

CONTENTS

PREFACE xlivi

CHAPTER 1: WELCOME TO LINUX 1

The History of UNIX and GNU–Linux	2
The Heritage of Linux: UNIX	2
Fade to 1983	3
Next Scene, 1991	4
The Code Is Free	5
Linux Is More Than a Kernel	6
Open-Source Software and Licensing	6
What Is So Good About Linux?	7
Overview of Linux	11
Linux Has a Kernel Programming Interface	11
Linux Can Support Many Users	12
Linux Can Run Many Tasks	12
Linux Provides a Secure Hierarchical Filesystem	12
The Shell: Command Interpreter and Programming Language	13
X Window System	15
GUIs: Graphical User Interfaces	16
A Large Collection of Useful Utilities	18
Interprocess Communication	18
(Inter)Networking Utilities	18
System Administration	19
Software Development	19
Choosing an Operating System	19
Chapter Summary	21
Exercises	21

PART I INSTALLING UBUNTU LINUX 23

CHAPTER 2: INSTALLATION OVERVIEW 25

Conventions Used in This Book	26
LPI and CompTIA Certification Icons	28
More Information	29
Planning the Installation	30
Considerations	30
Requirements	30
Processor Architecture	32
Interfaces: Installer and Installed System	33
Gathering Information About the System	34
Ubuntu Releases, Editions, and Derivatives	35
Ubuntu Releases	35
Ubuntu Standard Editions: Desktop and Server Images	35
Ubuntu Derivatives	37
Setting Up the Hard Disk	38
Primary, Extended, and Logical Partitions	39
The Linux Directory Hierarchy	40
Mount Points	40
Partitioning a Disk	41
RAID	45
LVM: Logical Volume Manager	46
Downloading an Image File and Burning/Writing the Installation Medium	47
The Easy Way to Download an Installation Image File	47
Other Ways to Download an Installation Image File	48
Verifying an Installation Image File	51
Burning a DVD	52
Writing to a USB Flash Drive	52
Chapter Summary	53
Exercises	54
Advanced Exercises	54

CHAPTER 3: STEP-BY-STEP INSTALLATION 55

Booting Ubuntu and Running a Live Session	56
Automatic Boot Sequence	56
Displaying the Boot Menu	57
Running a Live Session	59
Basic Installation	59
Installing from a Live Session	60
Installing from the Desktop Boot Menu	61
The ubiquity Graphical Installer	61

The ubiquity Advanced Partitioning Screen	67
Initializing Databases and Updating the System	70
Advanced Installation	71
The Boot Menus	72
Modifying Boot Parameters (Options)	75
Rescue Mode: Rescuing a Broken System	77
debian-installer: The Ubuntu Textual Installer	78
gnome-disks: The GNOME Disk Utility	88
Setting Up a Dual-Boot System	91
Chapter Summary	93
Exercises	94
Advanced Exercises	94

PART II USING UBUNTU LINUX 95

CHAPTER 4: INTRODUCTION TO UBUNTU 97

Curbing Your Power: root Privileges/ sudo	98
Logging In on the System	99
The Unity Desktop	100
Installing the GNOME Flashback Desktop	103
Working with the Unity Desktop	104
Terminology	105
The Dash and the Run a Command Window	106
Context Menus	106
Windows	106
Cutting and Pasting Objects Using the Clipboard	107
Logging Out	108
Using the Nautilus File Manager	108
The Nautilus File Browser Window	109
The Sidebar	109
Opening Files	110
Selecting Objects	110
The Object Properties Window	111
The System Settings Window	113
Desktop Appearance	115
Displays	116
Mouse & Touchpad	116
Time & Date	117
User Accounts: Changing Your Account Type and Password (GUI)	118
Getting Help	118
The Ubuntu Desktop Guide	118
Using the Internet to Get Help	119

Installing, Removing, and Updating Software Packages	121
Software & Updates Window	122
Updating Software	123
Adding and Removing Software	124
Installing Other Desktop Environments	124
Working from the Command Line	125
Running Commands from the Command Line	126
The Shell	128
Running Basic Command-Line Utilities	132
Writing and Executing a Basic Shell Script	134
Getting Help from the Command Line	135
More About Logging In and Passwords	142
What to Do If You Cannot Log In	142
Password Security	143
passwd: Changing Your Password (CLI)	144
Chapter Summary	145
Exercises	146
Advanced Exercises	147

CHAPTER 5: THE SHELL 149

Special Characters	150
Ordinary Files and Directory Files	151
The Working Directory	151
Your Home Directory	151
The Command Line	152
A Simple Command	152
Syntax	152
Simple Commands	155
Processing the Command Line	156
Executing a Command	158
Editing the Command Line	159
Standard Input and Standard Output	159
The Screen as a File	160
The Keyboard and Screen as Standard Input and Standard Output	160
Redirection	161
Pipelines	166
Lists	170
Running a Command in the Background	171
Moving a Job from the Foreground to the Background	172
kill: Aborting a Background Job	172
Filename Generation/Pathname Expansion	173
The ? Special Character	173

The * Special Character	174
The [] Special Characters	176
Builtins	178
Chapter Summary	178
Utilities and Builtins Introduced in This Chapter	179
Exercises	179
Advanced Exercises	181

CHAPTER 6: THE LINUX FILESYSTEM 183

The Hierarchical Filesystem	184
Ordinary Files and Directory Files	185
Filenames	186
Pathnames	189
Absolute Pathnames	189
Relative Pathnames	190
Working with Directories	191
mkdir: Creates a Directory	192
cd: Changes to Another Working Directory	193
rmdir: Deletes a Directory	194
Using Pathnames	195
mv, cp: Move or Copy Files	195
mv: Moves a Directory	196
Important Standard Directories and Files	197
Access Permissions	199
ls -l: Displays Permissions	199
chmod: Changes File Access Permissions	201
chown: Changes File Ownership	203
chgrp: Changes File Group Association	203
Setuid and Setgid Permissions	204
Directory Access Permissions	205
ACLs: Access Control Lists	206
Enabling ACLs	207
Working with Access Rules	207
Setting Default Rules for a Directory	210
Links	211
Hard Links	212
Symbolic Links	214
rm: Removes a Link	216
Chapter Summary	217
Exercises	219
Advanced Exercises	220

CHAPTER 7: THE LINUX UTILITIES 223

Basic Utilities 224

- cat: Joins and Displays Files 224
- date: Displays the System Time and Date 226
- echo: Displays Arguments 227
- hostname: Displays the System Name 227
- less Is more: Display a Text File One Screen at a Time 228
- ls: Displays Information About Files 229
- rm: Removes a File (Deletes a Link) 231

Working with Files 232

- cp: Copies Files 232
- cut: Selects Characters or Fields from Input Lines 233
- diff: Displays the Differences Between Two Text Files 235
- file: Displays the Classification of a File 237
- find: Finds Files Based on Criteria 237
- grep: Searches for a Pattern in Files 240
- head: Displays the Beginning of a File 243
- lpr: Sends Files to Printers 243
- mv: Renames or Moves a File 245
- sort: Sorts and/or Merges Files 247
- tail: Displays the Last Part of a File 249
- touch: Changes File Modification and Access Times 251
- wc: Displays the Number of Lines, Words, and Bytes in Files 252

Compressing and Archiving Files 253

- xz, bzip2, and gzip: Compress and Decompress Files 253
- tar: Stores or Extracts Files to/from an Archive File 257

Displaying User and System Information 260

- free: Displays Memory Usage Information 261
- uptime: Displays System Load and Duration Information 261
- w: Lists Users on the System 262
- who: Lists Users on the System 262

Miscellaneous Utilities 263

- which and whereis: Locate a Utility 263
- locate: Searches for a File 264
- script: Records a Shell Session 265
- tr: Replaces Specified Characters 266
- unix2dos: Converts Linux Files to Windows and Macintosh Format 268
- xargs: Converts Standard Input to Command Lines 268

Editing Files 270

- Tutorial: Using vim to Create and Edit a File 270
- Tutorial: Using nano to Create and Edit a File 277

Chapter Summary 280

Exercises 282

Advanced Exercises 283

CHAPTER 8: NETWORKING AND THE INTERNET 285

Introduction to Networking	286
Types of Networks and How They Work	288
Broadcast Networks	288
Point-to-Point Networks	289
Switched Networks	289
LAN: Local Area Network	290
WAN: Wide Area Network	293
Internetworking Through Gateways and Routers	293
Network Protocols	296
IPv4	298
IPv6	299
Host Address	302
CIDR: Classless Inter-Domain Routing	306
Hostnames	306
Communicate over a Network	307
Mailing List Servers	307
Network Utilities	308
Trusted Hosts	308
OpenSSH Tools	309
telnet: Logs In on a Remote System	309
ftp: Transfers Files over a Network	311
ping: Tests a Network Connection	311
traceroute: Traces a Route over the Internet	312
host and dig: Query Internet Nameservers	313
whois: Looks Up Information About an Internet Site	314
Distributed Computing	315
The Client/Server Model	315
DNS: Domain Name Service	316
Ports	318
NIS: Network Information Service	319
NFS: Network Filesystem	319
Network Services	319
Common Daemons	320
Proxy Servers	322
RPC Network Services	323
WWW: World Wide Web	325
Browsers	326
Search Engines	326
URL: Uniform Resource Locator	326
Chapter Summary	327
Exercises	328
Advanced Exercises	328

PART III SYSTEM ADMINISTRATION 331

CHAPTER 9: THE BOURNE AGAIN SHELL (bash) 333

Background	334
Startup Files	335
Login Shells	336
Interactive Nonlogin Shells	336
Noninteractive Shells	337
Setting Up Startup Files	337
.(Dot) or source: Runs a Startup File in the Current Shell	338
Commands That Are Symbols	339
Redirecting Standard Error	339
Writing and Executing a Shell Script	342
chmod: Makes a File Executable	343
#! Specifies a Shell	344
# Begins a Comment	346
Executing a Shell Script	346
Control Operators: Separate and Group Commands	347
; and NEWLINE Separate Commands	347
and & Separate Commands and Do Something Else	348
&& and Boolean Control Operators	349
() Groups Commands	350
\ Continues a Command	351
Job Control	352
jobs: Lists Jobs	352
fg: Brings a Job to the Foreground	353
Suspending a Job	354
bg: Sends a Job to the Background	354
Manipulating the Directory Stack	355
dirs: Displays the Stack	355
pushd: Pushes a Directory on the Stack	356
popd: Pops a Directory off the Stack	357
Parameters and Variables	358
User-Created Variables	359
Variable Attributes	362
Keyword Variables	364
Special Characters	372
Locale	374
LC_: Locale Variables	374
locale: Displays Locale Information	375
Time	377
Processes	379
Process Structure	379

Process Identification	380
Executing a Command	381
History	382
Variables That Control History	383
Reexecuting and Editing Commands	384
The Readline Library	392
Aliases	398
Single Versus Double Quotation Marks in Aliases	399
Examples of Aliases	400
Functions	402
Controlling <code>bash</code> : Features and Options	404
<code>bash</code> Command-Line Options	405
Shell Features	405
Processing the Command Line	409
History Expansion	410
Alias Substitution	410
Parsing and Scanning the Command Line	410
Command-Line Expansion	410
Chapter Summary	420
Exercises	421
Advanced Exercises	423

CHAPTER 10: SYSTEM ADMINISTRATION: CORE CONCEPTS 425

The Upstart Event-Based <code>init</code> Daemon	427
Software Package	428
Terminology	428
Jobs	430
SysVinit (<code>rc</code>) Scripts: Start and Stop System Services	435
System Operation	437
Runlevels	438
Booting the System	438
Going to Graphical Multiuser Mode	439
Logging In	440
Logging Out	441
Bringing the System Down	441
Crash	443
Using Loadable Kernel Modules	444
GRUB: The Linux Boot Loader	444
Terminology	445
Configuring GRUB	445
<code>grub-mkconfig</code> : Generates the <code>grub.cfg</code> File	449
<code>grub-install</code> : Installs the MBR and GRUB Files	450

Recovery (Single-User) Mode	450
Booting the System to Recovery (Single-User) Mode	451
Textual System Administration Utilities	454
Setting Up a Server	460
Standard Rules in Configuration Files	461
rpcinfo : Displays Information About rpcbind	463
DHCP: Configures Network Interfaces	464
How DHCP Works	465
DHCP Client	465
DHCP Server	466
nsswitch.conf : Which Service to Look at First	468
Information	469
Methods	469
Search Order	469
Action Items	470
compat Method: ± in passwd , group , and shadow Files	471
X Window System	471
Starting X from a Character-Based Display	472
Remote Computing and Local Displays	472
Stopping the X Server	475
Remapping Mouse Buttons (CLI)	475
Getting Help	476
Chapter Summary	477
Exercises	478
Advanced Exercises	478

CHAPTER 11: FILES, DIRECTORIES, AND FILESYSTEMS 479

Important Files and Directories	480
File Types	493
Ordinary Files, Directories, Links, and Inodes	493
Device Special Files	494
Filesystems	497
mount : Mounts a Filesystem	499
umount : Unmounts a Filesystem	501
du : Displays Disk Usage Information	501
fstab : Keeps Track of Filesystems	502
fsck : Checks Filesystem Integrity	503
tune2fs : Changes Filesystem Parameters	504
The XFS Filesystem	506
Chapter Summary	507
Exercises	508
Advanced Exercises	508

CHAPTER 12: FINDING, DOWNLOADING, AND INSTALLING SOFTWARE 509

Introduction	510
JumpStart: Installing and Removing Software Packages Using apt-get	512
Finding the Package That Holds an Application or File You Need	514
APT: Keeps the System Up to Date	515
Repositories	515
sources.list: Specifies Repositories for APT to Search	516
The APT Local Package Indexes and the APT Cache	518
The apt cron Script and APT Configuration Files	518
apt-get: Works with Packages and the Local Package Index	519
apt-cache: Displays Package Information	522
apt-get source: Downloads Source Files	523
dpkg: The Debian Package Management System	524
deb Files	524
dpkg: The Foundation of the Debian Package Management System	526
BitTorrent	531
Prerequisites	531
transmission-cli: Downloading a BitTorrent File	532
Installing Non-dpkg Software	533
The /opt and /usr/local Directories	534
GNU Configure and Build System	534
Keeping Software Up to Date	535
Bugs	535
curl: Downloads Files Noninteractively	536
Chapter Summary	536
Exercises	537
Advanced Exercises	537

CHAPTER 13: PRINTING WITH CUPS 539

Introduction	540
Prerequisites	541
More Information	541
Notes	542
The System Configures a Local Printer Automatically	542
JumpStart I: Configuring a Printer Using system-config-printer	542
Configuration Tabs	543
JumpStart II: Setting Up a Local or Remote Printer	544
Working with the CUPS Web Interface	548

Configuring Printers	549
Modifying a Printer	549
Using the CUPS Web Interface	550
CUPS on the Command Line	551
Sharing CUPS Printers	555
Traditional UNIX Printing	557
Printing from Windows	558
Printing Using CUPS	558
Printing Using Samba	559
Printing to Windows	560
Chapter Summary	560
Exercises	561
Advanced Exercises	561

CHAPTER 14: ADMINISTRATION TASKS 563

Configuring User and Group Accounts	564
unity-control-center: Manages User Accounts	564
Managing User Accounts from the Command Line	566
Backing Up Files	568
Choosing a Backup Medium	569
Backup Utilities	569
Performing a Simple Backup	572
Scheduling Tasks	573
cron and anacron: Schedule Routine Tasks	573
at: Runs Occasional Tasks	576
System Reports	576
vmstat: Reports Virtual Memory Statistics	576
top: Lists Processes Using the Most Resources	577
Maintaining the System	578
timedatectl: Reports on and Sets the System Clock	579
parted: Reports on and Partitions a Hard Disk	579
logrotate: Manages Log Files	582
rsyslogd: Logs System Messages	585
Solving Problems	587
Chapter Summary	593
Exercises	594
Advanced Exercises	594

CHAPTER 15: SYSTEM SECURITY 595

Running Commands with root Privileges	596
Administrator	596
The Special Powers of a User Working with root Privileges	596

Gaining root Privileges	597
Real UID Versus Effective UID	599
Using su to Gain root Privileges	600
Using sudo to Gain root Privileges	602
Unlocking the root Account (Assigning a Password to root)	613
Avoiding a Trojan Horse	613
Passwords	615
Securing a Server	616
TCP Wrappers	616
Setting Up a chroot Jail	617
PAM	621
Cryptography	626
Features	626
Terminology	627
Encrypting a Message	627
Cryptographic Hash Functions	632
Signing a Message Using a Hash Value	636
SSL Certificates	637
GPG (GNU Privacy Guard)	641
Tutorial: Using GPG to Secure a File	641
gpg-agent: Holds Your Private Keys	648
Make Your Communication More Secure	648
Encrypting and Decrypting a File	649
Signing and Encrypting a File	650
Signing a Key on Your Keyring	651
Using a Keyserver	652
Security Resources	656
Chapter Summary	659
Exercises	660
Advanced Exercises	660

CHAPTER 16: CONFIGURING AND MONITORING A LAN 661

More Information	662
Setting Up the Hardware	662
Connecting the Computers	662
Routers	663
NIC: Network Interface Card	664
Tools	664
Configuring the Systems	666
NetworkManager: Configures Network Connections	667
The NetworkManager Applet Menu	668
Setting Up Servers	672

Introduction to Cacti	674
Configuring SNMP	675
Setting Up LAMP	675
Prerequisites	675
Configuring MySQL	676
Setting Up Cacti	677
Configuring Cacti	678
Basic Cacti Administration	680
Setting Up a Data Source	681
Chapter Summary	683
Exercises	684
Advanced Exercises	685

CHAPTER 17: SETTING UP VIRTUAL MACHINES LOCALLY AND IN THE CLOUD 687

VMs (Virtual Machines)	688
Implementations	690
gnome-boxes	690
QEMU/KVM	691
Prerequisites	692
virt-manager: Installing Ubuntu on QEMU/KVM	693
virsh: Work with VMs on the Command Line	697
VMware Player: Installing Ubuntu on VMware	698
Installing VMware Player on a Linux System	699
Installing VMware Player on a Windows System	700
Installing Ubuntu on VMware Player	700
Cloud Computing	703
AWS: Setting Up a Virtual System in the Cloud	704
Chapter Summary	708
Exercises	709
Advanced Exercises	709

PART IV USING CLIENTS AND SETTING UP SERVERS 711

CHAPTER 18: THE OPENSSH SECURE COMMUNICATION UTILITIES 713

Introduction to OpenSSH	714
Files	714
More Information	716
Running the ssh, scp, and sftp OpenSSH Clients	716
Prerequisites	716

JumpStart I: Using ssh and scp to Connect to an OpenSSH Server	716
Configuring OpenSSH Clients	717
ssh: Logs in or Executes Commands on a Remote System	720
scp: Copies Files to and from a Remote System	723
sftp: A Secure FTP Client	725
<code>~/.ssh/config</code> and <code>/etc/ssh/ssh_config</code> Configuration Files	726
Setting Up an OpenSSH Server (<code>sshd</code>)	727
Prerequisites	727
Note	728
JumpStart II: Starting an OpenSSH Server	728
Authorized Keys: Automatic Login	728
Randomart Image	730
ssh-agent: Holds Your Private Keys	731
Command-Line Options	732
<code>/etc/ssh/sshd_config</code> Configuration File	732
Troubleshooting	735
Tunneling/Port Forwarding	735
Forwarding X11	736
Port Forwarding	737
Chapter Summary	738
Exercises	739
Advanced Exercises	739

CHAPTER 19: THE rsync SECURE COPY UTILITY 741

Syntax	742
Arguments	742
Options	742
Notes	744
More Information	745
Examples	745
Using a Trailing Slash (/) on <i>source-file</i>	745
Removing Files	746
Copying Files to and from a Remote System	748
Mirroring a Directory	748
Making Backups	749
Restoring a File	752
Chapter Summary	752
Exercises	752

CHAPTER 20: FTP: TRANSFERRING FILES ACROSS A NETWORK 753

Introduction to FTP	754
Security	754
FTP Connections	755
FTP Clients	755
More Information	755
Notes	756

Running the <code>ftp</code> and <code>sftp</code> FTP Clients	756
Prerequisites	756
JumpStart I: Downloading Files Using <code>ftp</code>	756
Anonymous FTP	759
Automatic Login	760
Binary Versus ASCII Transfer Mode	760
<code>ftp</code> Specifics	761
Setting Up an FTP Server (<code>vsftpd</code>)	764
Prerequisites	764
Notes	765
JumpStart II: Starting a <code>vsftpd</code> FTP Server	765
Troubleshooting	765
Configuring a <code>vsftpd</code> Server	766
Chapter Summary	777
Exercises	778
Advanced Exercises	778

CHAPTER 21: **postfix**: SETTING UP MAIL SERVERS, CLIENTS, AND MORE 779

Overview	780
Mailboxes: <code>mbox</code> Versus <code>maildir</code> Format	780
Protocols: IMAP and POP3	781
Introduction to <code>postfix</code>	781
Outbound Email	782
Inbound Email	782
The <code>postfix</code> to <code>sendmail</code> Compatibility Interface	782
Alternatives to <code>postfix</code>	783
More Information	783
Setting Up a <code>postfix</code> Mail Server	784
Prerequisites	784
Notes	784
Testing <code>postfix</code>	785
<code>postfix</code> Log Files	786
JumpStart: Configuring <code>postfix</code> to Use Gmail as a Smarthost	787
Configuring <code>postfix</code>	789
The <code>/etc/mailname</code> File	789
The <code>/etc/postfix/main.cf</code> File	789
<code>postfix</code> Lookup Tables	793
The <code>/etc/postfix/master.cf</code> File	794
Aliases and Forwarding	794
<code>dpkg-reconfigure</code> : Reconfigures <code>postfix</code>	796

SpamAssassin	797
How SpamAssassin Works	797
Prerequisites	797
Testing SpamAssassin	798
Configuring SpamAssassin	799
Additional Email Tools	801
Webmail	801
Mailing Lists	804
dovecot: Setting Up an IMAP or POP3 Mail Server	807
Prerequisites	807
Notes	808
Testing dovecot	808
Chapter Summary	810
Exercises	811
Advanced Exercises	812

CHAPTER 22: NIS AND LDAP 813

Introduction to NIS	814
How NIS Works	814
More Information	816
Running an NIS Client	817
Prerequisites	817
Notes	818
Configuring an NIS Client	818
Troubleshooting an NIS Client	820
yppasswd: Changes NIS Passwords	821
Setting Up an NIS Server	822
Prerequisites	823
Notes	823
Configuring an NIS Server	824
Troubleshooting an NIS Server	829
yppasswd: The NIS Password Update Daemon	830
Introduction to LDAP	830
More Information	833
Setting Up an LDAP Server	833
Prerequisites	833
Notes	834
Test the Server	834
Modifying and Adding Directory Entries	834
Using Thunderbird with LDAP	838
Chapter Summary	839
Exercises	840
Advanced Exercises	840

CHAPTER 23: NFS: SHARING DIRECTORY HIERARCHIES 843

Introduction to NFS	845
More Information	847
Running an NFS Client	847
Prerequisites	847
JumpStart I: Mounting a Remote Directory Hierarchy	848
mount: Mounts a Directory Hierarchy	849
Improving Performance	852
/etc/fstab: Mounts Directory Hierarchies Automatically	853
Setting Up an NFS Server	853
Prerequisites	853
Notes	854
JumpStart II: Configuring an NFS Server Using shares-admin	855
Manually Exporting a Directory Hierarchy	857
Where the System Keeps NFS Mount Information	860
exportfs: Maintains the List of Exported Directory Hierarchies	861
Troubleshooting	862
automount: Mounts Directory Hierarchies on Demand	863
Chapter Summary	866
Exercises	867
Advanced Exercises	867

CHAPTER 24: SAMBA: LINUX AND WINDOWS FILE AND PRINTER SHARING 869

Introduction to Samba	870
More Information	871
Notes	871
Samba Users, User Maps, and Passwords	871
smbpasswd and pdbedit: Work with Samba Users and Passwords	873
Running Samba Clients	874
Prerequisites	874
Working with Shares from Linux	874
Working with Shares from Windows	877
Setting Up a Samba Server	878
Prerequisites	878
JumpStart: Configuring a Samba Server Using shares-admin	879
smb.conf: Manually Configuring a Samba Server	880
Troubleshooting	887
Chapter Summary	889
Exercises	890
Advanced Exercises	890

CHAPTER 25: DNS/BIND: TRACKING DOMAIN NAMES AND ADDRESSES 891

Introduction to DNS 892	
Nodes, Domains, and Subdomains 893	
Zones 895	
Queries 896	
Servers 896	
Resource Records 897	
DNS Queries and Responses 901	
Reverse Name Resolution 902	
How DNS Works 903	
More Information 904	
Setting Up a DNS Server 904	
Prerequisites 904	
Notes 905	
JumpStart: Setting Up a DNS Cache 906	
Configuring a DNS Server 907	
named.conf : The named Configuration File 907	
Zone Files 910	
Setting Up a DNS Cache 911	
DNS Glue Records 914	
TSIGs: Transaction Signatures 915	
Running BIND in a chroot Jail 917	
Troubleshooting 919	
Chapter Summary 920	
Exercises 921	
Advanced Exercises 921	

CHAPTER 26: ufw, gufw, AND iptables: SETTING UP A FIREWALL 923

ufw: The Uncomplicated Firewall 924	
gufw: The Graphical Interface to ufw 927	
The Firewall Window 927	
Adding Rules 928	
Introduction to iptables 932	
More Information 935	
Prerequisites 935	
Notes 935	
Anatomy of an iptables Command 936	
Building a Set of Rules Using iptables 937	
Commands 938	
Packet Match Criteria 939	
Display Criteria 940	
Match Extensions 940	
Targets 942	

Copying Rules to and from the Kernel	944
Sharing an Internet Connection Using NAT	945
Connecting Several Clients to a Single Internet Connection	946
Connecting Several Servers to a Single Internet Connection	948
Chapter Summary	948
Exercises	949
Advanced Exercises	949

CHAPTER 27: APACHE (**apache2**): SETTING UP A WEB SERVER 951

Introduction	952
More Information	952
Notes	953
Running an Apache Web Server	954
Prerequisites	954
JumpStart: Getting Apache Up and Running	955
Configuring Apache	957
Filesystem Layout	959
Configuration Directives	961
Directives You Might Want to Modify as You Get Started	962
Contexts and Containers	966
Advanced Configuration Directives	971
Advanced Configuration	984
Redirects	984
Content Negotiation	985
Server-Generated Directory Listings (Indexing)	986
Virtual Hosts	986
Troubleshooting	990
Modules	991
mod_cgi and CGI Scripts	992
mod_ssl	992
Authentication Modules and .htaccess Files	994
Scripting Modules	995
Multiprocessing Modules (MPMs)	996
webalizer : Analyzes Web Traffic	997
Error Codes	997
Chapter Summary	998
Exercises	998
Advanced Exercises	999

PART V PROGRAMMING TOOLS 1001

CHAPTER 28: PROGRAMMING THE BOURNE AGAIN SHELL (bash) 1003

Control Structures	1004
if...then	1005
if...then...else	1009
if...then...elif	1011
for...in	1017
for	1019
while	1021
until	1025
break and continue	1027
case	1028
select	1034
Here Document	1036
File Descriptors	1038
Opening a File Descriptor	1039
Duplicating a File Descriptor	1039
File Descriptor Examples	1039
Determining Whether a File Descriptor Is Associated with the Terminal	1042
Parameters	1044
Positional Parameters	1044
Special Parameters	1049
Variables	1053
Shell Variables	1053
Environment, Environment Variables, and Inheritance	1054
Expanding Null and Unset Variables	1058
Array Variables	1060
Variables in Functions	1061
Builtin Commands	1062
type : Displays Information About a Command	1063
read : Accepts User Input	1063
exec : Executes a Command or Redirects File Descriptors	1067
trap : Catches a Signal	1069
kill : Aborts a Process	1072
eval : Scans, Evaluates, and Executes a Command Line	1073
getopts : Parses Options	1074
A Partial List of Builtins	1077
Expressions	1078
Arithmetic Evaluation	1078

Logical Evaluation (Conditional Expressions)	1079
String Pattern Matching	1080
Arithmetic Operators	1081
Implicit Command-Line Continuation	1085
Shell Programs	1086
A Recursive Shell Script	1087
The <code>quiz</code> Shell Script	1090
Chapter Summary	1096
Exercises	1098
Advanced Exercises	1100

CHAPTER 29: THE PYTHON PROGRAMMING LANGUAGE 1103

Introduction	1104
Invoking Python	1104
More Information	1106
Writing to Standard Output and Reading from Standard Input	1107
Functions and Methods	1107
Scalar Variables, Lists, and Dictionaries	1108
Scalar Variables	1108
Lists	1109
Dictionaries	1113
Control Structures	1114
if	1115
if...else	1115
if...elif...else	1116
while	1117
for	1117
Reading from and Writing to Files	1119
File Input and Output	1119
Exception Handling	1120
Pickle	1122
Regular Expressions	1123
Defining a Function	1124
Using Libraries	1125
Standard Library	1125
Nonstandard Libraries	1125
SciPy and NumPy Libraries	1126
Namespace	1126
Importing a Module	1127
Example of Importing a Function	1128
Lambda Functions	1129

List Comprehensions	1130
Chapter Summary	1131
Exercises	1132
Advanced Exercises	1132

CHAPTER 30: THE MARIADB SQL DATABASE MANAGEMENT SYSTEM 1135

History	1136
Notes	1136
Terminology	1137
Syntax and Conventions	1138
More Information	1139
Installing a MariaDB Server	1140
Client Options	1140
Setting Up MariaDB	1141
Assigning a Password to the MariaDB User Named <code>root</code>	1141
Removing Anonymous Users	1141
Running the Secure Installation Script	1142
<code>~/.my.cnf</code> : Configures a MariaDB Client	1142
<code>~/.mysql_history</code> : Stores Your MariaDB History	1142
Creating a Database	1143
Adding a User	1144
Examples	1145
Logging In	1145
Creating a Table	1145
Adding Data	1147
Retrieving Data	1148
Backing Up a Database	1150
Modifying Data	1150
Creating a Second Table	1151
Joins	1152
Chapter Summary	1157
Exercises	1157
Advanced Exercises	1157

PART VI APPENDICES 1159

APPENDIX A: REGULAR EXPRESSIONS	1161
Characters	1162
Delimiters	1162

Simple Strings	1162
Special Characters	1162
Periods	1163
Brackets	1163
Asterisks	1164
Caret and Dollar Signs	1164
Quoting Special Characters	1165
Rules	1165
Longest Match Possible	1165
Empty Regular Expressions	1166
Bracketing Expressions	1166
The Replacement String	1166
Ampersand	1167
Quoted Digit	1167
Extended Regular Expressions	1167
Appendix Summary	1169

APPENDIX B: HELP 1171

Solving a Problem	1172
Finding Linux-Related Information	1173
Desktop Applications	1173
Programming Languages	1174
Linux Newsgroups	1174
Mailing Lists	1175
Specifying a Terminal	1175

APPENDIX C: KEEPING THE SYSTEM UP TO DATE USING yum 1177

Installing and Removing Software Packages Using yum	1178
Working with yum	1179
Finding the Package That Holds a File You Need	1179
Updating Packages	1180
yum Commands	1181
yum.conf: Configures yum	1182
yum Repositories	1182

APPENDIX D: LPI AND COMPTIA CERTIFICATION 1183

More Information	1184
Linux Essentials	1184
Topic 1: The Linux Community and a Career in Open Source	1184

Topic 2: Finding Your Way on a Linux System	1187
Topic 3: The Power of the Command Line	1190
Topic 4: The Linux Operating System	1192
Topic 5: Security and File Permissions	1195
Certification Exam 1 Objectives: LX0-101	1198
101 System Architecture	1198
102 Linux Installation and Package Management	1200
103 GNU and Unix Commands	1203
104 Devices, Linux Filesystems, Filesystem Hierarchy Standard	1210
Certification Exam 2 Objectives: LX0-102	1214
105 Shells, Scripting and Data Management	1214
106 User Interfaces and Desktops	1217
107 Administrative Tasks	1218
108 Essential System Services	1221
109 Networking Fundamentals	1223
110 Security	1226
GLOSSARY	1231
JUMPSTART INDEX	1285
FILE TREE INDEX	1287
UTILITY INDEX	1291
MAIN INDEX	1297

