CONTENTS

Online Resources x

Preface xi			Multiprocessor and Multicore 77
About the Author xix		2.7	Microsoft Windows Overview 80
		2.8	Traditional UNIX Systems 90
Chapter 0	Reader's and Instructor's	2.9	Modern UNIX Systems 92
	Guide 1	2.10	Linux 94
0.1	Outline of this Book 2	2.11	Linux VServer Virtual Machine
0.2	Example Systems 2		Architecture 100
0.3	A Roadmap for Readers and	2.12	Recommended Reading and Web
	Instructors 3		Sites 101
0.4	Internet and Web Resources 4	2.13	Key Terms, Review Questions, and Problems 103
PART 1 B.	ACKGROUND 7		
Chapter 1	Computer System	PART 2 PROCESSES 106	
1	Overview 7	Chapter 3	Process Description and
1.1	Basic Elements 8	-	Control 106
1.2	Evolution of the	3.1	What Is a Process? 108
1.2	Microprocessor 10	3.2	Process States 110
1.3	Instruction Execution 11	3.3	Process Description 126
1.4	Interrupts 14	3.4	Process Control 134
1.5	The Memory Hierarchy 24	3.5	Execution of the Operating
1.6	Cache Memory 27		System 140
1.7	Direct Memory Access 31	3.6	Security Issues 143
1.8	Multiprocessor and Multicore	3.7	UNIX SVR4 Process
	Organization 33		Management 147
1.9	Recommended Reading and	3.8	Summary 152
	Web Sites 36	3.9	Recommended Reading 152
1.10	Key Terms, Review Questions,	3.10	Key Terms, Review Questions, and
	and Problems 37		Problems 153
1 A	Performance Characteristics of Two-Level Memories 39	Chapter 4	Threads 157
		4.1	Processes and Threads 158
Chapter 2	Operating System	4.2	Types of Threads 164
	Overview 46	4.3	Multicore and Multithreading 171
2.1	Operating System Objectives and	4.4	Windows 7 Thread and SMP
	Functions 48		Management 176
2.2	The Evolution of Operating	4.5	Solaris Thread and SMP
	Systems 52		Management 182
2.3	Major Achievements 62	4.6	Linux Process and Thread
2.4	Developments Leading to Modern		Management 186
	Operating Systems 71	4.7	Mac OS X Grand Central
2.5	Virtual Machines 74		Dispatch 189

2.6

OS Design Considerations for

Multiprocessor and Multicore 77

4.8	Summary 192	7.3	Paging 321
4.9	Recommended Reading 192	7.4	Segmentation 325
4.10	Key Terms, Review Questions, and	7.5	Security Issues 326
	Problems 193	7.6	Summary 330
Chapter 5	Concurrency: Mutual Exclu-	7.7	Recommended Reading 330
•	sion and Synchronization 198	7.8	Key Terms, Review Questions, and
5.1	Principles of Concurrency 201	7A	Problems 331
5.2	Mutual Exclusion: Hardware		Loading and Linking 334
	Support 209	Chapter 8	Virtual Memory 340
5.3	Semaphores 213	8.1	Hardware and Control
5.4	Monitors 226		Structures 341
5.5	Message Passing 233	8.2	Operating System Software 360
5.6	Readers/Writers Problem 239	8.3	UNIX and Solaris Memory
5.7	Summary 243		Management 379
5.8	Recommended Reading 244	8.4	Linux Memory Management 384
5.9	Key Terms, Review Questions,	8.5	Windows Memory
	and Problems 245		Management 386
Chapter 6	Concurrency: Deadlock and	8.6	Summary 389
	Starvation 258	8.7	Recommended Reading and Web
6.1	Principles of Deadlock 259		Sites 390
6.2	Deadlock Prevention 268	8.8	Key Terms, Review Questions,
6.3	Deadlock Avoidance 270		and Problems 391
6.4	Deadlock Detection 276	DADT 4 SC	CHEDITING 205
6.4 6.5	Deadlock Detection 276 An Integrated Deadlock		CHEDULING 395
6.4 6.5	An Integrated Deadlock	PART 4 SC Chapter 9	CHEDULING 395 Uniprocessor Scheduling 395
	An Integrated Deadlock Strategy 278		
6.5	An Integrated Deadlock Strategy 278 Dining Philosophers Problem 279	Chapter 9	Uniprocessor Scheduling 395
6.5	An Integrated Deadlock Strategy 278	Chapter 9 9.1	Uniprocessor Scheduling 395 Types of Processor Scheduling 396
6.5	An Integrated Deadlock Strategy 278 Dining Philosophers Problem 279 UNIX Concurrency Mechanisms 281	Chapter 9 9.1 9.2	Uniprocessor Scheduling 395 Types of Processor Scheduling 396 Scheduling Algorithms 400
6.5 6.6 6.7	An Integrated Deadlock Strategy 278 Dining Philosophers Problem 279 UNIX Concurrency	Chapter 9 9.1 9.2	Uniprocessor Scheduling 395 Types of Processor Scheduling 396 Scheduling Algorithms 400 Traditional UNIX Scheduling 422 Summary 424
6.5 6.6 6.7	An Integrated Deadlock Strategy 278 Dining Philosophers Problem 279 UNIX Concurrency Mechanisms 281 Linux Kernel Concurrency Mechanisms 285	Chapter 9 9.1 9.2 9.3	Uniprocessor Scheduling 395 Types of Processor Scheduling 396 Scheduling Algorithms 400 Traditional UNIX Scheduling 422 Summary 424 Recommended Reading 425
6.5 6.6 6.7 6.8	An Integrated Deadlock Strategy 278 Dining Philosophers Problem 279 UNIX Concurrency Mechanisms 281 Linux Kernel Concurrency	Chapter 9 9.1 9.2 9.3	Uniprocessor Scheduling 395 Types of Processor Scheduling 396 Scheduling Algorithms 400 Traditional UNIX Scheduling 422 Summary 424 Recommended Reading 425 Key Terms, Review Questions,
6.5 6.6 6.7 6.8	An Integrated Deadlock Strategy 278 Dining Philosophers Problem 279 UNIX Concurrency Mechanisms 281 Linux Kernel Concurrency Mechanisms 285 Solaris Thread Synchronization	9.1 9.2 9.3 9.4 9.5	Uniprocessor Scheduling 395 Types of Processor Scheduling 396 Scheduling Algorithms 400 Traditional UNIX Scheduling 422 Summary 424 Recommended Reading 425
6.5 6.6 6.7 6.8 6.9	An Integrated Deadlock Strategy 278 Dining Philosophers Problem 279 UNIX Concurrency Mechanisms 281 Linux Kernel Concurrency Mechanisms 285 Solaris Thread Synchronization Primitives 292	Chapter 9 9.1 9.2 9.3 9.4 9.5 9.6	Uniprocessor Scheduling 395 Types of Processor Scheduling 396 Scheduling Algorithms 400 Traditional UNIX Scheduling 422 Summary 424 Recommended Reading 425 Key Terms, Review Questions,
6.5 6.6 6.7 6.8 6.9	An Integrated Deadlock Strategy 278 Dining Philosophers Problem 279 UNIX Concurrency Mechanisms 281 Linux Kernel Concurrency Mechanisms 285 Solaris Thread Synchronization Primitives 292 Windows 7 Concurrency	Chapter 9 9.1 9.2 9.3 9.4 9.5 9.6	Uniprocessor Scheduling 395 Types of Processor Scheduling 396 Scheduling Algorithms 400 Traditional UNIX Scheduling 422 Summary 424 Recommended Reading 425 Key Terms, Review Questions, and Problems 426
6.5 6.6 6.7 6.8 6.9 6.10	An Integrated Deadlock Strategy 278 Dining Philosophers Problem 279 UNIX Concurrency Mechanisms 281 Linux Kernel Concurrency Mechanisms 285 Solaris Thread Synchronization Primitives 292 Windows 7 Concurrency Mechanisms 294	9.1 9.2 9.3 9.4 9.5 9.6 Chapter 10	Uniprocessor Scheduling 395 Types of Processor Scheduling 396 Scheduling Algorithms 400 Traditional UNIX Scheduling 422 Summary 424 Recommended Reading 425 Key Terms, Review Questions, and Problems 426 Multiprocessor and Real-Time Scheduling 430
6.5 6.6 6.7 6.8 6.9 6.10 6.11	An Integrated Deadlock Strategy 278 Dining Philosophers Problem 279 UNIX Concurrency Mechanisms 281 Linux Kernel Concurrency Mechanisms 285 Solaris Thread Synchronization Primitives 292 Windows 7 Concurrency Mechanisms 294 Summary 298	9.1 9.2 9.3 9.4 9.5 9.6 Chapter 10	Uniprocessor Scheduling 395 Types of Processor Scheduling 396 Scheduling Algorithms 400 Traditional UNIX Scheduling 422 Summary 424 Recommended Reading 425 Key Terms, Review Questions, and Problems 426 Multiprocessor and Real-Time Scheduling 430 Multiprocessor Scheduling 431
6.5 6.6 6.7 6.8 6.9 6.10 6.11 6.12	An Integrated Deadlock Strategy 278 Dining Philosophers Problem 279 UNIX Concurrency Mechanisms 281 Linux Kernel Concurrency Mechanisms 285 Solaris Thread Synchronization Primitives 292 Windows 7 Concurrency Mechanisms 294 Summary 298 Recommended Reading 298	Chapter 9 9.1 9.2 9.3 9.4 9.5 9.6 Chapter 10	Uniprocessor Scheduling 395 Types of Processor Scheduling 396 Scheduling Algorithms 400 Traditional UNIX Scheduling 422 Summary 424 Recommended Reading 425 Key Terms, Review Questions, and Problems 426 Multiprocessor and Real-Time Scheduling 430 Multiprocessor Scheduling 431 Real-Time Scheduling 442
6.5 6.6 6.7 6.8 6.9 6.10 6.11 6.12 6.13	An Integrated Deadlock Strategy 278 Dining Philosophers Problem 279 UNIX Concurrency Mechanisms 281 Linux Kernel Concurrency Mechanisms 285 Solaris Thread Synchronization Primitives 292 Windows 7 Concurrency Mechanisms 294 Summary 298 Recommended Reading 298 Key Terms, Review Questions, and Problems 299	Chapter 9 9.1 9.2 9.3 9.4 9.5 9.6 Chapter 10 10.1 10.2 10.3	Uniprocessor Scheduling 395 Types of Processor Scheduling 396 Scheduling Algorithms 400 Traditional UNIX Scheduling 422 Summary 424 Recommended Reading 425 Key Terms, Review Questions, and Problems 426 Multiprocessor and Real-Time Scheduling 430 Multiprocessor Scheduling 431 Real-Time Scheduling 442 Linux Scheduling 457
6.5 6.6 6.7 6.8 6.9 6.10 6.11 6.12 6.13	An Integrated Deadlock Strategy 278 Dining Philosophers Problem 279 UNIX Concurrency Mechanisms 281 Linux Kernel Concurrency Mechanisms 285 Solaris Thread Synchronization Primitives 292 Windows 7 Concurrency Mechanisms 294 Summary 298 Recommended Reading 298 Key Terms, Review Questions,	Chapter 9 9.1 9.2 9.3 9.4 9.5 9.6 Chapter 10 10.1 10.2 10.3 10.4	Uniprocessor Scheduling 395 Types of Processor Scheduling 396 Scheduling Algorithms 400 Traditional UNIX Scheduling 422 Summary 424 Recommended Reading 425 Key Terms, Review Questions, and Problems 426 Multiprocessor and Real-Time Scheduling 430 Multiprocessor Scheduling 431 Real-Time Scheduling 442 Linux Scheduling 457 UNIX SVR4 Scheduling 461
6.5 6.6 6.7 6.8 6.9 6.10 6.11 6.12 6.13	An Integrated Deadlock Strategy 278 Dining Philosophers Problem 279 UNIX Concurrency Mechanisms 281 Linux Kernel Concurrency Mechanisms 285 Solaris Thread Synchronization Primitives 292 Windows 7 Concurrency Mechanisms 294 Summary 298 Recommended Reading 298 Key Terms, Review Questions, and Problems 299	Chapter 9 9.1 9.2 9.3 9.4 9.5 9.6 Chapter 10 10.1 10.2 10.3	Uniprocessor Scheduling 395 Types of Processor Scheduling 396 Scheduling Algorithms 400 Traditional UNIX Scheduling 422 Summary 424 Recommended Reading 425 Key Terms, Review Questions, and Problems 426 Multiprocessor and Real-Time Scheduling 430 Multiprocessor Scheduling 431 Real-Time Scheduling 442 Linux Scheduling 457
6.5 6.6 6.7 6.8 6.9 6.10 6.11 6.12 6.13	An Integrated Deadlock Strategy 278 Dining Philosophers Problem 279 UNIX Concurrency Mechanisms 281 Linux Kernel Concurrency Mechanisms 285 Solaris Thread Synchronization Primitives 292 Windows 7 Concurrency Mechanisms 294 Summary 298 Recommended Reading 298 Key Terms, Review Questions, and Problems 299	Chapter 9 9.1 9.2 9.3 9.4 9.5 9.6 Chapter 10 10.1 10.2 10.3 10.4 10.5	Uniprocessor Scheduling 395 Types of Processor Scheduling 396 Scheduling Algorithms 400 Traditional UNIX Scheduling 422 Summary 424 Recommended Reading 425 Key Terms, Review Questions, and Problems 426 Multiprocessor and Real-Time Scheduling 430 Multiprocessor Scheduling 431 Real-Time Scheduling 442 Linux Scheduling 457 UNIX SVR4 Scheduling 461 UNIX FreeBSD Scheduling 463
6.5 6.6 6.7 6.8 6.9 6.10 6.11 6.12 6.13 PART 3 M	An Integrated Deadlock Strategy 278 Dining Philosophers Problem 279 UNIX Concurrency Mechanisms 281 Linux Kernel Concurrency Mechanisms 285 Solaris Thread Synchronization Primitives 292 Windows 7 Concurrency Mechanisms 294 Summary 298 Recommended Reading 298 Key Terms, Review Questions, and Problems 299 EMORY 305 Memory Management 305 Memory Management Requirements 307	Chapter 9 9.1 9.2 9.3 9.4 9.5 9.6 Chapter 10 10.1 10.2 10.3 10.4 10.5 10.6	Uniprocessor Scheduling 395 Types of Processor Scheduling 396 Scheduling Algorithms 400 Traditional UNIX Scheduling 422 Summary 424 Recommended Reading 425 Key Terms, Review Questions, and Problems 426 Multiprocessor and Real-Time Scheduling 430 Multiprocessor Scheduling 431 Real-Time Scheduling 442 Linux Scheduling 457 UNIX SVR4 Scheduling 461 UNIX FreeBSD Scheduling 463 Windows Scheduling 466
6.5 6.6 6.7 6.8 6.9 6.10 6.11 6.12 6.13 PART 3 M	An Integrated Deadlock Strategy 278 Dining Philosophers Problem 279 UNIX Concurrency Mechanisms 281 Linux Kernel Concurrency Mechanisms 285 Solaris Thread Synchronization Primitives 292 Windows 7 Concurrency Mechanisms 294 Summary 298 Recommended Reading 298 Key Terms, Review Questions, and Problems 299 EMORY 305 Memory Management 305 Memory Management	Chapter 9 9.1 9.2 9.3 9.4 9.5 9.6 Chapter 10 10.1 10.2 10.3 10.4 10.5 10.6	Uniprocessor Scheduling 395 Types of Processor Scheduling 396 Scheduling Algorithms 400 Traditional UNIX Scheduling 422 Summary 424 Recommended Reading 425 Key Terms, Review Questions, and Problems 426 Multiprocessor and Real-Time Scheduling 430 Multiprocessor Scheduling 431 Real-Time Scheduling 442 Linux Scheduling 457 UNIX SVR4 Scheduling 461 UNIX FreeBSD Scheduling 463 Windows Scheduling 466 Linux Virtual Machine Process

vi CONTENTS

10.9	Recommended Reading 470		Operating Systems 576
10.10	Key Terms, Review Questions, and	13.3	eCos 579
	Problems 471	13.4	TinyOS 594
		13.5	Recommended Reading and
PART 5 IN	PUT/OUTPUT AND		Web Sites 603
FILES 474		13.6	Key Terms, Review Questions,
Chapter 11	I/O Management and Disk		and Problems 604
1	Scheduling 474		
11.1	I/O Devices 475	PART 7 C	OMPUTER SECURITY 607
11.1	Organization of the I/O	Chapter 14	Computer Security
11.2	Function 477	F	Threats 607
11.3	Operating System Design Issues 480	14.1	Commutan Security
11.3		14.1	Computer Security
	I/O Buffering 483	14.2	Concepts 608
11.5	Disk Scheduling 487	14.2	Threats, Attacks, and Assets 610 Intruders 616
11.6	RAID 494	14.3	
11.7	Disk Cache 502	14.4	Malicious Software
11.8	UNIX SVR4 I/O 506	145	Overview 619
11.9	Linux I/O 509	14.5	Viruses, Worms, and Bots 623
11.10	Windows I/O 512	14.6	Rootkits 633
11.11	Summary 515	14.7	Recommended Reading and
11.12	Recommended Reading 516	44.0	Web Sites 635
11.13	Key Terms, Review Questions, and	14.8	Key Terms, Review Questions,
	Problems 517		and Problems 636
Chapter 12	File Management 520	Chapter 15	Computer Security
Chapter 12 12.1	File Management 520 Overview 522	Chapter 15	Computer Security Techniques 639
_	Overview 522	Chapter 15 15.1	-
12.1		_	Techniques 639
12.1 12.2	Overview 522 File Organization and Access 527 B-Trees 532	15.1	Techniques 639 Authentication 640
12.1 12.2 12.3	Overview 522 File Organization and Access 527 B-Trees 532 File Directories 535	15.1 15.2	Techniques 639 Authentication 640 Access Control 646
12.1 12.2 12.3 12.4	Overview 522 File Organization and Access 527 B-Trees 532 File Directories 535 File Sharing 540	15.1 15.2 15.3	Techniques 639 Authentication 640 Access Control 646 Intrusion Detection 653 Malware Defense 657
12.1 12.2 12.3 12.4 12.5	Overview 522 File Organization and Access 527 B-Trees 532 File Directories 535 File Sharing 540 Record Blocking 541	15.1 15.2 15.3 15.4	Techniques 639 Authentication 640 Access Control 646 Intrusion Detection 653
12.1 12.2 12.3 12.4 12.5 12.6	Overview 522 File Organization and Access 527 B-Trees 532 File Directories 535 File Sharing 540 Record Blocking 541 Secondary Storage	15.1 15.2 15.3 15.4	Techniques 639 Authentication 640 Access Control 646 Intrusion Detection 653 Malware Defense 657 Dealing with Buffer Overflow Attacks 663
12.1 12.2 12.3 12.4 12.5 12.6	Overview 522 File Organization and Access 527 B-Trees 532 File Directories 535 File Sharing 540 Record Blocking 541 Secondary Storage Management 543	15.1 15.2 15.3 15.4 15.5	Techniques 639 Authentication 640 Access Control 646 Intrusion Detection 653 Malware Defense 657 Dealing with Buffer Overflow Attacks 663 Windows 7 Security 667
12.1 12.2 12.3 12.4 12.5 12.6 12.7	Overview 522 File Organization and Access 527 B-Trees 532 File Directories 535 File Sharing 540 Record Blocking 541 Secondary Storage Management 543 File System Security 551	15.1 15.2 15.3 15.4 15.5	Techniques 639 Authentication 640 Access Control 646 Intrusion Detection 653 Malware Defense 657 Dealing with Buffer Overflow Attacks 663
12.1 12.2 12.3 12.4 12.5 12.6 12.7	Overview 522 File Organization and Access 527 B-Trees 532 File Directories 535 File Sharing 540 Record Blocking 541 Secondary Storage Management 543 File System Security 551 UNIX File Management 553	15.1 15.2 15.3 15.4 15.5	Techniques 639 Authentication 640 Access Control 646 Intrusion Detection 653 Malware Defense 657 Dealing with Buffer Overflow Attacks 663 Windows 7 Security 667 Recommended Reading and Web Sites 672
12.1 12.2 12.3 12.4 12.5 12.6 12.7	Overview 522 File Organization and Access 527 B-Trees 532 File Directories 535 File Sharing 540 Record Blocking 541 Secondary Storage Management 543 File System Security 551 UNIX File Management 553 Linux Virtual File System 560	15.1 15.2 15.3 15.4 15.5 15.6 15.7	Techniques 639 Authentication 640 Access Control 646 Intrusion Detection 653 Malware Defense 657 Dealing with Buffer Overflow Attacks 663 Windows 7 Security 667 Recommended Reading and
12.1 12.2 12.3 12.4 12.5 12.6 12.7 12.8 12.9 12.10 12.11	Overview 522 File Organization and Access 527 B-Trees 532 File Directories 535 File Sharing 540 Record Blocking 541 Secondary Storage Management 543 File System Security 551 UNIX File Management 553 Linux Virtual File System 560 Windows File System 564	15.1 15.2 15.3 15.4 15.5 15.6 15.7	Techniques 639 Authentication 640 Access Control 646 Intrusion Detection 653 Malware Defense 657 Dealing with Buffer Overflow Attacks 663 Windows 7 Security 667 Recommended Reading and Web Sites 672 Key Terms, Review Questions,
12.1 12.2 12.3 12.4 12.5 12.6 12.7 12.8 12.9 12.10 12.11 12.12	Overview 522 File Organization and Access 527 B-Trees 532 File Directories 535 File Sharing 540 Record Blocking 541 Secondary Storage Management 543 File System Security 551 UNIX File Management 553 Linux Virtual File System 560 Windows File System 564 Summary 569	15.1 15.2 15.3 15.4 15.5 15.6 15.7	Techniques 639 Authentication 640 Access Control 646 Intrusion Detection 653 Malware Defense 657 Dealing with Buffer Overflow Attacks 663 Windows 7 Security 667 Recommended Reading and Web Sites 672 Key Terms, Review Questions,
12.1 12.2 12.3 12.4 12.5 12.6 12.7 12.8 12.9 12.10 12.11 12.12	Overview 522 File Organization and Access 527 B-Trees 532 File Directories 535 File Sharing 540 Record Blocking 541 Secondary Storage Management 543 File System Security 551 UNIX File Management 553 Linux Virtual File System 560 Windows File System 564 Summary 569 Recommended Reading 570	15.1 15.2 15.3 15.4 15.5 15.6 15.7 15.8	Authentication 640 Access Control 646 Intrusion Detection 653 Malware Defense 657 Dealing with Buffer Overflow Attacks 663 Windows 7 Security 667 Recommended Reading and Web Sites 672 Key Terms, Review Questions, and Problems 674 ISTRIBUTED SYSTEMS 677
12.1 12.2 12.3 12.4 12.5 12.6 12.7 12.8 12.9 12.10 12.11 12.12	Overview 522 File Organization and Access 527 B-Trees 532 File Directories 535 File Sharing 540 Record Blocking 541 Secondary Storage Management 543 File System Security 551 UNIX File Management 553 Linux Virtual File System 560 Windows File System 564 Summary 569	15.1 15.2 15.3 15.4 15.5 15.6 15.7 15.8	Techniques 639 Authentication 640 Access Control 646 Intrusion Detection 653 Malware Defense 657 Dealing with Buffer Overflow Attacks 663 Windows 7 Security 667 Recommended Reading and Web Sites 672 Key Terms, Review Questions, and Problems 674 ISTRIBUTED SYSTEMS 677 Distributed Processing, Client/
12.1 12.2 12.3 12.4 12.5 12.6 12.7 12.8 12.9 12.10 12.11 12.12	Overview 522 File Organization and Access 527 B-Trees 532 File Directories 535 File Sharing 540 Record Blocking 541 Secondary Storage Management 543 File System Security 551 UNIX File Management 553 Linux Virtual File System 560 Windows File System 564 Summary 569 Recommended Reading 570 Key Terms, Review Questions, and	15.1 15.2 15.3 15.4 15.5 15.6 15.7 15.8 PART 8 D Chapter 16	Authentication 640 Access Control 646 Intrusion Detection 653 Malware Defense 657 Dealing with Buffer Overflow Attacks 663 Windows 7 Security 667 Recommended Reading and Web Sites 672 Key Terms, Review Questions, and Problems 674 ISTRIBUTED SYSTEMS 677 Distributed Processing, Client/ Server, and Clusters 677
12.1 12.2 12.3 12.4 12.5 12.6 12.7 12.8 12.9 12.10 12.11 12.12 12.13 12.14	Overview 522 File Organization and Access 527 B-Trees 532 File Directories 535 File Sharing 540 Record Blocking 541 Secondary Storage Management 543 File System Security 551 UNIX File Management 553 Linux Virtual File System 560 Windows File System 564 Summary 569 Recommended Reading 570 Key Terms, Review Questions, and	15.1 15.2 15.3 15.4 15.5 15.6 15.7 15.8 PART 8 D Chapter 16	Authentication 640 Access Control 646 Intrusion Detection 653 Malware Defense 657 Dealing with Buffer Overflow Attacks 663 Windows 7 Security 667 Recommended Reading and Web Sites 672 Key Terms, Review Questions, and Problems 674 ISTRIBUTED SYSTEMS 677 Distributed Processing, Client/ Server, and Clusters 677 Client/Server Computing 678
12.1 12.2 12.3 12.4 12.5 12.6 12.7 12.8 12.9 12.10 12.11 12.12 12.13 12.14	Overview 522 File Organization and Access 527 B-Trees 532 File Directories 535 File Sharing 540 Record Blocking 541 Secondary Storage Management 543 File System Security 551 UNIX File Management 553 Linux Virtual File System 560 Windows File System 564 Summary 569 Recommended Reading 570 Key Terms, Review Questions, and Problems 571 MBEDDED SYSTEMS 573	15.1 15.2 15.3 15.4 15.5 15.6 15.7 15.8 PART 8 D Chapter 16	Authentication 640 Access Control 646 Intrusion Detection 653 Malware Defense 657 Dealing with Buffer Overflow Attacks 663 Windows 7 Security 667 Recommended Reading and Web Sites 672 Key Terms, Review Questions, and Problems 674 ISTRIBUTED SYSTEMS 677 Distributed Processing, Client/ Server, and Clusters 677 Client/Server Computing 678 Service-Oriented
12.1 12.2 12.3 12.4 12.5 12.6 12.7 12.8 12.9 12.10 12.11 12.12 12.13 12.14	Overview 522 File Organization and Access 527 B-Trees 532 File Directories 535 File Sharing 540 Record Blocking 541 Secondary Storage Management 543 File System Security 551 UNIX File Management 553 Linux Virtual File System 560 Windows File System 564 Summary 569 Recommended Reading 570 Key Terms, Review Questions, and Problems 571 MBEDDED SYSTEMS 573 Embedded Operating	15.1 15.2 15.3 15.4 15.5 15.6 15.7 15.8 PART 8 D Chapter 16	Techniques 639 Authentication 640 Access Control 646 Intrusion Detection 653 Malware Defense 657 Dealing with Buffer Overflow Attacks 663 Windows 7 Security 667 Recommended Reading and Web Sites 672 Key Terms, Review Questions, and Problems 674 ISTRIBUTED SYSTEMS 677 Distributed Processing, Client/ Server, and Clusters 677 Client/Server Computing 678 Service-Oriented Architecture 689
12.1 12.2 12.3 12.4 12.5 12.6 12.7 12.8 12.9 12.10 12.11 12.12 12.13 12.14 PART 6 EM	Overview 522 File Organization and Access 527 B-Trees 532 File Directories 535 File Sharing 540 Record Blocking 541 Secondary Storage Management 543 File System Security 551 UNIX File Management 553 Linux Virtual File System 560 Windows File System 564 Summary 569 Recommended Reading 570 Key Terms, Review Questions, and Problems 571 MBEDDED SYSTEMS 573 Embedded Operating Systems 573	15.1 15.2 15.3 15.4 15.5 15.6 15.7 15.8 PART 8 D Chapter 16	Techniques 639 Authentication 640 Access Control 646 Intrusion Detection 653 Malware Defense 657 Dealing with Buffer Overflow Attacks 663 Windows 7 Security 667 Recommended Reading and Web Sites 672 Key Terms, Review Questions, and Problems 674 ISTRIBUTED SYSTEMS 677 Distributed Processing, Client/ Server, and Clusters 677 Client/Server Computing 678 Service-Oriented Architecture 689 Distributed Message Passing 691
12.1 12.2 12.3 12.4 12.5 12.6 12.7 12.8 12.9 12.10 12.11 12.12 12.13 12.14	Overview 522 File Organization and Access 527 B-Trees 532 File Directories 535 File Sharing 540 Record Blocking 541 Secondary Storage Management 543 File System Security 551 UNIX File Management 553 Linux Virtual File System 560 Windows File System 564 Summary 569 Recommended Reading 570 Key Terms, Review Questions, and Problems 571 MBEDDED SYSTEMS 573 Embedded Operating	15.1 15.2 15.3 15.4 15.5 15.6 15.7 15.8 PART 8 D Chapter 16	Techniques 639 Authentication 640 Access Control 646 Intrusion Detection 653 Malware Defense 657 Dealing with Buffer Overflow Attacks 663 Windows 7 Security 667 Recommended Reading and Web Sites 672 Key Terms, Review Questions, and Problems 674 ISTRIBUTED SYSTEMS 677 Distributed Processing, Client/ Server, and Clusters 677 Client/Server Computing 678 Service-Oriented Architecture 689