CONTENTS

Online	Resources	11
Omme	1/c20n1/c2	_11

Preface 12

Notation 18

About the Authors 19

Chapter 0	Reader's and Instructor's Guide 21
0.1	Outline of this Book 22
0.2	A Roadmap for Readers and Instructors 22
0.3	Support for CISSP Certification 23
0.4	Support for NSA/DHS Certification 25
0.5	Support for ACM/IEEE Computer Society Computer Science Curricula 2013 26
0.6	Internet and Web Resources 28
0.7	Standards 29
Chapter 1	Overview 31
1.1	Computer Security Concepts 32
1.2	Threats, Attacks, and Assets 39
1.3	Security Functional Requirements 45
1.4	Fundamental Security Design Principles 47
1.5	Attack Surfaces and Attack Trees 51
1.6	Computer Security Strategy 54
1.7	Recommended Reading 56
1.8	Key Terms, Review Questions, and Problems 57

PART ONE COMPUTER SECURITY TECHNOLOGY AND PRINCIPLES 60

Chapter 2	Cryptographic Tools 60
2.1	Confidentiality with Symmetric Encryption 61
2.2	Message Authentication and Hash Functions 67
2.3	Public-Key Encryption 75
2.4	Digital Signatures and Key Management 80
2.5	Random and Pseudorandom Numbers 84
2.6	Practical Application: Encryption of Stored Data 86
2.7	Recommended Reading 87
2.8	Key Terms, Review Questions, and Problems 88
Chapter 3	User Authentication 92
3.1	Electronic User Authentication Principles 94
3.2	Password-Based Authentication 98
3.3	Token-Based Authentication 110
3.4	Biometric Authentication 116
3.5	Remote User Authentication 120

6 CONTENTS

3.6	Security Issues for User Authentication 123
3.7	Practical Application: An Iris Biometric System 125
3.8	Case Study: Security Problems for ATM Systems 127
3.9	Recommended Reading 130
3.10	Key Terms, Review Questions, and Problems 130
Chapter 4	Access Control 133
4.1	Access Control Principles 134
4.2	Subjects, Objects, and Access Rights 137
4.3	Discretionary Access Control 138
4.4	Example: UNIX File Access Control 144
4.5	Role-Based Access Control 147
4.6	Attribute-Based Access Control 153
4.7	Identity, Credential, and Access Management 159
4.8	Trust Frameworks 163
4.9	Case Study: RBAC System for a Bank 167
4.10	Recommended Reading 170
4.11	Key Terms, Review Questions, and Problems 171
Chapter 5	Database and Cloud Security 175
5.1	The Need for Database Security 176
5.2	Database Management Systems 177
5.3	Relational Databases 179
5.4	SQL Injection Attacks 183
5.5	Database Access Control 189
5.6	Inference 193
5.7	Database Encryption 196
5.8	Cloud Computing 200
5.9	Cloud Security Risks and Countermeasures 207
5.10	Data Protection in the Cloud 209
5.11	Cloud Security as a Service 209
5.12	Recommended Reading 213
5.13	Key Terms, Review Questions, and Problems 214
Chapter 6	Malicious Software 219
6.1	Types of Malicious Software (Malware) 220
6.2	Advanced Persistent Threat 223
6.3	Propagation—Infected Content—Viruses 224
6.4	Propagation—Vulnerability Exploit—Worms 230
6.5	Propagation—Social Engineering—Spam E-Mail, Trojans 238
6.6	Payload—System Corruption 241
6.7	Payload—Attack Agent—Zombie, Bots 242
6.8	Payload—Information Theft—Keyloggers, Phishing, Spyware 24
6.9	Payload—Stealthing—Backdoors, Rootkits 246
6.10	Countermeasures 249
6.11	Recommended Reading 255
6.12	Key Terms, Review Questions, and Problems 256

Chapter 7	Denial-of-Service Attacks 260
7.1	Denial-of-Service Attacks 261
7.2	Flooding Attacks 268
7.3	Distributed Denial-of-Service Attacks 270
7.4	Application-Based Bandwidth Attacks 272
7.5	Reflector and Amplifier Attacks 274
7.6	Defenses Against Denial-of-Service Attacks 279
7.7	Responding to a Denial-of-Service Attack 283
7.8	Recommended Reading 284
7.9	Key Terms, Review Questions, and Problems 284
Chapter 8	Intrusion Detection 287
8.1	Intruders 288
8.2	Intrusion Detection 292
8.3	Analysis Approaches 295
8.4	Host-Based Intrusion Detection 298
8.5	Network-Based Intrusion Detection 303
8.6	Distributed or Hybrid Intrusion Detection 309
8.7	Intrusion Detection Exchange Format 311
8.8	Honeypots 314
8.9	Example System: Snort 316
8.10	Recommended Reading 320
8.11	Key Terms, Review Questions, and Problems 320
Chapter 9	Firewalls and Intrusion Prevention Systems 324
9.1	The Need for Firewalls 325
9.2	Firewall Characteristics and Access Policy 326
9.3	Types of Firewalls 328
9.4	Firewall Basing 334
9.5	Firewall Location and Configurations 337
9.6	Intrusion Prevention Systems 342
9.7	Example: Unified Threat Management Products 346
9.8	Recommended Reading 350
9.9	Key Terms, Review Questions, and Problems 351
PART TWO	O SOFTWARE SECURITY AND TRUSTED SYSTEMS 356
	Buffer Overflow 356
_	Stack Overflows 358
10.1	Defending Against Buffer Overflows 379
10.2	Other Forms of Overflow Attacks 385
10.3	Recommended Reading 392
10.5	Key Terms, Review Questions, and Problems 392
	Software Security 395
11.1	Software Security Issues 396
11.1	Handling Program Input 400
11.4	Tanding Togram input 700

8 CONTENTS

11.3	Writing Safe Program Code 412
11.4	Interacting with the Operating System and Other Programs 416
11.5	Handling Program Output 429
11.6	Recommended Reading 431
11.7	Key Terms, Review Questions, and Problems 432
Chapter 12	Operating System Security 436
12.1	Introduction to Operating System Security 438
12.2	System Security Planning 439
12.3	Operating Systems Hardening 439
12.4	Application Security 444
12.5	Security Maintenance 445
12.6	Linux/Unix Security 446
12.7	Windows Security 450
12.8	Virtualization Security 452
12.9	Recommended Reading 456
12.10	Key Terms, Review Questions, and Problems 457
Chapter 13	Trusted Computing and Multilevel Security 459
13.1	The Bell-LaPadula Model for Computer Security 460
13.2	Other Formal Models for Computer Security 470
13.3	The Concept of Trusted Systems 476
13.4	Application of Multilevel Security 479
13.5	Trusted Computing and the Trusted Platform Module 485
13.6	Common Criteria for Information Technology Security Evaluation 489
13.7	Assurance and Evaluation 495
13.8 13.9	Recommended Reading 500 Voy Tarms Provings and Problems 501
13.9	Key Terms, Review Questions, and Problems 501
PART THE	REE MANAGEMENT ISSUES 505
Chapter 14	IT Security Management and Risk Assessment 505
14.1	IT Security Management 506
14.2	Organizational Context and Security Policy 509
14.3	Security Risk Assessment 512
14.4	Detailed Security Risk Analysis 515
14.5	Case Study: Silver Star Mines 527
14.6	Recommended Reading 532
14.7	Key Terms, Review Questions, and Problems 533
_	IT Security Controls, Plans, and Procedures 535
15.1	IT Security Management Implementation 536
15.2	Security Controls or Safeguards 536
15.3	IT Security Plan 544
15.4	Implementation of Controls 545
15.5	Monitoring Risks 546
15.6	Case Study: Silver Star Mines 549
15.7	Recommended Reading 552
15.8	Key Terms, Review Questions, and Problems 552

Chapter 16	Physical and Infrastructure Security 554
16.1	Overview 555
16.2	Physical Security Threats 556
16.3	Physical Security Prevention and Mitigation Measures 563
16.4	Recovery From Physical Security Breaches 566
16.5	Example: A Corporate Physical Security Policy 566
16.6	Integration of Physical and Logical Security 567
16.7	Recommended Reading 573
16.8	Key Terms, Review Questions, and Problems 574
Chapter 17	Human Resources Security 576
17.1	Security Awareness, Training, and Education 577
17.2	Employment Practices and Policies 583
17.3	E-Mail and Internet Use Policies 586
17.4	Computer Security Incident Response Teams 587
17.5	Recommended Reading 594
17.6	Key Terms, Review Questions, and Problems 595
Chapter 18	Security Auditing 597
18.1	Security Auditing Architecture 599
18.2	Security Audit Trail 604
18.3	Implementing the Logging Function 608
18.4	Audit Trail Analysis 620
18.5	Example: An Integrated Approach 624
18.6	Recommended Reading 627
18.7	Key Terms, Review Questions, and Problems 628
Chapter 19	Legal and Ethical Aspects 630
19.1	Cybercrime and Computer Crime 631
19.2	Intellectual Property 635
19.3	Privacy 641
19.4	Ethical Issues 646
19.5	Recommended Reading 653
19.6	Key Terms, Review Questions, and Problems 654
PART FOU	UR CRYPTOGRAPHIC ALGORITHMS 657
Chapter 20	Symmetric Encryption and Message Confidentiality 657
-	Symmetric Encryption Principles 658
20.2	Data Encryption Standard 663
20.3	Advanced Encryption Standard 665
20.4	Stream Ciphers and RC4 671
20.5	Cipher Block Modes of Operation 675
20.6	Location of Symmetric Encryption Devices 680
20.7	Key Distribution 682
20.8	Recommended Reading 684
20.9	Key Terms, Review Questions, and Problems 684

Chapter 21	Public-Key Cryptography and Message Authentication 689
21.1	Secure Hash Functions 690
21.2	HMAC 695
21.3	The RSA Public-Key Encryption Algorithm 699
21.4	Diffie-Hellman and Other Asymmetric Algorithms 704
21.5	Recommended Reading 709
21.6	Key Terms, Review Questions, and Problems 709
PART FIV	E NETWORK SECURITY 713
Chapter 22	Internet Security Protocols and Standards 713
22.1	Secure E-Mail and S/MIME 714
22.2	DomainKeys Identified Mail 717
22.3	Secure Sockets Layer (SSL) and Transport Layer Security (TLS) 720
22.4	HTTPS 727
22.5	IPv4 and IPv6 Security 728
22.6	Recommended Reading 734
22.7	Key Terms, Review Questions, and Problems 734
Chapter 23	Internet Authentication Applications 737
23.1	Kerberos 738
23.2	X.509 744
23.3	Public-Key Infrastructure 747
23.4	Recommended Reading 749
23.5	Key Terms, Review Questions, and Problems 750
Chapter 24	Wireless Network Security 753
24.1	Wireless Security 754
24.2	Mobile Device Security 757
24.3	IEEE 802.11 Wireless LAN Overview 761
24.4	IEEE 802.11i Wireless LAN Security 767
24.5	Recommended Reading 782
24.6	Key Terms, Review Questions, and Problems 783
Appendix A Projects and Other Student Exercises for Teaching Computer Security 785	
A.1	Hacking Project 785
A.2	Laboratory Exercises 786
A.3	Security Education (SEED) Projects 786
A.4	Research Projects 788
A.5	Programming Projects 789
A.6 A.7	Practical Security Assessments 789 Firewall Projects 789
A.7 A.8	Case Studies 790
A.9	Reading/Report Assignments 790
A.10	Writing Assignments 790
A.11	Webcasts for Teaching Computer Security 791
Acronyms	,
-	
References	/93

Index 811 Credits 835