. What is a calculating machine?
8. What is the key feature of the Jacquard's punch card?
9. Name the first calculating device for the counting of large numbers.
10. Who is called the Father of Computer?

Section 1.5.1

11. The first generation computers used _____ for circuitry.
12. Describe the first generation computer based on the (a) Hardware (b) Software (c) Computing characteristics (d) Physical appearance, and (e) Their applications.
13. Give two examples of first generation computers.
14. List the drawbacks of the first generation computers.

Section 1.5.2

15. The second generation computers used _____ for circuitry.
16. Describe the second generation computer based on the (a) Hardware (b) Software (c) Computing characteristics (d) Physical appearance and (e) Their applications.
17. Give two examples of second generation computers.
18. List the drawbacks of the second generation computers.

Section 1.5.3

19. The third generation computers used _____ for circuitry.

20. Describe the third generation computer based on the (a) Hardware (b) Software (c) Computing characteristics (d) Physical appearance, and (e) Their applications.
21. Give two examples of third generation computers.
22. List the drawbacks of the third generation computers.

Section 1.5.4

23. The fourth generation computers used _____ for circuitry.
24. Describe the fourth generation computer based on the (a) Hardware (b) Software (c) Computing characteristics (d) Physical appearance and (e) Their applications.
25. Give two examples of fourth generation computers.
26. List the drawbacks of the fourth generation computers.

Section 1.5.5

27. The fifth generation computers used _____ for circuitry.
28. Describe the fifth generation computer based on the (a) Hardware (b) Software (c) Computing characteristics (d) Physical appearance and (e) Their applications.
29. Give two examples of fifth generation computers.
30. Compare in detail the five generations of computers based on the (a) Hardware (b) Software (c) Computing characteristics (d) Physical appearance and (e) Their applications. Also give at least one example of each generation of computer.

Section 1.6.1

31. Define microcomputer.
32. Give two examples of microcomputer.
33. List three categories of microcomputers.

Section 1.6.2

34. Define minicomputers.
35. Give two examples of minicomputer.

Section 1.6.3

36. Define mainframe computer.
37. Give two examples of mainframe computer.
38. Define a dumb terminal.
39. Define an intelligent terminal.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.

THE COMPUTER SYSTEM HARDWARE

2

Contents

- ⊙ Central Processing Unit (CPU)
 - Arithmetic logic unit
 - Registers
 - Control Unit (CU)
- ⊙ Memory unit
 - Cache memory
 - Primary memory
 - Secondary memory
- ⊙ Instruction format
- ⊙ Instruction set
- ⊙ Instruction cycle—Fetching, decoding, executing, storing
- ⊙ Microprocessor—CISC, RISC
- ⊙ Interconnecting the units of a computer—System bus, expansion bus, external ports
- ⊙ Performance of a computer—Registers, RAM, system clock, bus, cache memory
- ⊙ Inside a computer cabinet—Motherboard, ports and interfaces, expansion slots, ribbon cables, memory chips, storage devices, processor

Why this chapter

The computer as a machine consists of different components that interact with each other to provide the desired functionality of the computer. As a user of the computer, we need to be aware of the main components of the computer, their functions and the interconnection between the different components of the computer. This chapter describes the different hardware components of the computer.

2.1 INTRODUCTION

When we talk of computer hardware, the three related terms that require introduction are—computer architecture, computer organization and computer design. *Computer architecture* refers to the structure and behavior of the computer. It includes the specifications of the components, for example, instruction format, instruction set and techniques for addressing memory, and how they connect to the other components. Given the components, *computer organization* focuses on the organizational structure. It deals with how the hardware components operate and the way they are connected to form the computer. Given the system specifications, *computer design* focuses on the hardware to be used and the interconnection of parts. Different kinds of computer, such as a PC or a mainframe computer may have different organization; however, basic organization of the computer remains the same.

A computer consists of three main components—(1) Input/Output (I/O) Unit, (2) Central Processing Unit (CPU), and (3) Memory Unit. The computer user interacts with the computer via the I/O unit. The purpose of I/O unit is to provide data and instructions as input to the computer and to present relevant



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.

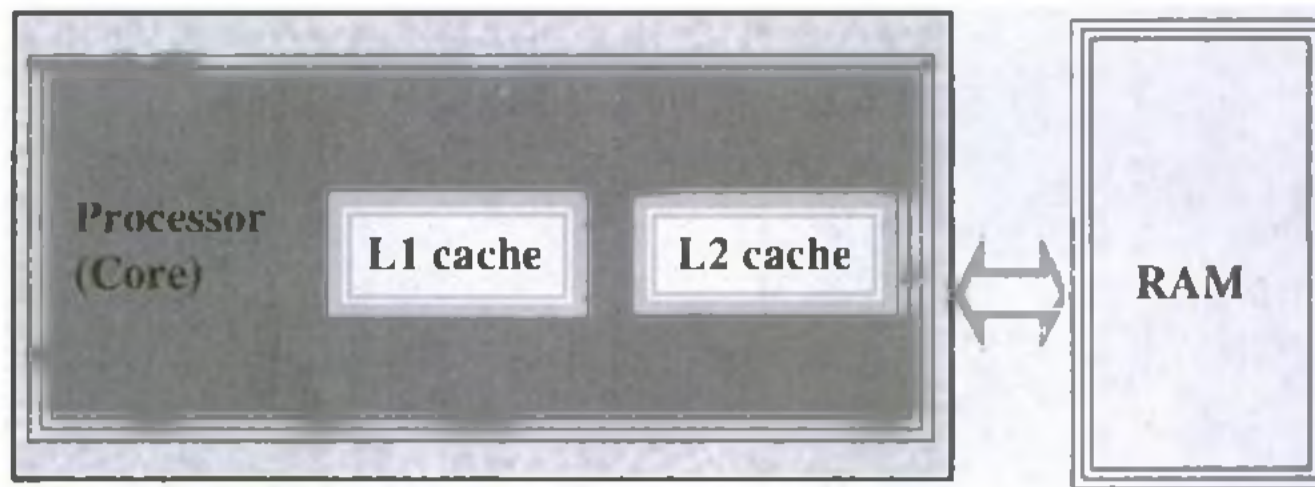


Figure 2.3 Illustration of cache memory

- ⊙ Cache memory is built into the processor, and may also be located next to it on a separate chip between the CPU and RAM. Cache built into the CPU is faster than separate cache, running at the speed of the microprocessor itself. However, separate cache is roughly twice as fast as RAM.
- ⊙ The CPU has a built-in *Level 1 (L1)* cache and *Level 2 (L2)* cache, as shown in Figure 2.3. In addition to the built-in L1 and L2 cache, some CPUs have a separate cache chip on the motherboard. This cache on the motherboard is called *Level 3 (L3)* cache. Nowadays, high-end processor comes with built-in L3 cache, like in Intel core i7. The L1, L2 and L3 cache store the most recently run instructions, the next ones and the possible ones, respectively. Typically, CPUs have cache size varying from 256KB (L1), 6 MB (L2), to 12MB (L3) cache.
- ⊙ Cache memory is very expensive, so it is smaller in size. Generally, computers have cache memory of sizes 256 KB to 2 MB.

2.3.2 Primary Memory

- ⊙ Primary memory is the main memory of computer. It is used to store data and instructions during the processing of data. Primary memory is semiconductor memory.
- ⊙ Primary memory is of two kinds—Random Access Memory (RAM) and Read Only Memory (ROM).
- ⊙ RAM is volatile. It stores data when the computer is on. The information stored in RAM gets erased when the computer is turned off. RAM provides *temporary storage* for data and instructions.
- ⊙ ROM is non-volatile memory, but is a read only memory. The storage in ROM is permanent in nature, and is used for storing standard processing programs that permanently reside in the computer. ROM comes programmed by the manufacturer.
- ⊙ RAM stores data and instructions during the execution of instructions. The data and instructions that require processing are brought into the RAM from the storage devices like hard disk. CPU accesses the data and the instructions from RAM, as it can access it at a *fast* speed than the storage devices connected to the input and output unit (Figure 2.4).
- ⊙ The input data that is entered using the input unit is stored in RAM, to be made available during the processing of data. Similarly, the output data generated after processing is stored in RAM before being sent to the output device. Any intermediate results generated during the processing of program are stored in RAM.
- ⊙ RAM provides a *limited storage capacity*, due to its *high cost*.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.

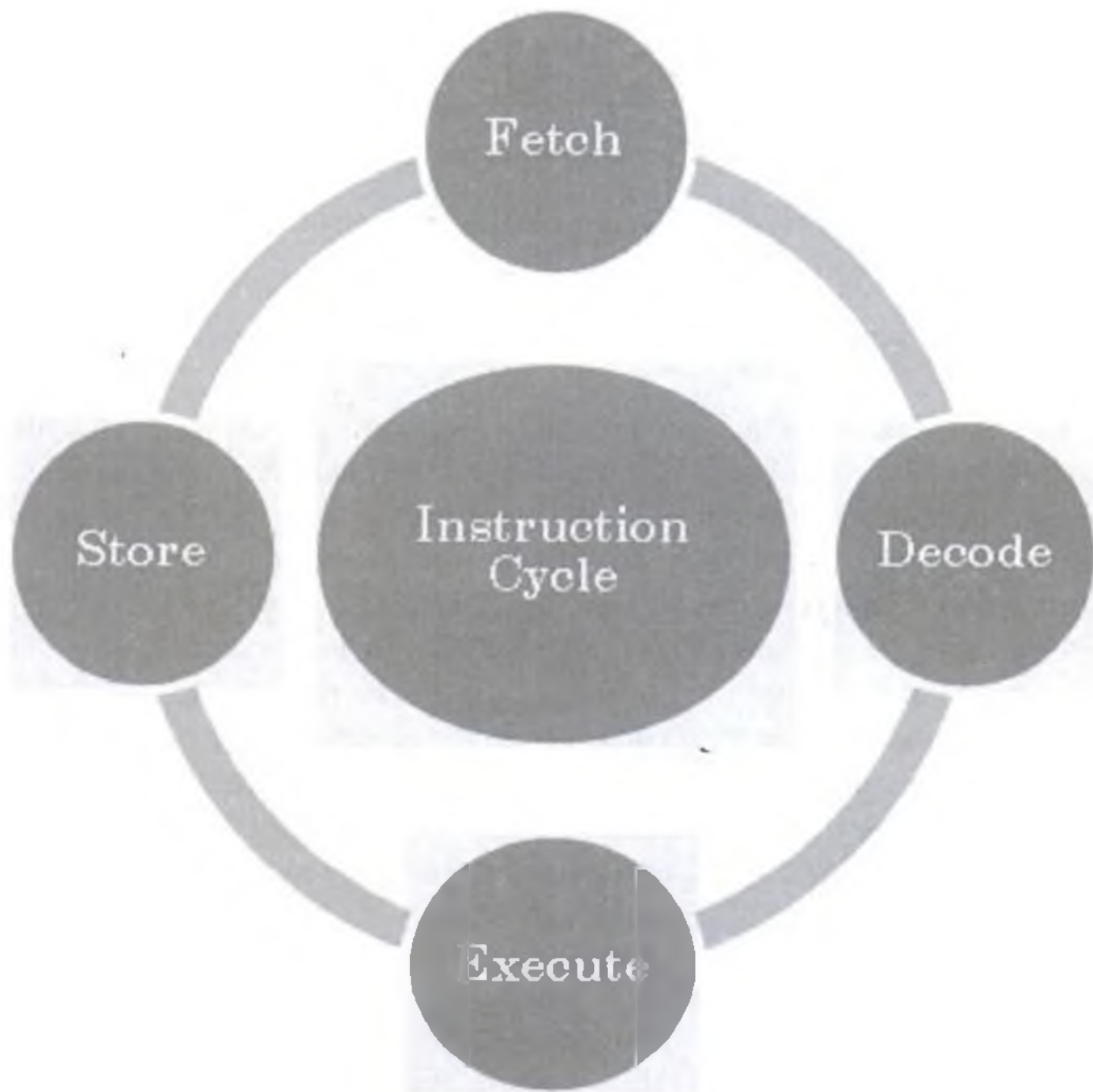


Figure 2.8 Instruction cycle

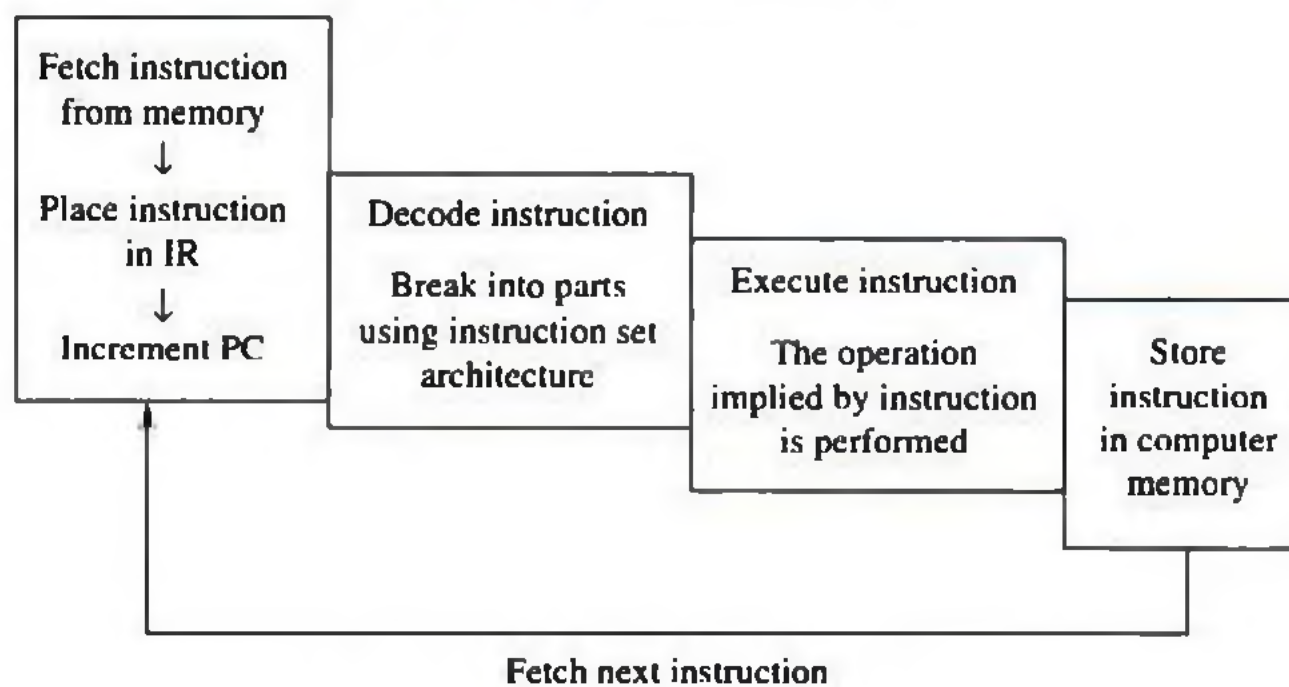


Figure 2.9 Steps in instruction cycle

- ⊙ Instructions are of different categories. Some categories of instructions are—
- Memory access or transfer of data between registers.
 - Arithmetic operations like addition and subtraction.
 - Logic operations such as AND, OR and NOT.
 - Control the sequence, conditional connections, etc.

A CPU performance is measured by the number of instructions it executes in a second, i.e., *MIPS* (million instructions per second), or *BIPS* (billion instructions per second).

2.7 MICROPROCESSOR

A processor's instruction set is a determining factor in its architecture. On the basis of the instruction set, microprocessors are classified as—Reduced Instruction Set Computer (RISC), and Complex Instruction Set Computer (CISC). The *x86* instruction set of the original Intel 8086 processor is of the CISC type. The PCs are based on the *x86* instruction set.

- ⊙ *CISC* architecture hardwires the processor with complex instructions, which are difficult to create otherwise using basic instructions. CISC combines the different instructions into one single CPU.
 - CISC has a large instruction set that includes simple and fast instructions for performing basic tasks, as well as complex instructions that correspond to statements in the high level language.
 - An increased number of instructions (200 to 300) results in a much more complex processor, requiring millions of transistors.
 - Instructions are of variable lengths, using 8, 16 or 32 bits for storage. This results in the processor's time being spent in calculating where each instruction begins and ends.
 - With large number of application software programs being written for the processor, a new processor has to be backwards compatible to the older version of processors.
 - AMD and Cyrix are based on CISC.
- ⊙ *RISC* has simple, single-cycle instructions, which performs only basic instructions. RISC architecture does not have hardwired advanced functions. All high-level language support is done in the software.
 - RISC has fewer instructions and requires fewer transistors, which results in the reduced manufacturing cost of processor.
 - The instruction size is fixed (32 bits). The processor need not spend time in finding out where each instruction begins and ends.
 - RISC architecture has a reduced production cost compared to CISC processors.
 - The instructions, simple in nature, are executed in just one clock cycle, which speeds up the program execution when compared to CISC processors.
 - RISC processors can handle multiple instructions simultaneously by processing them in parallel.
 - Apple Mac G3 and PowerPC are based on RISC.

Processors like Athlon XP and Pentium IV use a hybrid of both technologies.

Pipelining improves instruction execution speed by putting the execution steps into parallel. A CPU can receive a single instruction, begin executing it, and receive another instruction before it has completed the first. This allows for more instructions to be performed, about, one instruction per clock cycle.

Parallel Processing is the simultaneous execution of instructions from the same program on different processors. A program is divided into multiple processes that are handled in parallel in order to reduce execution time.

2.8 INTERCONNECTING THE UNITS OF A COMPUTER

CPU sends data, instructions and information to the components inside the computer as well as to the peripherals and devices attached to it. *Bus* is a set of electronic signal pathways that allows information



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.

- USB Ports—to connect newer peripherals like cameras, scanners and printers to the computer. It uses a thin wire to connect to the devices, and many devices can share that wire simultaneously.
- Firewire is another bus, used today mostly for video cameras and external hard drives.
- RJ45 connector (called LAN or Ethernet port) is used to connect the computer to a network. It corresponds to a network card integrated into the motherboard.
- VGA connector for connecting a monitor. This connector interfaces with the built-in graphics card.
- Audio plugs (line-in, line-out and microphone), for connecting sound speakers and the microphone. This connector interfaces with the built-in sound card.
- PS/2 port to connect mouse and keyboard into PC.
- SCSI port for connecting the hard disk drives and network connectors.

2.10.3 Expansion Slots

The expansion slots (Figure 2.17) are located on the motherboard. The expansion cards are inserted in the expansion slots. These cards give the computer new features or increased performance. There are several types of slots:

- ISA (Industry Standard Architecture) slot—To connect modem and input devices.
- PCI (Peripheral Component InterConnect) slot—To connect audio, video and graphics. They are much faster than ISA cards.
- AGP (Accelerated Graphic Port) slot—A fast port for a graphics card.
- PCI (Peripheral Component InterConnect) Express slot—Faster bus architecture than AGP and PCI buses.
- PC Card—It is used in laptop computers. It includes Wi-Fi card, network card and external modem.

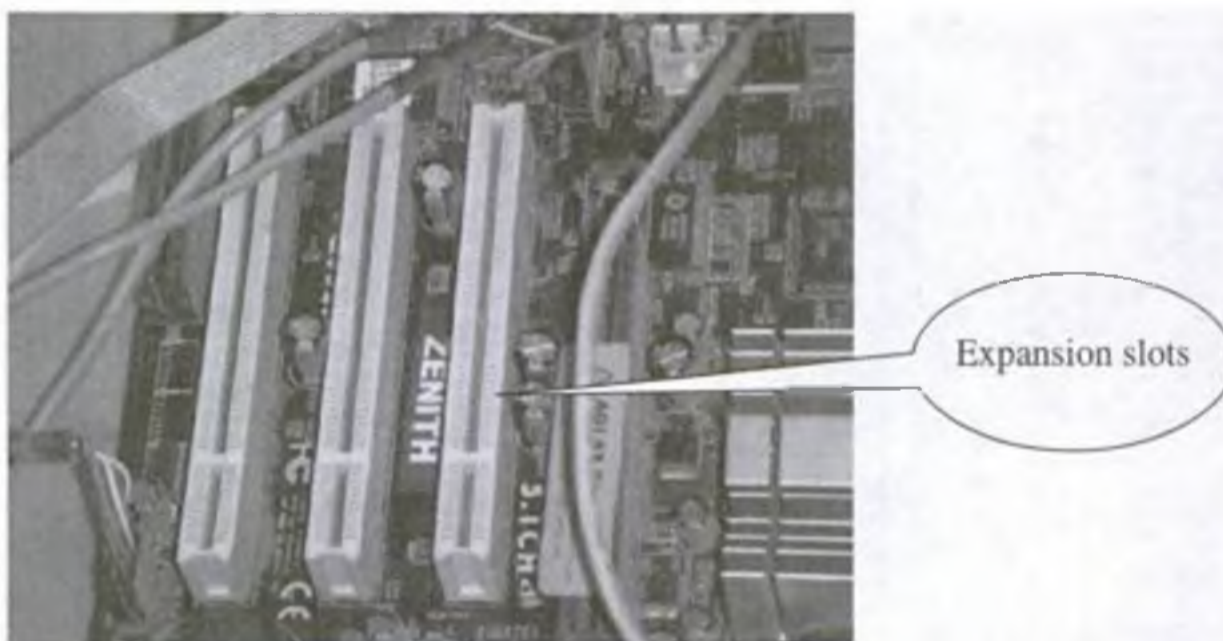


Figure 2.17 Expansion slots

2.10.4 Ribbon Cables

Ribbon cables (Figure 2.18) are flat, insulated and consist of several tiny wires moulded together that carry data to different components on the motherboard. There is a wire for each bit of the word or byte and additional wires to coordinate the activity of moving information. They also connect the floppy drives, disk drives and CD-ROM drives to the connectors in the motherboard. Nowadays, Serial Advanced Technology Attachment (SATA) cables have replaced the ribbon cables to connect the drives to the motherboard.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.

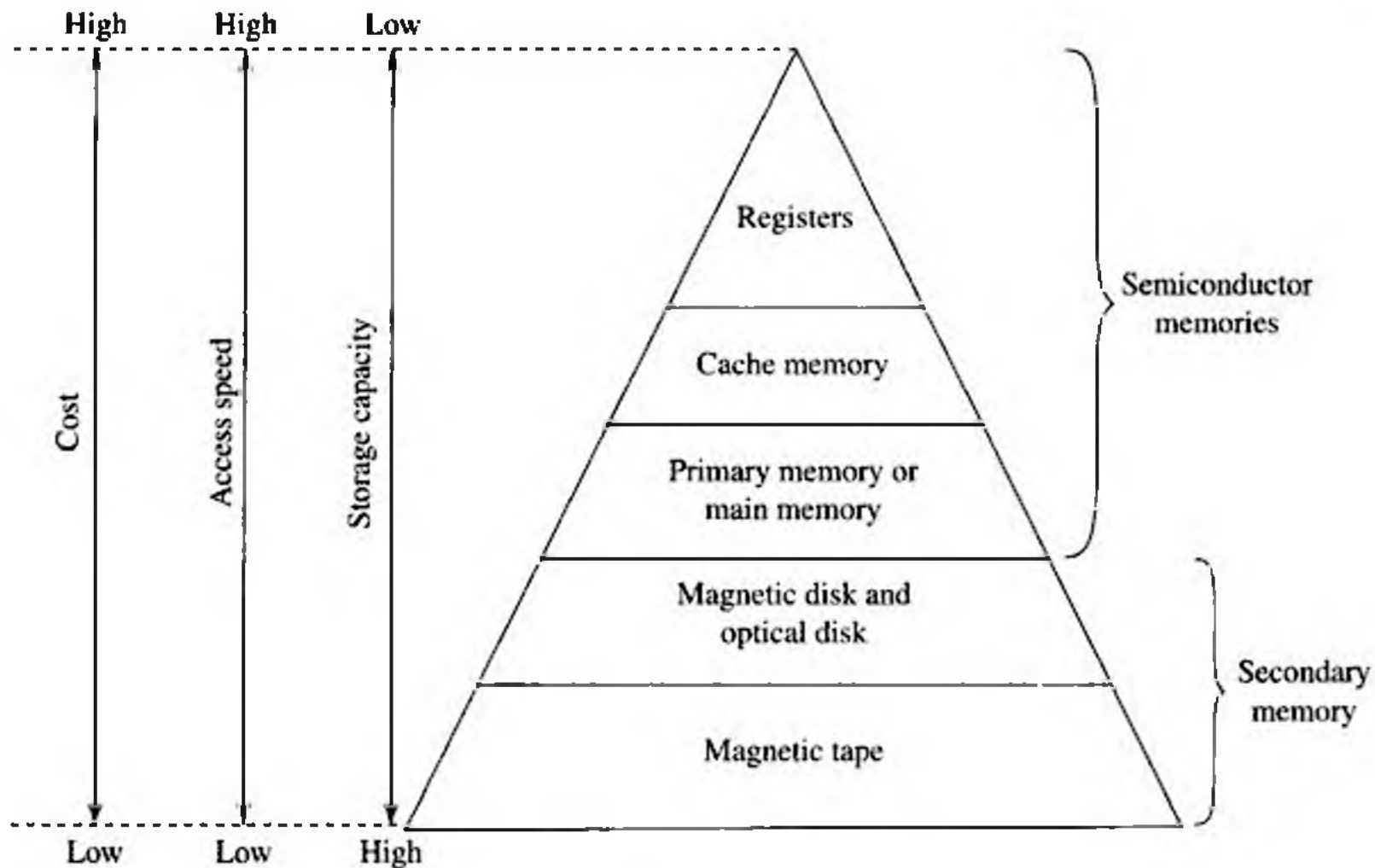


Figure 3.2 Memory hierarchy

The internal memory and external memory are the two broad categories of memory used in the computer. The internal memory consists of the CPU registers, cache memory and primary memory. The internal memory is used by the CPU to perform the computing tasks. The external memory is also called the secondary memory. The secondary memory is used to store the large amount of data and the software.

In general, referring to the computer memory usually means the internal memory.

- ⊙ **Internal Memory**—The key features of internal memory are—(1) limited storage capacity, (2) temporary storage, (3) fast access, and (4) high cost. Registers, cache memory, and primary memory constitute the internal memory. The primary memory is further of two kinds—RAM and ROM. Registers are the fastest and the most expensive among all the memory types. The registers are located inside the CPU, and are directly accessible by the CPU. The speed of registers is between 1–2 ns (nanosecond). The sum of the size of registers is about 200B. Cache memory is next in the hierarchy and is placed between the CPU and the main memory. The speed of cache is between 2–10 ns. The cache size varies between 32 KB to 4MB. Any program or data that has to be executed must be brought into RAM from the secondary memory. Primary memory is relatively slower than the cache memory. The speed of RAM is around 60ns. The RAM size varies from 512KB to 3GB.
- ⊙ **Secondary Memory**—The key features of secondary memory storage devices are—(1) very high storage capacity, (2) permanent storage (non-volatile), unless erased by user, (3) relatively slower access, (4) stores data and instructions that are not currently being used by CPU but may be required later for processing, and (5) cheapest among all memory. The storage devices consist of two parts—drive and device. For example, magnetic tape drive and magnetic tape, magnetic disk drive and disk, and, optical disk drive and disk. The speed of magnetic disk is around 60ms.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.

- ⊙ The ROM memory chip (Figure 3.5) stores the *Basic Input Output System (BIOS)*. BIOS provides the processor with the information required to boot the system. It provides the system with the settings and resources that are available on the system. BIOS is a permanent part of the computer. It does not load from disk but instead is stored in a ROM memory chip. The program code in the BIOS differs from ordinary software since it acts as an integral part of the computer. When the computer is turned on, the BIOS does the following things—

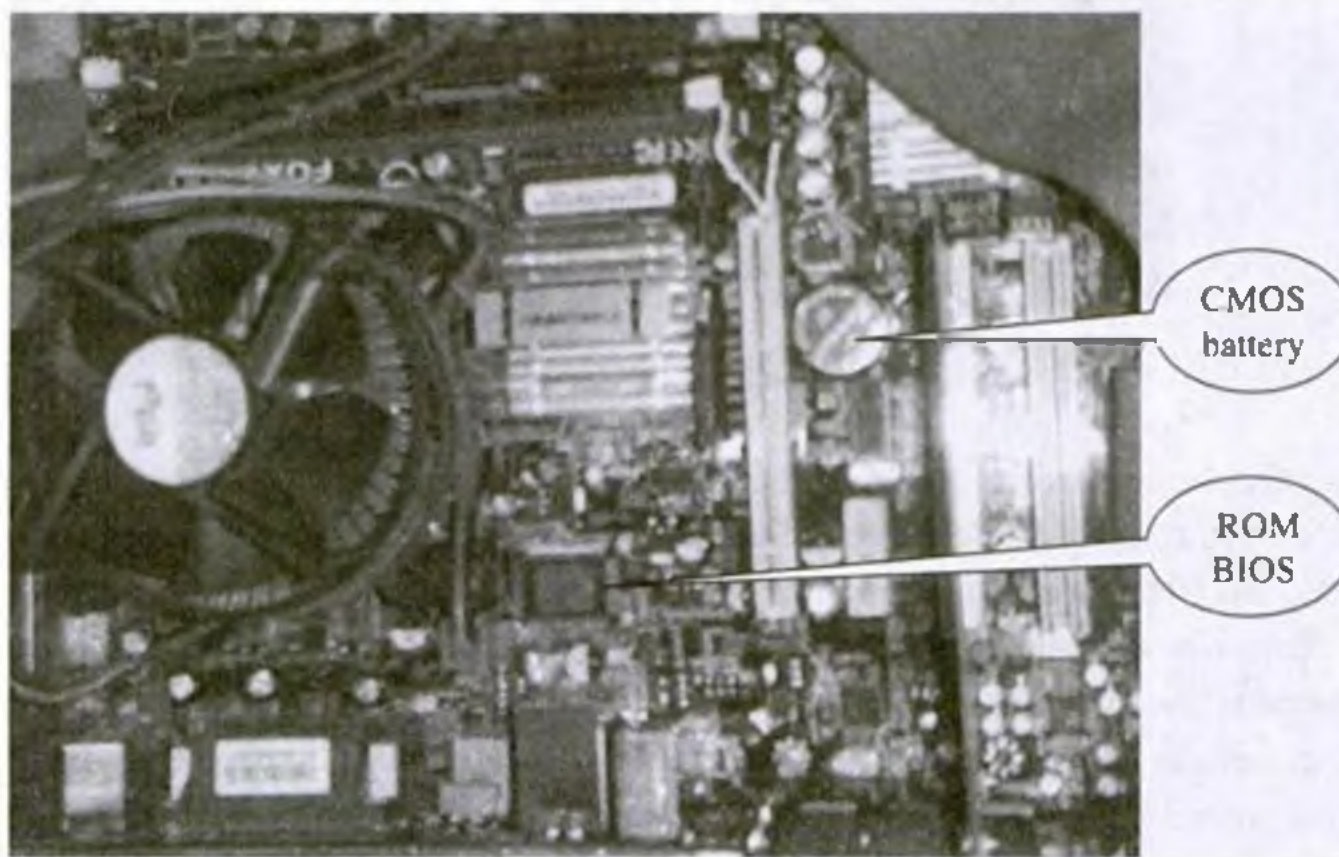


Figure 3.5 ROM BIOS and CMOS battery on a motherboard

- *Power On Self Test (POST)* is a program that runs automatically when the system is booted. BIOS performs the power-on self-test. It checks that the major hardware components are working properly.
 - BIOS setup program, which is a built-in utility in BIOS, lets the user set the many functions that control how the computer works. BIOS displays the system settings and finds the bootable devices. It loads the interrupt handlers and device drivers. It also initializes the registers.
 - *Bootstrap Loader* is a program whose purpose is to start the computer software for operation when the power is turned on. It loads the operating system into RAM and launches it. It generally seeks the operating system on the hard disk. The bootstrap loader resides in the ROM. The BIOS initiates the bootstrap sequence.
- ⊙ ROMs are of different kinds. They have evolved from the fixed read only memory to the ones that can be programmed and re-programmed. They vary in the number of re-writes and the method used for the re-writing. Programmable ROM (PROM), Erasable Programmable ROM (EPROM) and Electrically Erasable Programmable ROM (EEPROM) are some of the ROMs. All the different kinds of ROM retain their content when the power is turned off.
 - **PROM** can be programmed with a special tool, but after it has been programmed the contents cannot be changed. PROM memories have thousands of fuses (or diodes). High voltage (12 V) is applied to the fuses to be burnt. The burnt fuses correspond to 0 and the others to 1.
 - **EPROM** can be programmed in a similar way as PROM, but it can be erased by exposing it to ultra violet light and re-programmed. EPROM chips have to be removed from the computer for re-writing.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.

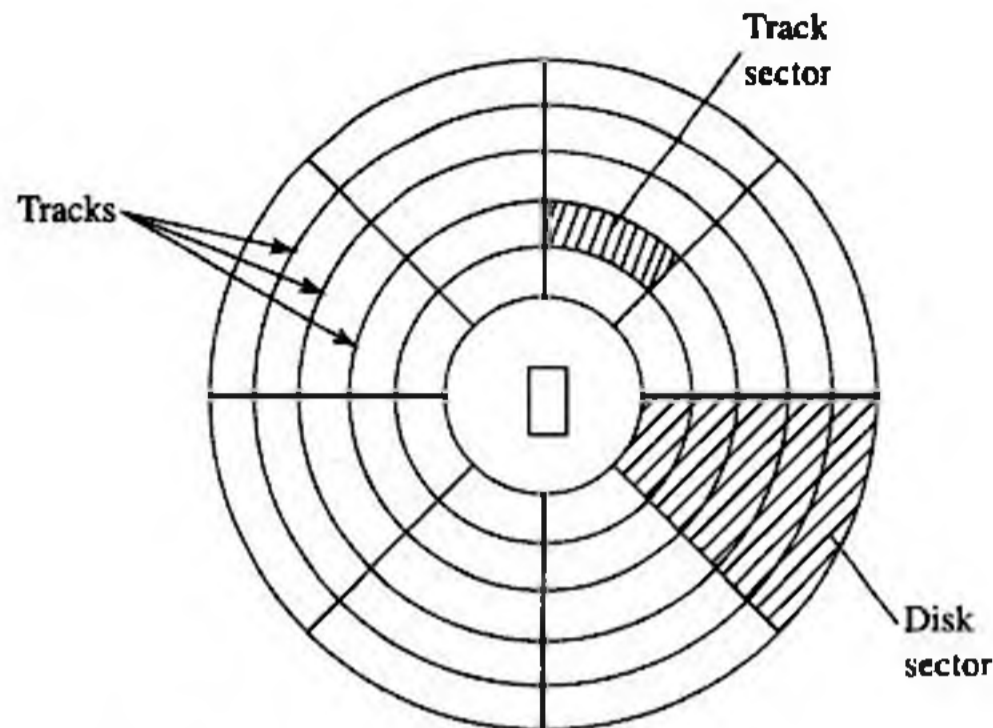


Figure 3.10 Tracks and sectors of a disk

- ⊙ Magnetic disk is inserted into a magnetic disk drive for access. The drive consists of a read/write head that is attached to a disk arm, which moves the head. The disk arm can move inward and outward on the disk.
- ⊙ During reading or writing to disk, the motor of disk drive moves the disk at high speed (60–150 times/sec.)
- ⊙ Accessing data on the disk requires the following—
 - The read/write head is positioned to the desired track where the data is to be read from or written to. The time taken to move the read/write head to the desired track is called the *seek time*.
 - Once the read/write head is at the right track, then the head waits for right sector to come under it (disk is moving at high speed). The time taken for desired sector of the track to come under read/write head is called the *latency time*.
 - Once the read/write head is positioned at the right track and sector, the data has to be written to disk or read from disk. The rate at which data is written to disk or read from disk is called *data transfer rate*.
 - The sum of seek time, latency time and time for data transfer is the *access time* of the disk.
- ⊙ The storage capacity of disk drive is measured in gigabytes (GB).
- ⊙ Large disk storage is created by stacking together multiple disks. A set of same tracks on all disks forms a *cylinder*. Each disk has its own read/write head which work in coordination.
- ⊙ A disk can also have tracks and sectors on both sides. Such a disk is called *double-sided disk*.

The features of magnetic disk are—

- ⊙ Cheap storage device
- ⊙ Can store a large amount of data
- ⊙ Easy to carry or transport
- ⊙ Suitable for frequently read/write data
- ⊙ Fast access device
- ⊙ More reliable storage device
- ⊙ To be prevented from dust, as the read/write head flies over the disk. Any dust particle in between can corrupt the disk.

Finding data on a magnetic disk is as follows—

- ⊙ In order to use a disk, it has to be formatted. Formatting includes assigning addresses to various locations on disk, assigning location of root directory and checking for defects on the surface of disk.
- ⊙ During formatting, the tracks and sectors of a disk are labeled, which provides an address to each location of the disk.
- ⊙ There are different methods to format a disk. File Allocation Table (FAT) is the commonly used logical format for disk formatting performed by Windows.
- ⊙ Four areas are created when a disk is formatted using FAT—
 - **Boot Sector** It contains the program that runs when the computer is started. The program checks if the disk has files required to run the operating system. It then transfers control to an operating system program which continues the startup process. Boot sector also contains information about the disk, like number of bytes per sector and number of sectors per track. This information is required by the operating system to access the data on the disk.
 - **File Allocation Table** It records the location of each file and status of each sector. While reading or writing to disk, operating system checks the FAT to find free area or locate where data is stored on disk, respectively.
 - **Root Directory** This is the main folder of disk. It contains other folders in it, creating a hierarchical system of folders. The root directory contains information about all folders on the disk.
 - **Data Area** The remaining area of the disk (after boot sector, FAT, root directory) is the data area. It stores the program files and data files that are stored on the disk.
- ⊙ The Windows XP and the Windows 2000 operating system use the New Technology File System (NTFS) 5 file system. The NTFS 5 file system offers better security and increased performance. It allows using of filenames that are more than eight characters long.
- ⊙ Floppy disk, hard disk and zip disk are the different types of magnetic disks.

3.10.1 Floppy Disk

- ⊙ Floppy disk (FD) is a flat, round, single disk made of Mylar plastic and enclosed in square plastic jacket (Figure 3.11).
- ⊙ Floppy Disk Drive (FDD) is the disk drive for floppy disk.
- ⊙ The floppy disk is inserted into the floppy disk drive to read or write data to it.
- ⊙ Floppy disk has a write-protect slide tab that prevents a user from writing to it.
- ⊙ A floppy disk may be single-sided or double-sided disk, i.e., data can be read and written on one and both sides of floppy disk, respectively.



Figure 3.11 Floppy disk

- ⊙ They are portable. They can be removed from the disk drive, carried or stored separately.
- ⊙ They are small and inexpensive.
- ⊙ Floppy disks are slower to access than hard disk. They have less storage capacity and are less expensive than hard disk.
- ⊙ They come in two basic sizes—5-¼ inch and 3-½ inch.

- ⊙ The 5-¼ inch disk came around 1987. It can store 360 KB to 1.2 MB of data.
- ⊙ The 3-½ inch disk has capacity of 400 KB to 1.44 MB. It usually contains 40 tracks and 18 sectors per track and can store 512 bytes per sector.

3.10.2 Hard Disk

- ⊙ A hard disk (HD) consists of one or more platters divided into concentric tracks and sectors. It is mounted on a central spindle, like a stack. It can be read by a read/write head that pivots across the rotating disks. The data is stored on the platters covered with magnetic coating (Figure 3.12).

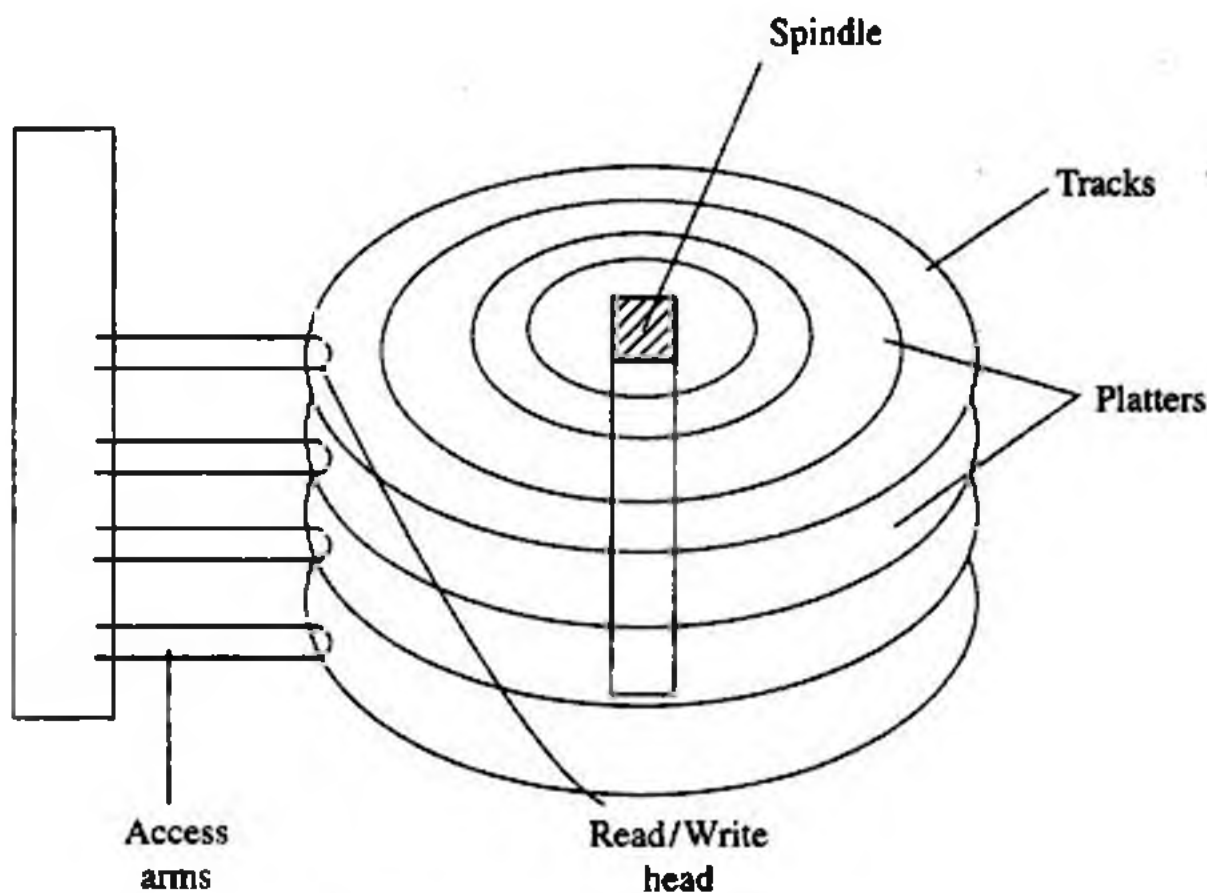


Figure 3.12 Parts of hard disk

- ⊙ Hard disk is a fixed disk. The disk is not removable from the drive, unlike floppy disk.
- ⊙ The hard disk and Hard Disk Drive (HDD) is a single unit.
- ⊙ Hard disk can store much more data than floppy disk. The data in hard disk are packed more closely (because fast spinning uses smaller magnetic charges) and they have multiple platters, with data being stored on both sides of each platter. Large capacity hard disks may have 12 or more platters.
- ⊙ Unlike floppy disk, the read/write head of hard disk does not touch the disk during accessing.
- ⊙ Hard disk can spin at the speed of up to 10,000 revolutions per minute and have an access time of 9–14 ms. It stores 512 bytes per sector but the number of sectors are more per track (54 or more) than floppy disk.
- ⊙ Nowadays, hard disks are available that can store up to 500 GB of data. Generally, PCs come with 160 GB hard disk.
- ⊙ Hard disk is the key secondary storage device of computer. The operating system is stored on the hard disk. The performance of computer like speed of computer boot up, loading of programs to

primary memory, loading of large files like images, video, audio etc., is also dependent on the hard disk.

- ⊙ Nowadays, *portable external hard disk drive* is available which can be attached to the USB drive of the computer. They come in the storage capacities of 80 GB to 500 GB.



Figure 3.13 Zip disk

3.10.3 Zip Disk

- ⊙ They are high-capacity removable disk and drive.
- ⊙ They have the speed and capacity of hard disk and portability of floppy disk.
- ⊙ Zip disk are of the same size as floppy disk, i.e., 3-½ inch but have a much higher capacity than the floppy disk (Figure 3.13).
- ⊙ Zip disk and drive were made by Iomega Corp. It comes as a complete unit—disk, drive, connection cable, power cord and operating system. It can be connected to the computer system externally using a parallel chord or SCSI cable.
- ⊙ Their capacity ranges from 100 MB to 750 MB. They can be used to store large files, audio and video data.

3.11 OPTICAL DISK

Optical disk (Figure 3.14) is a flat and circular disk which is coated with reflective plastic material that can be altered by laser light. Optical disk does not use magnetism. The bits 1 and 0 are stored as spots that are relatively bright and light, respectively.



Figure 3.14 Optical disk

- ⊙ An optical disk consists of a single spiral track that starts from the edge to the centre of disk. Due to its spiral shape, it can access large amount of data sequentially, for example music and video. The random access on optical disk is slower than that of magnetic disk, due to its spiral shape.
- ⊙ The tracks on optical disk are further divided into sectors which are of same length. Thus, the sectors near the centre of disk wrap around the disk longer than the sectors on the edges of disk. Reading the disk thus requires spinning the disk faster when reading near the centre and slower when reading near the edge of disk. Optical disks are generally slower than hard disks. Figure 3.15 shows the tracks and sectors in a magnetic disk and optical disk.

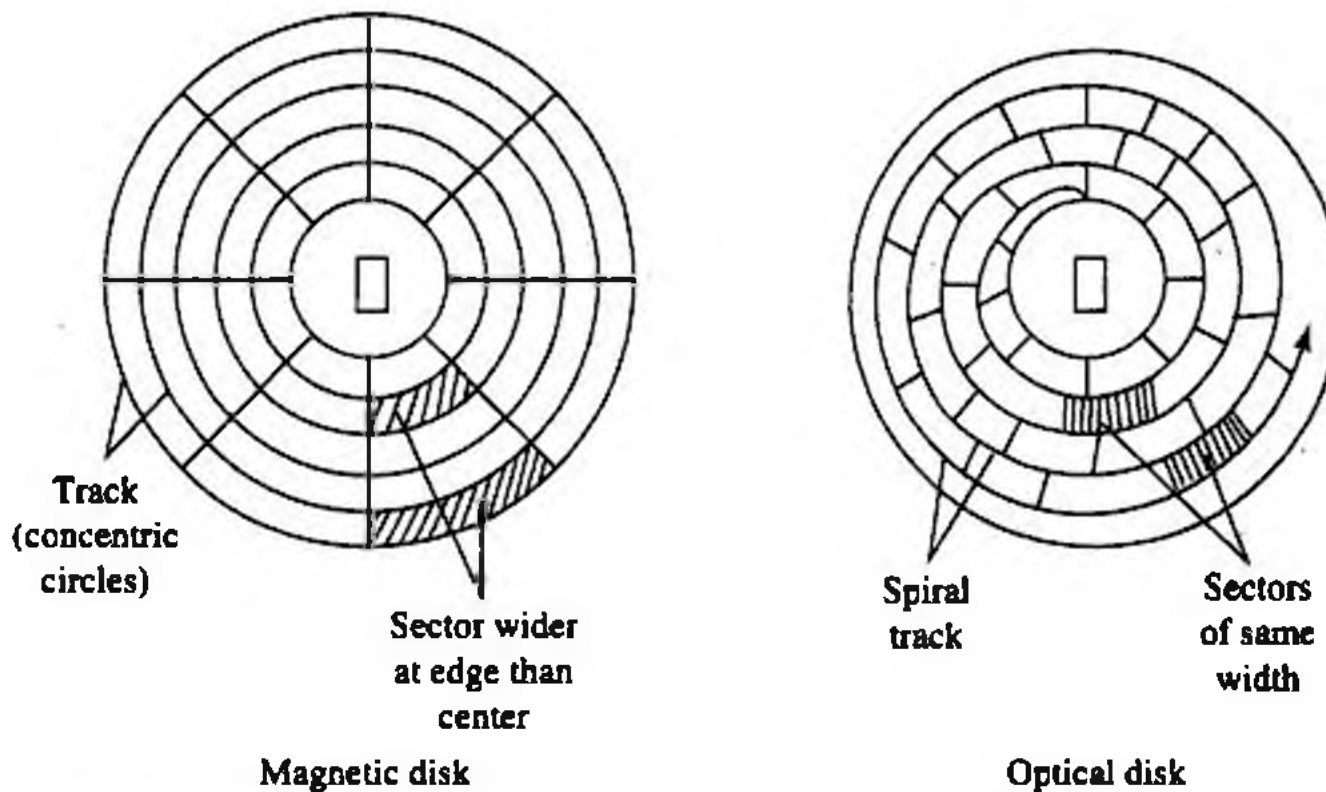


Figure 3.15 Sectors and track in magnetic disk and optical disk

- ⊙ Optical disks can store large amount of data, up to 6 GB, in a small space. Commonly used optical disks store 600–700 MB of data.
- ⊙ The access time for an optical disk ranges from 100 to 200 ms.
- ⊙ There are two most common categories of optical disks—read-only optical disks and recordable optical disks.

3.11.1 CD-ROM

- ⊙ Originally, Compact Disk (CD) was a popular medium for storing music. Now, it is used in computers to store data and is called Compact Disk-Read Only Memory (CD-ROM).
- ⊙ As the name suggests, CD-ROM (Figure 3.16) is an optical disk that can only be read and not written on. CD-ROM is written on by the manufacturer of the CD-ROM using the laser light.
- ⊙ A CD-ROM drive reads data from the compact disk. Data is stored as pits (depressions) and lands (flat area) on CD-ROM disk. When the laser light is focused on the disk, the pits scatter the light (interpreted as 0) and the lands reflect the light to a sensor (interpreted as 1).
- ⊙ As CD-ROM is read only, no changes can be made into the data contained in it.
- ⊙ Since there is no head touching the disk, but a laser light, CD-ROM does not get worn out easily.
- ⊙ The storage density of CD-ROM is very high and cost is low as compared to floppy disk and hard disk.
- ⊙ Access time of CD-ROM is less. CD-ROM drives can read data at 150Kbps. They come in multiples of this speed like—2x, 4x, 52x, 75x, etc.
- ⊙ It is a commonly used medium for distributing software and large data.

3.11.2 DVD-ROM

- ⊙ Digital Video Disk-Read Only Memory (DVD-ROM) is an optical storage device used to store digital video or computer data (Figure 3.17).
- ⊙ DVDs look like CDs, in shape and physical size.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.

user, have slow access, store the data and instructions that are not currently being used by CPU, and are cheapest among all memory. Magnetic disk and optical disk are storage devices.

- ⊙ *Organization of memory* with respect to the CPU, is as follows—registers are placed inside CPU, cache memory is placed inside CPU, primary memory is placed next in the hierarchy, and secondary memory is the farthest from CPU.
- ⊙ *Registers* are very high-speed storage areas located inside the CPU. Registers are manipulated directly by the control unit of the CPU during instruction execution.
- ⊙ *Cache*, the fast memory, is placed between the CPU and the RAM. The contents from the RAM are stored in the cache.
- ⊙ *RAM* stores data and instructions during the operation of computer. RAM is a random access volatile memory having limited size due to its high cost. RAM affects the speed and power of the computer.
- ⊙ *RAM memory chips* are of two types—DRAM and SRAM. DRAM is used as main memory as it is small and cheap. SRAM chip is used in cache memory due to its high speed.
- ⊙ *ROM* is a non-volatile primary memory which stores the data needed for the start up of the computer. Instructions to initialize different devices attached to computer and the bootstrap loader are stored in ROM. PROM, EPROM and EEPROM are some of the ROMs.
- ⊙ *Flash memory* is a kind of semiconductor-based non-volatile, rewritable computer memory. It is used in digital camera, mobile phone, printer, laptop computer, and MP3 players.
- ⊙ *Magnetic tapes* are inexpensive, can store a large amount of data, are easy to transport, are slow access device, and are suitable for back-up storage.
- ⊙ *Magnetic disks* are cheap storage device, can store a large amount of data, are easy to carry, are suitable for frequently read/write data and are fast access device. Access time of disk is the sum of seek time, latency time and time for data transfer.
- ⊙ *Floppy disk* is a flat, round, single disk enclosed in a jacket. It is portable, small, inexpensive and slower to access than hard disk. It comes in two basic sizes—5-¼ inch and 3-½ inch.
- ⊙ *Hard disk* is a fixed disk and can store much more data than floppy disk. Hard disk is the key secondary storage device of computer.
- ⊙ *Zip disk* have the speed and capacity of hard disk and portability of floppy disk.
- ⊙ *Optical disk* consists of a single spiral track that starts from the edge to the centre of disk. It can store large amount of data in small space.
- ⊙ *CD-ROM* is an optical disk that can only be read and not written on. It has high-storage density and is a low-cost device compared to floppy disk and hard disk.
- ⊙ *DVD-ROM* is a high-density optical storage device which stores data on both sides of the disk. It is used to store a full-length movie.
- ⊙ *Recordable optical disks* are CD-R, CD-RW and DVD-R.
- ⊙ *Computer uses its memory* from the time you switch on the computer till you switch it off.

KEYWORDS

Access time 40	Compact Disk - Read Only Memory (CD-ROM) 53	Digital Video Disk-Recordable (DVD-R) 55
Basic Input Output System (BIOS) 45	Compact Disk-Recordable (CD-R) 55	Direct Access 46
Bit 40	Compact Disk-ReWritable (CD-RW) 55	Dual Inline Memory Module (DIMM) 44
Boot sector 50	Complementary Metal-Oxide Semiconductor (CMOS) 45	Dynamic RAM (DRAM) 43
Bootstrap loader 45	Data Transfer Rate 49	Electrically Erasable Programmable ROM (EEPROM) 45
Byte 40	Digital Video Disk-Read Only Memory (DVD-ROM) 53	Erasable Programmable ROM (EPROM) 45
Cache Hit 42		File Allocation Table (FAT) 50
Cache memory 42		
Cache Miss 42		
Compact Disk (CD) 53		



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.

INPUT AND OUTPUT DEVICES

4

- ⊙ Input-output unit—Input unit, output unit
- ⊙ Input devices—Human data entry devices, source data entry devices
 - ⊙ Human data entry devices
 - Keyboard
 - Pointing devices—Mouse, trackball, joystick, digitizing tablet
 - Pick devices—Light pen, touch screen
 - ⊙ Source data entry devices
 - Audio input device (microphone, sound card, speech recognition)
 - Video input device (video camera, digital camera)
 - Optical input devices—Scanner (hand held, flat bed), OCR, MICR, OMR, barcode reader
- ⊙ Output devices—Hard copy devices, soft copy devices
 - ⊙ Hard copy devices
 - Printer—Impact printers (dot matrix, daisy wheel, drum), non-impact printers (ink-jet, laser)
 - Plotter—Drum plotter, flatbed plotter
 - Computer output on microfilm (microfiche)
 - ⊙ Soft copy devices—Monitor, visual display terminal, video output, audio response (speakers, headphone)
 - ⊙ I/O port—Parallel port, serial port, USB port, firewire port
 - ⊙ Working of I/O system—I/O devices, device controller, device driver



Why This Chapter

What is the use of the computer for us? We may want to process data, write project reports, listen to sound recordings, watch a movie and do many more things. But to do any of these things, we should be able to provide the data to the computer and also get the output from it. The input devices and output devices are used this purpose. The aim of this chapter is to introduce the different kinds of input and output devices.

4.1 INTRODUCTION

A computer interacts with the external environment via the input-output (I/O) devices attached to it. Input device is used for providing data and instructions to the computer. After processing the input data, computer provides output to the user via the output device. The I/O devices that are attached, externally, to the computer machine are also called *peripheral devices*. Different kinds of input and output devices are used for different kinds of input and output requirements. In this chapter, we shall discuss different kinds of input devices and output devices.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.

4.4.2 Pointing Devices

Pointing devices are used for providing the input to computer by moving the device to point to a location on computer monitor. The input data is not typed; instead, the data is entered by moving the pointing device. The cursor on the computer monitor moves with the moving pointing device. Operations like move, click and drag can be performed using the pointing devices. Mouse, trackball, joystick and digitizing tablet are some of the common pointing devices.

4.4.2.1 Mouse

Features It is the most common pointing input device. The data is entered by pointing the mouse to a location on the computer screen. The mouse may also be used to position the cursor on screen, move an object by dragging, or select an object by clicking. The key benefit of using a mouse is that the cursor moves with the mouse. So, the cursor can be positioned at any location on the screen by simply moving the mouse. Moreover, it provides an easy way to select and choose commands from menus, dialog boxes, icons, etc. Mouse is used extensively, while working with graphics elements such as line, curve, shapes, etc.

Description Mouse is a small hand-held device having two or three buttons on its upper side. In addition to the buttons, mouse also has a small wheel between the buttons. Figure 4.3 (i) shows a mouse. The wheel of the mouse is used for the up and down movement, for example, scrolling a long document. A mouse is classified as physical mouse or optical mouse.

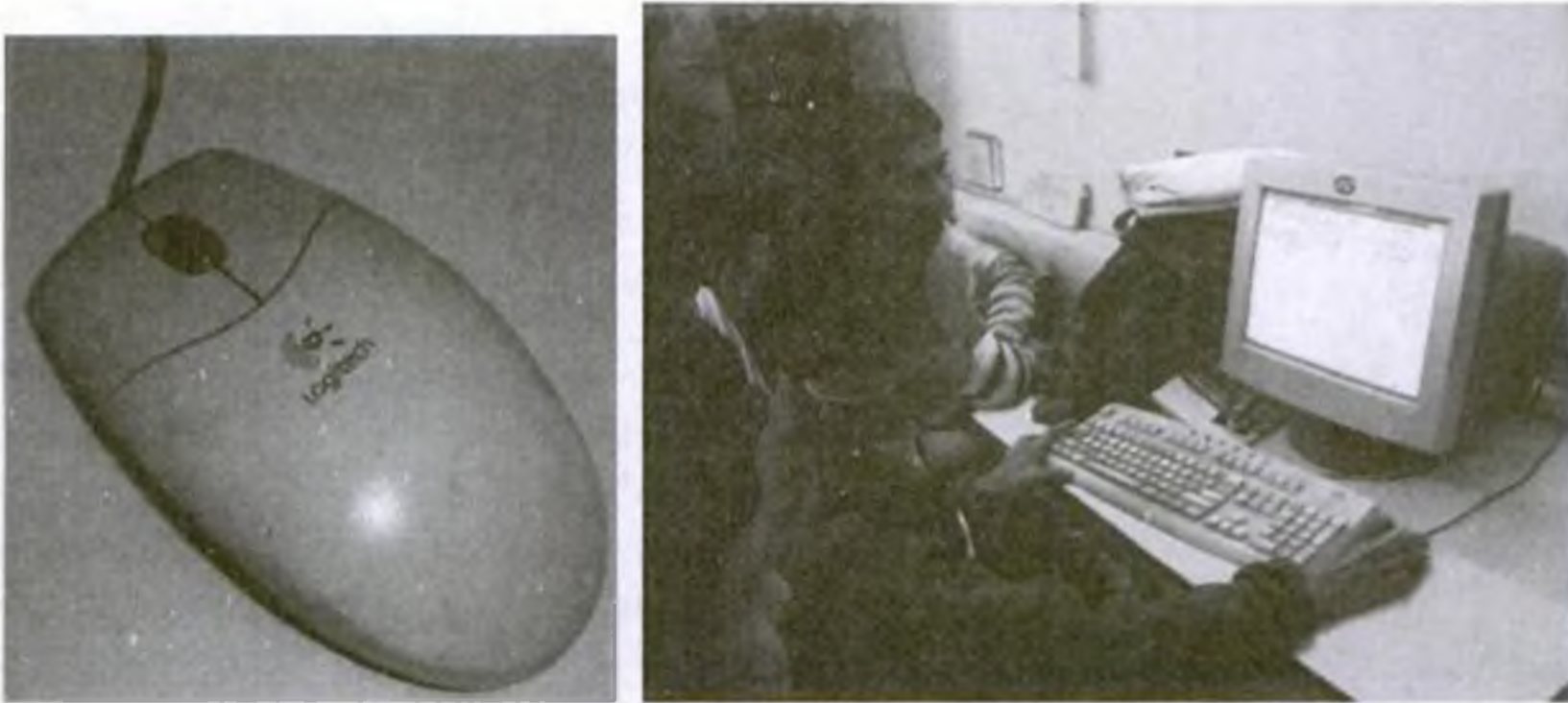


Figure 4.3 (i) Mouse, (ii) A user working with a mouse

Physical Mouse has a rubber ball on the bottom side that protrudes when the mouse is moved. It requires a smooth, dust free surface, such as a mouse pad, on which it is rolled.

Optical Mouse uses a Light Emitting Diode (LED) and a sensor to detect the movement of mouse. Optical mouse requires an opaque flat surface underneath it. Optical mouse was introduced by Microsoft in 1999. Optical mouse is better than physical mouse as there is no moving part that can cause wear and tear, and dirt cannot get inside it. A user is working with an optical mouse in Figure 4.3 (ii).

Working In a *physical mouse*, rollers and sensors are used to sense the direction and rate of movement of mouse. When the ball of mouse moves, the rollers sense the horizontal and vertical movement and



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.

generally used in applications like Automated Teller Machine (ATM), public information computers like hospitals, airline reservation, railway reservation, supermarkets, etc. (Figure 4.8).

Description Touch screen consists of a clear glass panel that is placed over the view area of computer screen. In addition to the glass panel with sensors, it has a device driver, and a controller that translates the information captured by the glass panel sensors to a form that the computer can understand.

Working Touch screens have an infrared beam that criss-cross the surface of screen. When a fingertip is touched on the screen, the beam is broken, and the location is recorded. Some touch screens have ultrasonic acoustic waves that cross the surface of screen. When a fingertip is touched on the screen, the wave is interrupted, and the location is recorded. The recorded location is sent to the computer via the controller of touch screen, in a form that the computer can understand.

4.5 SOURCE DATA ENTRY DEVICES

Source data entry devices are used for audio input, video input and to enter the source document directly to the computer. Source data entry devices do not require data to be typed-in, keyed-in or pointed to a particular location.

4.5.1 Audio Input Device

Audio input can be provided to the computer using human voice or speech. Audio input to the computer can be used for different purposes. It can be used for making telephone calls, for audio and video conferencing over Internet, to record voice, to create audio files and embed these files to be sent over e-mail, or, to translate spoken words into text, etc.

Audio input devices like a *microphone* is used to input a person's voice into the computer. A *sound card* (Figure 4.9 (i)) translates analog audio signals from microphone into digital codes that the computer can store and process. Sound card also translates back the digital sound into analog signals that can be sent to the speakers. Translating spoken words into text is also known as *speech recognition or voice recognition*. The audio input along with the software for voice recognition forms the speech recognition system or voice recognition system.

The computer can be operated using voice commands. The user can dictate the commands to the computer, instead of typing them. The computer has to be trained to recognize the voice of user using the speech patterns and pronunciation of words. The system thus adapts to the voice of user.

Speech recognition systems are costly and difficult to develop. They are generally used by people who have difficulty in typing, people with disabilities or by corporate world for dictation. Audio input can be recorded on an mp3 recorder and provided as an input to computer. Open source software like Audacity is used for recording and editing of audio files (Figure 4.9 (ii)).

4.5.2 Video Input Device

Video input is provided to the computer using *video camera and digital camera* (Figure 4.10). Video camera can capture full motion video images. The images are digitized and can be compressed and stored in the computer disk. Webcam is a common video camera device. It is placed on the computer above the screen to capture the images of the user who is working on the computer. A video capture card allows the user to connect video devices like camcorders to the computer.

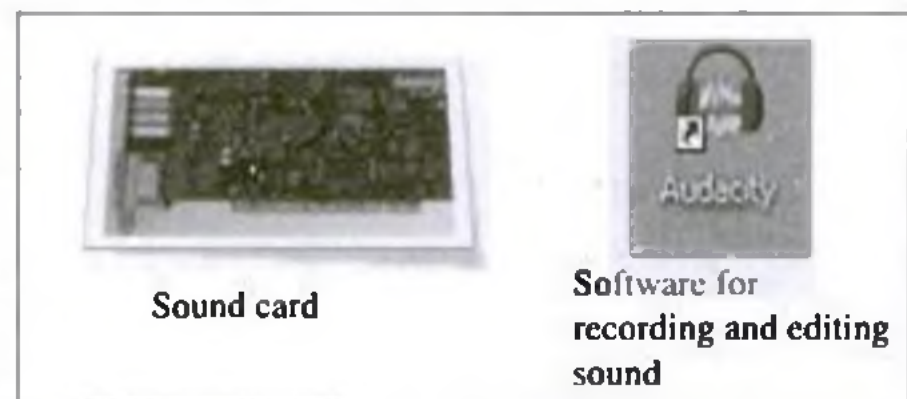


Figure 4.9 (i) Sound card, (ii) Audacity software



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.

(sharpness and clarity of print) of the printer is determined by the resolution of the printer. Resolution is measured in dots per inch (dpi). Printers with a high resolution (more dpi) provide better quality output. Different kinds of printers are available for different types of applications. Printers are classified into two categories—impact printer and non-impact printer.

Impact printers use the typewriter approach of physically striking a typeface against the paper and inked ribbon. Impact printers can print a character or an entire line at a time. Impact printers are low-cost printers useful for bulk printing. Dot matrix printers, daisy wheel printers and drum printers are examples of impact printers.

- ⊙ **Dot Matrix Printers** (Figure 4.17) print one character at a time. The speed of dot matrix printer lies between 200 and 600 characters per second (cps) and their resolution ranges from 72 to 360 dpi. Dot matrix printers normally come in two sizes—80 column printer and 132 column printer. Dot matrix printers can print alphanumeric characters, special characters, charts and graphs. They can print only in black and white. Some dot matrix printers can print in both directions - left to right and right to left. Dot matrix printers are commonly used for printing in applications like payroll and accounting.

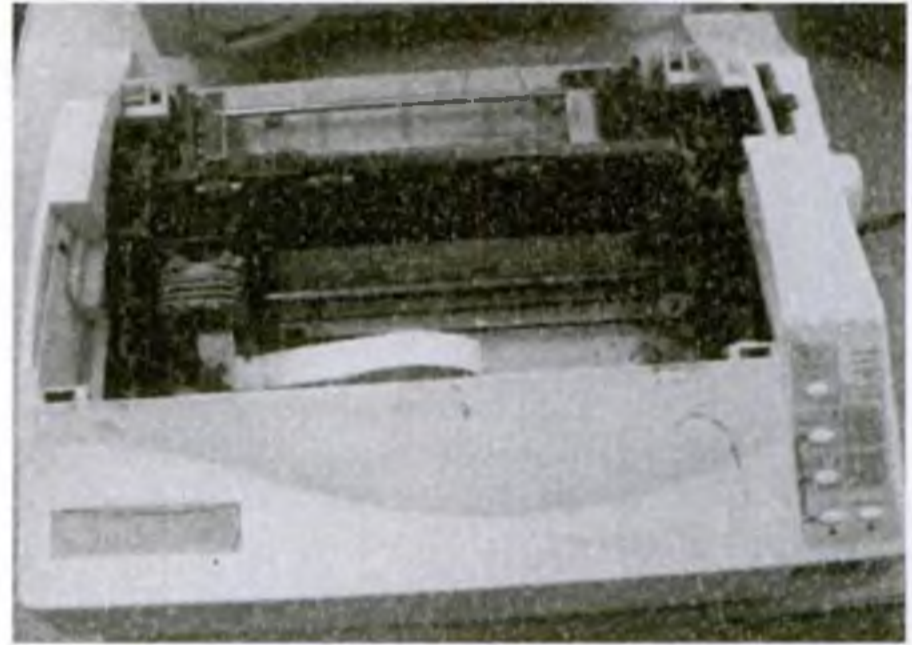


Figure 4.17 Dot matrix printer

- ⊙ **Daisy Wheel Printers** (Figure 4.18) print one character at a time. They produce letter quality document which is better than a document printed by a dot matrix printer. The speed of daisy wheel printers is about 100 cps. The print head of the printer is like a daisy flower, hence the name. These printers are slow, can only print text (not graphics), and are costly in comparison to dot matrix printers. Daisy wheel printers are used where high quality printing is needed and no graphics is needed.



Figure 4.18 Daisy wheel for printers

- ⊙ **Drum Printers** are line printers. They are expensive and faster than character printers but produce a low quality output. They can print 200–2500 lines per minute. Drum printers are generally used for voluminous print outputs.

Non-Impact Printers do not hit or impact a ribbon to print. They use electro-static chemicals and ink-jet technologies. Non-impact printers are faster and quieter than impact printers. They produce high quality output and can be used for printing text and graphics both in black and white, and color. Ink-jet printers and laser printers are non-impact printers.

- ⊙ **Ink-jet Printers** spray ink drops directly on the paper like a jet (Figure 4.19 (i)). Their resolution is more than 500 dpi. They produce high quality graphics and text. Ink-jet printers are commonly found in homes and offices.
- ⊙ **Laser Printers** (Figure 4.19 (ii)) provide highest quality of text and graphics printing. Laser printers process and store the entire page before printing and are also known as *page printers*. The laser printer can print 5-24 pages of text per minute and their resolution ranges from 400 to



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.

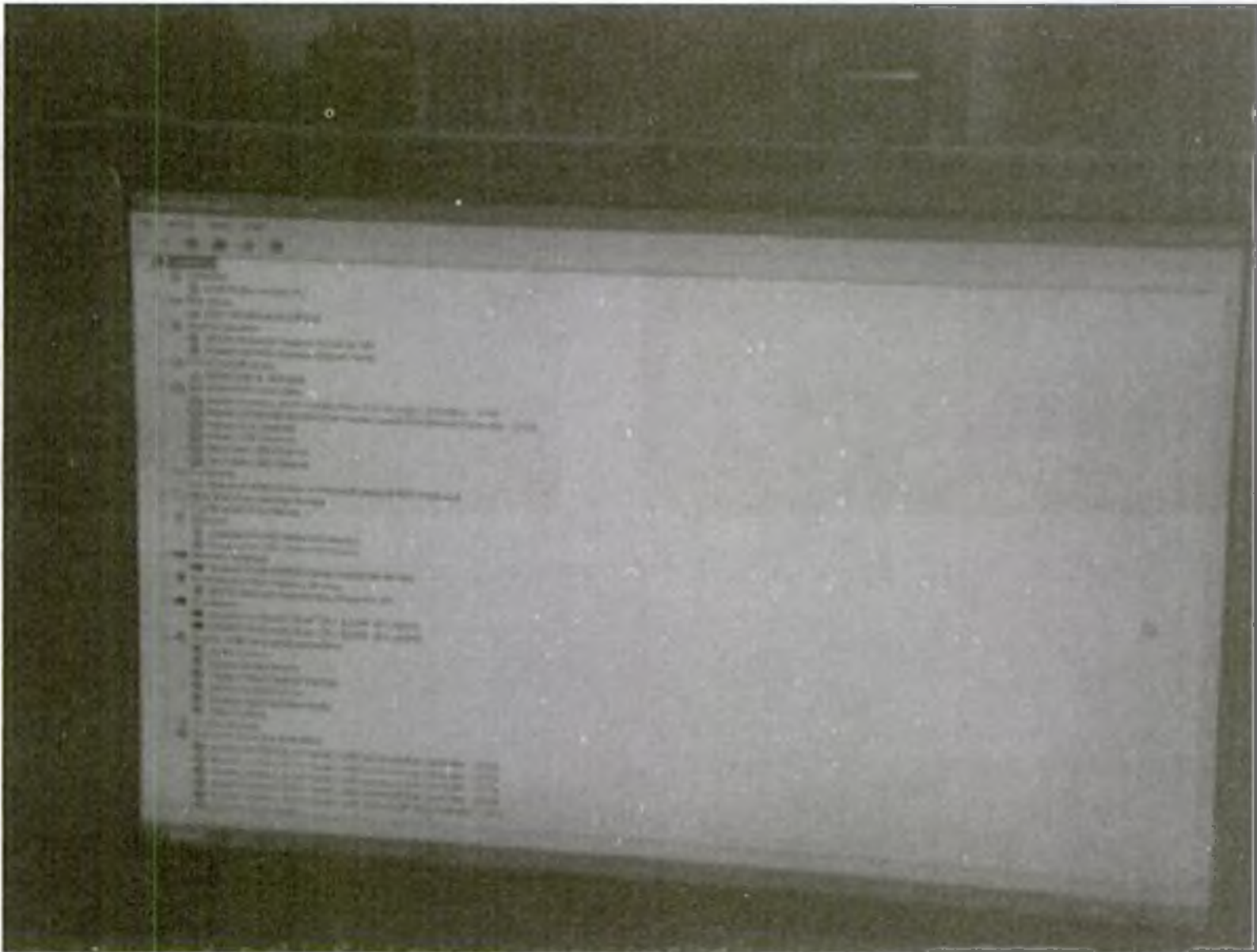


Figure 4.23 LCD monitor



Figure 4.24 A user viewing the output on a LCD monitor



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.

35. Name three optical scanner devices.
36. Why is a scanner used?
37. Describe hand-held scanners and flat-bed scanners.
38. What is the purpose of OCR software in optical character recognition?
39. An application where MICR is commonly used is _____.
40. Name an application of OMR.
41. How does optical character reader recognize characters?
42. How does magnetic ink character reader recognize the magnetic characters?
43. How does optical mark reader recognize marks?
44. What is the use of barcode reader?

Section 4.6–4.6.1.1

45. Dot Matrix printers come in two sizes—_____ column printer and _____ column printer.
46. The sharpness and clarity of print of the printer is determined by the _____ of printer.
47. Resolution of printer is measured in _____.
48. Describe a dot-matrix printer.
49. Describe a daisywheel printer.
50. Dot matrix and daisy wheel printers are character printer but drum printer is a _____ printer and laser printer is a _____ printer.
51. Describe non-impact printers.

Section 4.6.1.2–4.6.2.4

52. What is the use of a plotter?
53. Plotters are of two kinds—_____plotter and _____plotter.
54. Name two applications where plotters are used.
55. Define a microfilm.
56. When do we use a microfilm?
57. Give a description of the monitor.
58. Define the resolution of the screen.
59. Define the refresh rate of the screen.
60. Define the dot pitch of the screen.
61. The common resolution of computer screen is _____ and _____.

62. Describe the three factors on which the clarity of image on the computer screen depends.
63. Name the three factors on which the clarity of image on the computer screen depends.
64. Name some color adapters.
65. What is a visual display terminal?
66. Why are screen image projectors used?
67. Describe how the audio response system works.
68. Name two applications of audio response system.

Section 4.7–4.8

69. Name the different types of I/O ports.
70. Name at least one device each that can be connected to the serial port, parallel port, USB port, MIDI port and firewire.
71. Explain the working of the I/O system.
72. What is the purpose of ports, buses and controllers in the I/O system?
73. What is a device driver?
74. What is the use of the device driver?
75. Is device controller a hardware or software?
76. Is device driver a hardware or software?

Extra Questions

77. Give full form of the following abbreviations

(i) I/O	(ii) LED	(iii) CAD
(iv) ATM	(v) MICR	(vi) OMR
(vii) OCR	(viii) dpi	(ix) cps
(x) CAM	(xi) COM	(xii) CRT
(xiii) LCD	(xiv) VDT	(xv) USB
(xvi) MIDI		
78. Write short notes on

(a) Input-iutput unit	(b) Input Unit
(c) Output unit	(d) Keyboard
(e) Mouse	(f) Trackball
(g) Joystick	(h) Digitizing tablet
(i) Light pen	(j) Touch screen
(k) Input devices	(l) Audio input device
(m) Video input device	(n) Optical input devices
(o) Scanner	(p) MICR
(q) OMR	(r) OCR
(s) Printer	(t) Impact printers



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.

- ⊙ The position value and quantity of a digit at different positions in a number are as follows—

Position:	3	2	1	0	.	-1	-2	-3
Position Value:	10^3	10^2	10^1	10^0	.	10^{-1}	10^{-2}	10^{-3}
Quantity:	1000	100	10	1	.	1/10	1/100	1/1000

5.2.2 Binary Number System

- ⊙ The binary number system consists of two digits—0 and 1.
- ⊙ All binary numbers are formed using combination of 0 and 1. For example, 1001, 11000011 and 10110101.
- ⊙ The position value and quantity of a digit at different positions in a number are as follows—

Position:	3	2	1	0	.	-1	-2	-3
Position Value:	2^3	2^2	2^1	2^0	.	2^{-1}	2^{-2}	2^{-3}
Quantity:	8	4	2	1	.	1/2	1/4	1/8

5.2.3 Octal Number System

- ⊙ The octal number system consists of eight digits—0 to 7.
- ⊙ All octal numbers are represented using these eight digits. For example, 273, 103, 2375, etc.
- ⊙ The position value and quantity of a digit at different positions in a number are as follows—

Position:	3	2	1	0	.	-1	-2	-3
Position Value:	8^3	8^2	8^1	8^0	.	8^{-1}	8^{-2}	8^{-3}
Quantity:	512	64	8	1	.	1/8	1/64	1/512

5.2.4 Hexadecimal Number System

- ⊙ The hexadecimal number system consists of sixteen digits—0 to 9, A, B, C, D, E, F, where (A is for 10, B is for 11, C-12, D-13, E-14, F-15).
- ⊙ All hexadecimal numbers are represented using these 16 digits. For example, 3FA, 87B, 113, etc.
- ⊙ The position value and quantity of a digit at different positions in a number are as follows—

Position:	3	2	1	0	.	-1	-2	-3
Position Value:	16^3	16^2	16^1	16^0	.	16^{-1}	16^{-2}	16^{-3}
Quantity:	4096	256	16	1	.	1/16	1/256	1/4096

Table 5.1 summarizes the base, digits and largest digit for the above discussed number systems. Table 5.2 shows the binary, octal and hexadecimal equivalents of the decimal numbers 0–16.

	Base	Digits	Largest Digit
Decimal	10	0–9	9
Binary	2	0,1	1
Octal	8	0–7	7
Hexadecimal	16	0–9, A, B, C, D, E, F	F (15)

Table 5.1 Summary of number system



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.

- (3) Record the non-fractional part of the resulting number.
- (4) Repeat the above steps at least four times.
- (5) Write the digits in the non-fractional part starting from *upwards to downwards*.

Example 5: Convert 0.2345 from Base 10 to Base 2.

$$\begin{array}{r}
 0.2345 \\
 \underline{\times 2} \\
 0.4690 \\
 \\
 .4690 \\
 \underline{\times 2} \\
 0.9380 \\
 \\
 .9380 \\
 \underline{\times 2} \\
 1.8760 \\
 \\
 .8760 \\
 \underline{\times 2} \\
 1.7520 \\
 \\
 .7520 \\
 \underline{\times 2} \\
 1.5040 \\
 \\
 .5040 \\
 \underline{\times 2} \\
 1.0080
 \end{array}$$

The binary equivalent of $(0.2345)_{10}$ is $(0.001111)_2$

Example 5a: Convert 0.865 from Base 10 to Base 2, 8 and 16.

$$\begin{array}{r}
 0.865 \\
 \underline{\times 2} \\
 1.730 \\
 \underline{\times 2} \\
 1.460 \\
 \underline{\times 2} \\
 0.920 \\
 \underline{\times 2} \\
 1.840 \\
 \underline{\times 2} \\
 1.680 \\
 \underline{\times 2} \\
 1.360
 \end{array}$$

$$\begin{array}{r}
 0.865 \\
 \underline{\times 8} \\
 6.920 \\
 \underline{\times 8} \\
 7.360 \\
 \underline{\times 8} \\
 2.880 \\
 \underline{\times 8} \\
 7.040
 \end{array}$$

The octal equivalent of $(0.865)_{10}$ is $(.6727)_8$

$$\begin{array}{r}
 0.865 \\
 \underline{\times 16} \\
 5190 \\
 \underline{865 \times} \\
 13.840 \\
 \underline{\times 16} \\
 5040 \\
 \underline{840 \times} \\
 13.440 \\
 \underline{\times 16} \\
 2640 \\
 \underline{440 \times} \\
 7.040
 \end{array}$$

The binary equivalent of $(.865)_{10}$ is $(.110111)_2$

The number 13 in hexadecimal is D.

The hexadecimal equivalent of $(0.865)_{10}$ is $(.DD7)_{16}$



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.



You have either reached a page that is unavailable for viewing or reached your viewing limit for this book.

Computer Fundamentals

Anita Goel

Any undergraduate course, irrespective of the streams—commerce, humanities, management, science or engineering—cannot be completed without a basic understanding of computers. This book has been written keeping in mind the requirements of this vast audience. The language used in the book is lucid, simple and reader-friendly so that a novice can easily comprehend underlying concepts in computing. Logical organization of the chapters, step-by-step presentation of the concepts, illustrations, flow charts, photographs (both color and black-and-white) and chapter-end exercises makes the book a perfect choice for an introductory course.



CONTEMPORARY IN COVERAGE

- Windows Vista and Windows 7
- Flash, SIMM and DIMM Memory
- Wireless Networking
- Notebook, Netbook and Smartphones
- Aspect Oriented Programming (AOP)
- Digital Signature and Biometrics



EXCLUSIVE AND EXHAUSTIVE CHAPTERS

- Information Systems
- Fundamentals of Databases
- Computer Security
- MS Access and LaTeX
- Network and Internet Connections



PRACTICE WHILE YOU LEARN

- Creating MP3 Files from an Audio CD
- Assembling a PC
- Working with MS Office 2007



SUPPLEMENTS FOR SUPPORT

- Lecture Slides
- Solution Manual
- mQuest

Anita Goel is Associate Professor, Department of Computer Science, Dyal Singh College, University of Delhi. She has teaching experience of over two decades. She is guiding several students for their doctoral studies, and has several national and international research publications to her credit. She has been appointed as Fellow for Computer Science, Institute of Life Long Learning (ILLL), at the University of Delhi.

mQuest

PEARSON

Online resources available at

www.pearsoned.co.in/anitagael

ISBN 978-81-317-3309-7



9 788131 733097

www.pearsoned.co.in