

Chapter 1 : Introduction to Wireless Communication Systems 1-1 to 1-38

Syllabus : Evolution of mobile communications, Mobile Radio System around the world, Types of Wireless communication System, Comparison of Common wireless system, Trend in Cellular radio and personal communication. Second generation Cellular Networks, Third Generation (3G) Wireless Networks, Wireless Local Loop(WLL), Wireless Local Area network (WLAN), Bluetooth and Personal Area Networks.

1.1 Introduction1-2
 1.1.1 Wireless Communication1-2
 1.1.2 Need of Wireless Communication1-2
 1.2 Evolution of Mobile Communications1-3
 1.3 Mobile Radiotelephony in the U.S.1-4
 1.3.1 Cellular Radiotelephony1-4
 1.3.2 AMPS1-4
 1.3.3 Spectrum Allocated to the U.S. Cellular Radio Service1-5
 1.3.4 Digital Cellular Telephony1-5
 1.3.5 CDMA Based Systems1-5
 1.4 Mobile Radio Systems Around the World1-6
 1.4.1 AMPS1-6
 1.4.2 Narrowband-AMPS (N-AMPS)1-7
 1.4.3 CDMA IS-951-8
 1.4.4 GSM (Global System for Mobile Communications)1-8
 1.4.5 UMTS (Universal Mobile Telecommunication Service)1-8
 1.4.6 CDMA 20001-9
 1.5 Examples of Wireless Communication Systems1-9
 1.5.1 Important Definitions1-9
 1.5.2 Paging Systems1-11
 1.5.3 Cordless Telephone Systems1-12
 1.5.4 Cellular Telephone System1-13
 1.5.5 Comparison of Wireless Systems1-15
 1.6 Trends in Cellular Radio and Personal Communications1-16
 1.6.1 Advantages of Wireless Communication Systems1-17
 1.6.2 Disadvantages of Wireless Communication Systems1-17
 1.6.3 Applications of Wireless Communication Systems1-17

1.7 Wireless Generations1-18
 1.7.1 First Generation Cellular Networks1-18
 1.8 Growth of Cellular Communication1-19
 1.9 Second Generation Cellular Networks1-20
 1.9.1 Types of 2G Standards1-20
 1.9.2 Technical Specifications1-21
 1.9.3 Features of 2G Systems1-22
 1.9.4 Evolution to 2.5G Mobile Radio Networks1-23
 1.9.5 Evolution for 2.5-G TDMA Standards1-24
 1.9.5.1 HSCSD for 2.5-G GSM1-24
 1.9.5.2 GPRS for 2.5- G GSM and IS-1361-25
 1.9.5.3 EDGE for 2.5-G GSM and IS-1361-26
 1.9.6 IS-95 B for 2.5-G CDMA1-27
 1.9.7 Comparison of HSCSD, GPRS and EDGE1-27
 1.10 Third Generation (3-G) Wireless Networks1-28
 1.10.1 Features of Third Generation1-28
 1.10.2 Services Provided by 3G Systems1-28
 1.10.3 Advantages of 3-G Networks1-29
 1.10.4 3G W-CDMA (UMTS)1-29
 1.10.5 Comparison of GSM and W-CDMA1-31
 1.10.6 Comparison of Various Mobile System Generations1-31
 1.11 Fixed Wireless Networks1-32
 1.11.1 Wireless Local Loop (WLL)1-32
 1.11.2 Wireless Local Area Network (WLAN)1-33
 1.12 Bluetooth and Personal Area Networks.....1-36
 • **Review Questions..... 1-37**

Chapter 2 : The Cellular Concept 2-1 to 2-42

Syllabus : The Cellular Concept : System Design Fundamentals : Cellular system, Hexagonal geometry cell and concept of frequency reuse, Channel Assignment Strategies, Distance to frequency reuse ratio, Channel and co-channel interference reduction factor, S/I ratio consideration and calculation for Minimum Co-channel and adjacent interference, Handoff Strategies, Umbrella Cell Concept, Trunking and Grade of Service, Improving Coverage and Capacity in Cellular System-Cell splitting, Cell sectorization, Repeaters, Micro cell zone concept, Channel antenna system design considerations.



2.1	Cellular Concept.....	2-2	2.9	Trunking and Grade of Service	2-31
2.1.1	Advantages of Cellular Concept	2-2	2.9.1	Trunking	2-31
2.2	The Basic Cellular System	2-2	2.9.2	Trunking and Queueing Theory	2-32
2.2.1	Structure of Cellular Phone System	2-3	2.9.3	Grade of Service (GOS).....	2-32
2.2.2	Advantages of Cellular Concept	2-4	2.9.4	Definitions Related to Trunking Theory	2-32
2.3	Hexagonal Cell Geometry	2-5	2.9.5	Capacity of a trunked system	2-33
2.4	Frequency Reuse	2-6	2.9.6	Types of Trunked systems	2-33
2.4.1	Advantages of Frequency Reuse	2-6	2.9.7	Blocked calls Cleared (BCC) System	2-33
2.4.2	Frequency Reuse Schemes	2-6	2.9.8	Blocked calls Delayed (BCD) System	2-34
2.4.3	Analysis of Frequency Reuse Concept	2-7	2.10	Improving Coverage and Capacity in Cellular Systems.....	2-34
2.4.4	Capacity of Cellular System (C)	2-7	2.10.1	Cell Splitting	2-34
2.4.5	Frequency Reuse Distance	2-7	2.10.2	Cell Sectoring	2-36
2.4.6	Selection of Cluster Size	2-9	2.10.3	Repeaters for Range Extension	2-38
2.5	Channel Assignment Strategies	2-15	2.10.4	A Microcell Zone Concept	2-39
2.5.1	Fixed Channel Assignment (FCA)	2-15	2.10.5	Comparison between Cell Sectoring and Cell Splitting	2-40
2.5.2	Dynamic Channel Assignment (DCA)	2-16	2.10.6	Types of Cells	2-40
2.5.3	Hybrid Channel Assignment	2-16	2.11	Channel Antenna System Design Considerations	2-40
2.5.4	Difference Between FCA and DCA	2-17	2.11.1	Antenna Requirements.....	2-41
2.6	Cellular System Operation and Planning	2-17		• Review Questions.....	2-42
2.6.1	System Architecture	2-17	<hr/>		
2.6.2	Location Updating and Call Setup	2-18	Chapter 3 : Mobile Radio Propagation 3-1 to 3-68		
2.7	Hand Off	2-19	Syllabus : Mobile Radio Propagation Model, Small Scale Fading and diversity : Large scale path loss : Free Space Propagation loss equation, Path-loss of NLOS and LOS systems, Reflection, Ray ground reflection model, Diffraction, Scattering, Link budget design, Maximum Distance Coverage formula, Empirical formula for path loss, Indoor and outdoor propagation models, Small scale multipath propagation, Impulse model for multipath channel, Delay spread, Feher's delay spread, Upper bound Small scale, Multipath Measurement parameters of multipath channels, Types of small scale Fading, Rayleigh and Rician distribution, Statistical models for multipath fading channels and diversity techniques in brief.		
2.7.1	Handoff Strategies	2-20			
2.7.2	Dwell Time	2-21			
2.7.3	Different Types of Hand Offs	2-21			
2.7.4	Cell Dragging	2-23			
2.7.5	Comparison of Hard and Soft Handoffs	2-23			
2.7.6	Comparison of Delayed and Queued Handoffs	2-23			
2.7.7	Umbrella Cell Approach	2-23			
2.7.8	Prioritizing Handoffs	2-24			
2.8	Interference and System Capacity	2-25			
2.8.1	Co-channel Interference and System Capacity	2-25	3.1.1	Radio Wave Propagation	3-3
2.8.2	The S/I Ratio of a Mobile System	2-27	3.1.2	Multipath Propagation	3-4
2.8.3	Channel Planning for Wireless Systems	2-30	3.1.3	Multipath Fading	3-4
2.8.4	Adjacent Channel Interference	2-30	3.2	Propagation Models	3-4
2.8.5	Power Control for Reducing Interference	2-31			



3.3	Free Space Propagation Model	3-5	3.15.1	Effects of Small Scale Fading	3-36
3.3.1	Friis Free Space Equation	3-6	3.15.2	Factors Affecting Small-Scale Fading	3-37
3.3.2	EIRP	3-6	3.15.3	Coherence Bandwidth	3-37
3.3.3	Path Loss	3-6	3.15.4	Doppler Shift	3-37
3.3.4	Validity of Friis Model	3-7	3.16	Impulse Response Model of a Multipath Channel	3-40
3.3.5	Fraun-hofer Region	3-7	3.17	Delay Spread	3-41
3.3.6	Received Power in Terms of Reference Distance	3-7	3.17.1	Power Delay Profile.....	3-43
3.4	Basic Propagation Mechanisms	3-10	3.18	Feher's Delay Spread - Upper Bound	3-44
3.5	Reflection	3-11	3.19	Small-Scale Multipath Measurements	3-45
3.5.1	Reflection from Dielectrics	3-11	3.19.1	Direct RF Pulse System	3-45
3.5.2	Plots of Reflection Coefficients	3-13	3.19.2	Spread Spectrum Sliding Correlator Channel Sounding	3-46
3.5.3	Brewster Angle	3-14	3.19.3	Frequency Domain Channel Sounding	3-48
3.5.4	Reflection from Perfect Conductors ...	3-15	3.20	Parameters of Multipath Channels	3-49
3.6	Ground Reflection (Two Ray) Model	3-15	3.20.1	Time Dispersion Parameters	3-50
3.6.1	Advantages of Two Ray Model	3-17	3.20.2	Coherence Bandwidth (B_c)	3-51
3.6.2	Disadvantage of Two Ray Model	3-17	3.20.3	Doppler Spread and Coherence Time	3-52
3.7	Diffraction	3-18	3.21	Types of Small Scale Fading	3-53
3.7.1	Huygen's Principle	3-18	3.21.1	Small-Scale Fading Effects Due to Multipath Time Delay Spread	3-53
3.7.2	Fresnel Zone Geometry	3-18	3.21.1.1	Flat Fading	3-53
3.7.3	Knife-edge Diffraction Model	3-20	3.21.1.2	Frequency Selective Fading	3-55
3.7.4	Multiple Knife-Edge Diffraction	3-21	3.21.2	Fading Effects Due to Doppler Spread	3-56
3.8	Scattering	3-23	3.22	Rayleigh and Rician Distributions	3-57
3.9	Link Budget Design	3-23	3.22.1	Rayleigh Distribution	3-57
3.9.1	Log-Distance Path Loss Model	3-24	3.22.2	Rician Fading Distribution	3-59
3.9.2	Log-normal Shadowing	3-25	3.22.3	Difference between Rayleigh and Rician Distribution	3-60
3.10	Maximum Distance Coverage Formula	3-25	3.23	Statistical Models for Multipath Fading Channels	3-60
3.11	Empirical Formula for Path Loss	3-26	3.23.1	Clarke's Model for Flat Fading	3-60
3.12	Outdoor Propagation Models	3-27	3.23.2	Simulation of Clarke and Gans Fading Model	3-61
3.12.1	Okumura Propagation Model	3-27	3.23.3	Level crossing and Fading Statistics ...	3-61
3.12.2	Hata Model	3-29	3.23.4	Two-Ray Rayleigh Fading Model	3-62
3.12.3	Longley-Rice Propagation Model	3-30	3.23.5	Saleh and Valenzuela Indoor Statistical Model	3-62
3.12.4	Durkin's Propagation Model	3-30	3.24	Diversity Reception	3-63
3.13	Indoor Propagation Models	3-31	3.25	Diversity Techniques	3-63
3.13.1	Partition Losses (Same Floor of a Building)	3-32			
3.13.2	Partition Losses between Floors	3-32			
3.13.3	Log-distance Path Loss Model	3-33			
3.13.4	Ericsson Multiple Breakpoint Model ..	3-34			
3.13.5	Attenuation Factor Model	3-34			
3.14	Signal Penetration into Buildings	3-35			
3.15	Small Scale Multipath Propagation	3-36			



<p>3.26 Types of Diversity Techniques 3-65</p> <p> 3.26.1 Space Diversity 3-65</p> <p> 3.26.1.1 Classification of Space Diversity Reception Methods 3-66</p> <p> 3.26.1.2 Advantages of Space Diversity 3-66</p> <p> 3.26.1.3 Disadvantages Space Diversity 3-66</p> <p> 3.26.2 Polarization Diversity 3-66</p> <p> 3.26.3 Frequency Diversity 3-66</p> <p> 3.26.4 Time Diversity 3-67</p> <p> • Review Questions 3-67</p> <hr/> <p>Chapter 4 : Multiple Access Techniques 4-1 to 4-30</p> <div style="border: 1px solid black; padding: 5px; margin: 5px 0;"> <p>Syllabus : Introduction, Comparisons of multiple Access Strategies TDMA, CDMA, FDMA, OFDM, CSMA Protocols, NOMA.</p> </div> <p>4.1 Multiple Access 4-2</p> <p> 4.1.1 Frequency Division Duplexing (FDD) 4-2</p> <p> 4.1.2 Time Division Duplexing (TDD) 4-2</p> <p>4.2 Multiple Access Techniques 4-3</p> <p> 4.2.1 Types of Multiple Access Based on the Bandwidth Availability 4-3</p> <p>4.3 Frequency Division Multiple Access (FDMA) 4-4</p> <p> 4.3.1 Features of FDMA 4-4</p> <p> 4.3.2 Nonlinear Effects in FDMA 4-5</p> <p> 4.3.3 Number of FDMA Channels 4-5</p> <p> 4.3.4 Merits of FDMA 4-6</p> <p> 4.3.5 Demerits of FDMA 4-6</p> <p>4.4 Time Division Multiple Access (TDMA) 4-6</p> <p> 4.4.1 Number of Channels in TDMA System 4-7</p> <p> 4.4.2 Efficiency of TDMA System 4-7</p> <p> 4.4.3 TDMA Features 4-8</p> <p> 4.4.4 Advantages of TDMA 4-8</p> <p> 4.4.5 Advantages of TDMA over FDMA 4-8</p> <p> 4.4.6 Disadvantages of TDMA 4-8</p> <p> 4.4.7 Problems with FDMA and TDMA 4-8</p> <p>4.5 Code Division Multiple Access (CDMA) 4-9</p> <p> 4.5.1 Spread Spectrum and CDMA 4-10</p> <p> 4.5.2 Basic Structure of CDMA System 4-10</p> <p> 4.5.3 Salient Features of CDMA Systems 4-11</p> <p> 4.5.4 Multiple Access Techniques in Cellular Systems 4-12</p> <p> 4.5.5 Advantages of CDMA 4-12</p>	<p> 4.5.6 Disadvantages 4-12</p> <p> 4.5.7 CDMA Applications 4-12</p> <p>4.6 Spread-Spectrum Multiple Access (SSMA) 4-12</p> <p> 4.6.1 Model of Spread Spectrum Modulation System 4-14</p> <p>4.7 Direct Sequence Spread Spectrum (DSSS) Multiple Access 4-15</p> <p> 4.7.1 Advantages of DS-SS System 4-15</p> <p> 4.7.2 Disadvantages of DS-SS System 4-16</p> <p> 4.7.3 Applications of DS-SS System 4-16</p> <p>4.8 Frequency Hop Spread Spectrum (FH-SS) Multiple Access 4-16</p> <p> 4.8.1 Operation of FHSS 4-16</p> <p> 4.8.2 Types of Frequency Hopping 4-17</p> <p> 4.8.3 Advantages of FH-SS System 4-18</p> <p> 4.8.4 Disadvantages of FH-SS System 4-18</p> <p> 4.8.5 Applications of FHSS 4-18</p> <p> 4.8.6 Comparison of DS-SS and FHSS 4-18</p> <p>4.9 Orthogonal Frequency Division Multiplexing (OFDM) 4-18</p> <p> 4.9.1 Orthogonality 4-18</p> <p> 4.9.2 Assigning the Subcarriers 4-19</p> <p> 4.9.3 Generation of OFDM Signals 4-20</p> <p> 4.9.4 OFDM-PAPR (OFDM-Peak-to-peak Average Power Ratio) 4-20</p> <p> 4.9.5 Comparison of FDM and OFDM 4-20</p> <p>4.10 OFDMA (Orthogonal Frequency Division Multiple Access) 4-21</p> <p> 4.10.1 Features of OFDMA 4-22</p> <p> 4.10.2 Disadvantage of OFDMA 4-22</p> <p> 4.10.3 Applications of OFDMA 4-22</p> <p>4.11 CSMA Protocols 4-22</p> <p> 4.11.1 Types of CSMA 4-22</p> <p> 4.11.2 Flow diagram of CSMA-CA 4-22</p> <p> 4.11.3 RTS/CTS Handshake 4-23</p> <p> 4.11.4 Types of CSMA / CA 4-24</p> <p>4.12 Comparison of Multiple Access Strategies 4-25</p> <p>4.13 NOMA 4-26</p> <p> 4.13.1 Classification of NOMA 4-28</p> <p> 4.13.2 Resource Management in NOMA Networks 4-28</p> <p> 4.13.3 Implementation Challenges of NOMA 4-28</p>
---	---



4.13.4	Performance Enhancement.....	4-28	5.6.4	Subscriber Identity Module (SIM)	5-15
4.13.5	Advantages of NOMA.....	4-28	5.6.5	Mobile System ISDN (MSISDN)	5-15
4.13.6	Drawbacks of NOMA.....	4-29	5.6.6	LAI (Location Area Identity)	5-16
4.13.7	Comparison of OMA and NOMA	4-29	5.6.7	IMSEI (International MS Equipment Identity) / IMEI (International Mobile Equipment Identity)	5-16
	• Review Questions.....	4-29	5.6.8	MS Roaming Number (MSRN)	5-17
Chapter 5 : Wireless Systems-GSM		5-1 to 5-40	5.6.9	TMSI [Temporary Mobile Subscriber Identity]	5-17
Syllabus : GSM system architecture, Radio interface, Protocols, Localization and calling, Handover, Authentication and security in GSM, GSM speech coding.					
5.1	Global System for Mobile (GSM).....	5-2	5.7	GSM Channels	5-17
5.2	GSM System Architecture	5-2	5.8	GSM Logical Channel	5-17
5.2.1	Detail Architecture of GSM	5-3	5.8.1	GSM Traffic Channels (TCHs)	5-18
5.2.2	Various Subsystems in GSM	5-4	5.8.2	GSM Control Channels (CCH)	5-19
5.2.3	MS (Mobile Station)	5-4	5.9	Frame Structure of GSM System	5-20
5.2.4	BSS (Base Station Subsystem)	5-5	5.10	GSM Burst Structures	5-22
5.2.5	NSS (Network Switching Subsystem) ...	5-6	5.10.1	Normal Burst / Frame Structure of GSM System	5-22
5.2.6	OMSS Operation and Maintenance Subsystem	5-7	5.10.2	Frequency Correction Burst	5-23
5.2.7	Characteristics / Features of GSM Standard	5-8	5.10.3	Synchronization Burst	5-23
5.3	GSM Radio Interface.....	5-9	5.10.4	Access Burst	5-23
5.3.1	GSM air Interface Specifications	5-10	5.10.5	Dummy Burst	5-24
5.4	GSM Signalling Protocol Architecture	5-11	5.11	Signal Processing in GSM	5-24
5.4.1	GSM Interfaces	5-12	5.11.1	An Example of Call Routing	5-26
5.4.2	Mobile Station-Base Transceiver Station Signaling Protocols	5-12	5.12	PLMN Interfaces	5-27
5.4.3	Abis Interface / Base Transceiver Station (BTS)-Base Station Controller (BSC) Signaling Protocols	5-13	5.13	Calling in GSM	5-28
5.4.4	A Interface / Base Station Controller (BSC) – Mobile Switching Centre (MSC) Signaling Protocols	5-14	5.13.1	Location Updating	5-28
5.5	Signalling System - 7 (SS7)	5-14	5.13.2	Mobile Terminated Call.....	5-28
5.5.1	Primary Characteristics of SS7	5-14	5.13.3	Mobile Originated Call	5-29
5.5.2	Functions of SS7	5-14	5.14	GSM Handoff or Handover	5-30
5.5.3	Features of SS7	5-14	5.14.1	Handover in GSM	5-30
5.6	Identifiers and Addresses used in GSM	5-14	5.14.2	Types of Handovers in GSM	5-30
5.6.1	IMSI (International Mobile Subscriber Identity)	5-15	5.15	Security in GSM	5-31
5.6.2	MSIN (Mobile Subscriber Identification Number)	5-15	5.15.1	Access Control and Authentication	5-32
5.6.3	MSRN (Mobile Station Roaming Number)	5-15	5.15.2	Confidentiality	5-32
			5.15.3	Anonymity	5-32
			5.15.4	Authentication in GSM	5-32
			5.15.5	Authentication Algorithm A-3	5-33
			5.15.6	Data Encryption Process using A-5 and A-8 Algorithm	5-33
			5.16	GSM Services	5-34
			5.16.1	Teleservices	5-35
			5.16.2	Data Services / Bearer Services	5-35
			5.16.3	Bearer Services	5-36

5.16.4 Supplementary Services 5-36

5.17 Applications of GSM 5-37

5.17.1 Other applications of GSM 5-38

5.18 Advantages of GSM..... 5-38

5.19 Disadvantages of GSM..... 5-39

• **Review Questions..... 5-39**

Chapter 6 : Wireless Systems-IS-95 6-1 to 6-38

Syllabus : Concept of spread spectrum, Architecture of IS-95 CDMA system, Air interface, CDMA forward channels, CDMA reverse channels, Soft handoff, CDMA features, Power control in CDMA, Performance of CDMA System, RAKE Receiver, CDMA 2000 cellular technology, GPRS system architecture.

<p>6.1 Introduction to 2G Cellular Systems 6-2</p> <p>6.1.1 Evolution from 2G to 3G Cellular Networks 6-2</p> <p>6.2 Interim Standard CDMA IS-95 6-2</p> <p>6.2.1 Types of Channels in IS-95 System 6-3</p> <p>6.3 Frequency and Channel Specifications of CDMA IS-95 6-3</p> <p>6.3.1 Frequency Specifications of IS-95 6-4</p> <p>6.3.2 Features of CDMA IS-95 6-4</p> <p>6.3.3 Forward Link 6-4</p> <p>6.3.4 Reverse Link 6-5</p> <p>6.3.5 Interferences in CDMA IS-95 System 6-5</p> <p>6.4 CDMA IS-95 System Architecture 6-6</p> <p>6.5 CDMA Air Interface 6-7</p> <p>6.5.1 Classification of CDMA IS-95 Channels 6-10</p> <p>6.5.2 IS-95 Air interface Standards 6-11</p> <p>6.6 IS - 95 CDMA Channel Structure 6-11</p> <p>6.6.1 The IS-95 CDMA Forward Channels ... 6-11</p> <p>6.6.2 The IS-95 CDMA Reverse Channels 6-13</p> <p>6.6.3 Comparison of Forward and Reverse IS-95 CDMA Channels 6-16</p> <p>6.7 Forward and Reverse Channel Modulation Process 6-16</p> <p>6.7.1 Forward Channel Modulation Process 6-16</p> <p>6.7.2 Reverse Channel Modulation Process 6-16</p> <p>6.8 IS-95 CDMA Call Processing 6-17</p> <p>6.9 IS-95 CDMA Packet and Frame Format 6-17</p>	<p>6.9.1 IS-95 Forward Channels Frame Format 6-18</p> <p>6.9.2 Frame Formats of Reverse Channel 6-19</p> <p>6.10 Handoffs in IS-95 CDMA 6-20</p> <p>6.10.1 Soft handoff 6-20</p> <p>6.10.2 Hard handoff 6-21</p> <p>6.10.3 Inter-sector or Softer handoff 6-21</p> <p>6.10.4 Soft-softer handoff..... 6-21</p> <p>6.11 Near-Far Problem 6-21</p> <p>6.12 Mobility and Radio Resource Management 6-22</p> <p>6.12.1 Mobility Management 6-22</p> <p>6.12.2 Concept of Resource Management 6-22</p> <p>6.13 Security and Authentication in IS-95 CDMA 6-24</p> <p>6.14 Output Power Control in CDMA 6-24</p> <p>6.14.1 Performance of the CDMA System 6-25</p> <p>6.15 Comparison of GSM and IS-95 6-25</p> <p>6.16 Advantages of CDMA IS-95 6-26</p> <p>6.17 Disadvantages of CDMA IS-95 6-26</p> <p>6.18 Rake Receiver 6-27</p> <p>6.18.1 Advantages of RAKE Receiver 6-29</p> <p>6.19 Evolution from GSM to 3G Networks 6-29</p> <p>6.20 GPRS - General Packet Radio Service 6-29</p> <p>6.20.1 Features of GPRS 6-30</p> <p>6.20.2 GPRS Architecture 6-30</p> <p>6.20.3 GPRS Radio Interface 6-32</p> <p>6.20.4 Advantages of GPRS 6-33</p> <p>6.20.5 Disadvantages of GPRS 6-33</p> <p>6.20.6 Applications of GPRS 6-33</p> <p>6.20.7 Comparison of GSM and GPRS 6-33</p> <p>6.21 Need of 3G Technology 6-34</p> <p>6.21.1 Advantages of 3G Wireless Networks 6-34</p> <p>6.21.2 Disadvantages of 3G Wireless Networks 6-34</p> <p>6.21.3 Applications of 3G Networks 6-34</p> <p>6.21.4 Various 3G Standards 6-35</p> <p>6.22 CDMA 2000 Technology 6-35</p> <p>6.22.1 Advanced Versions of CDMA 2000 6-35</p> <p>6.22.2 Specifications of CDMA 2000 6-36</p> <p>6.22.3 Forward and Reverse Channels 6-36</p> <p>6.22.4 Handoff and Power Control 6-36</p> <p>6.22.5 Features of CDMA 2000 6-37</p>
--	--



6.22.6	Advantages of CDMA 2000	6-37	7.10.3	Spread Spectrum Technology	7-13
6.22.7	Disadvantages of CDMA 2000	6-37	7.11	IEEE 802.11 Standard for WLAN	7-14
6.22.8	Comparison of IS-95 and CDMA 2000	6-37	7.11.1	Classification of WLANs	7-14
	• Review Questions	6-38	7.11.2	The IEEE 802.11 Protocol Stack	7-14
Chapter 7 : Recent Trends		7-1 to 7-54	7.11.3	802.11 Network Architecture	7-15
Syllabus : Introduction to Wi-Fi, WiMAX, ZigBee Networks, MIMO, Software Defined Radio, UWB Radio, Wireless Adhoc Network and Mobile Portability, Security issues and challenges in 5-G and above Wireless networks.			7.11.4	Types of Stations	7-16
7.1	Introduction to WLAN/Wi-Fi.....	7-2	7.12	The Physical Layer	7-16
7.1.1	IEEE Standards	7-2	7.12.5	Various PHY Specifications	7-17
7.1.2	Wi-Fi	7-2	7.13	MAC Sublayer	7-17
7.1.3	ISM Band	7-2	7.13.1	RTS and CTS Messages	7-18
7.2	Architectural Comparison of Wired and Wireless LANs	7-3	7.13.2	The Retry Counters	7-18
7.3	WLAN Equipment	7-4	7.13.3	Distributed Co-ordination Function (DCF)	7-18
7.3.1	LAN Adapter	7-4	7.13.4	Hidden Station Problem	7-20
7.3.2	Access Point (AP)	7-4	7.14	Point Co-ordinate Function (PDF)	7-20
7.3.3	Outdoor LAN Bridges	7-5	7.14.1	Fragmentation	7-21
7.4	WLAN Topologies	7-6	7.14.2	Exposed Station Problem	7-21
7.4.1	Peer-to-peer (ad hoc) Topology	7-6	7.15	Framing in WLAN	7-22
7.4.2	AP Based Topology	7-6	7.15.1	Advantages of WLANs	7-23
7.5	Characteristics of WLANs	7-6	7.15.2	Disadvantages of WLAN	7-23
7.5.1	Attenuation	7-6	7.15.3	Applications of Wireless LAN	7-23
7.5.2	Interference	7-7	7.16	Wireless MAN (WMAN)	7-24
7.5.3	Multipath Propagation	7-7	7.16.1	Wi-MAX	7-24
7.5.4	Error	7-7	7.16.2	Wi-Bro (Wireless Broadband)	7-25
7.6	Design Goals for WLANs	7-7	7.16.3	Need of Wireless MAN (WMAN)	7-25
7.6.1	Factors Considered to Deploy WLAN	7-8	7.17	IEEE 802.16 (Wi-MAX)	7-25
7.7	Technical Issues in WLANs	7-9	7.17.1	Wi-Max Standards	7-25
7.8	Medium Access Control	7-9	7.17.2	Structure of WMAN	7-25
7.9	MAC Protocol Issues	7-10	7.17.3	IEEE Project 802.16 (Wi-Max)	7-26
7.9.1	Hidden Terminal Problem	7-10	7.17.4	New Standards	7-26
7.9.2	Exposed Station Problem	7-11	7.17.5	Spectrum Allocation	7-27
7.9.3	Reliability	7-12	7.17.6	Specifications of IEEE 802.16	7-27
7.9.4	Collision Avoidance	7-12	7.18	Wi-Max Services	7-27
7.10	WLAN Technologies	7-12	7.18.1	Fixed Wi-Max Services	7-27
7.10.1	IR (Infrared) Technology	7-12	7.18.2	Mobile Wi-Max Services	7-27
7.10.2	UHF Narrowband Technology	7-13	7.18.3	Internet Access	7-28
			7.18.4	Mobile Phones based on Wi-Max	7-28
			7.18.5	Spectral Efficiency	7-28
			7.18.6	Advantages of IEEE 802.16 (Wi-MAX)	7-28
			7.18.7	Disadvantages of Wi-MAX	7-29
			7.18.8	Uses / Applications of Wi-Max	7-29



7.18.9	Comparison of IEEE 802.11 and IEEE 802.16	7-29	7.25.5	UWB Disadvantages	7-41
7.19	Wireless PAN (WPAN)	7-30	7.25.6	UWB Applications	7-42
7.19.1	Need of Wireless PAN	7-30	7.25.7	Comparison between WPAN Systems	7-42
7.20	ZigBee (IEEE 802.15.4)	7-30	7.26	Wireless Ad hoc Network	7-43
7.20.1	Features of ZigBee	7-31	7.26.1	Need of adhoc Wireless Networks	7-43
7.20.2	Radio Specifications	7-31	7.26.2	Features of Wireless Ad hoc Network	7-43
7.21	ZigBee Topologies	7-31	7.26.3	Quantitative Features	7-43
7.21.1	Star Topology	7-32	7.26.4	Qualitative Features	7-44
7.21.2	Mesh (Peer to Peer) Topology	7-32	7.26.5	Advantages of Wireless Ad hoc Network	7-45
7.21.3	Cluster Tree Topology	7-32	7.26.6	Applications of Wireless Ad hoc Network	7-45
7.21.4	Applications of ZigBee	7-33	7.26.7	Difference between Ad-hoc and Cellular Networks	7-45
7.21.5	Comparison of Bluetooth and ZigBee	7-33	7.27	5-G and Above Wireless Networks	7-46
7.22	Multi-antenna Technologies	7-34	7.27.1	Why 5-G?.....	7-46
7.22.1	Single Input Single Output (SISO)	7-34	7.27.2	Features of 5-G	7-46
7.22.2	Single Input Multiple Output (SIMO)	7-34	7.27.3	Features of Fifth Generation	7-47
7.22.3	Multiple Input Single Output (MISO)	7-34	7.27.4	Expectations in 5-G Network	7-47
7.22.4	Multiple Input Multiple Output (MIMO)	7-35	7.27.5	Technologies of 5G	7-47
7.23	MIMO Systems	7-35	7.27.6	Advantages of 5-G Technology	7-47
7.23.1	Types of MIMO	7-35	7.27.7	Applications of 5-G	7-47
7.23.2	A 2 x 2 MIMO	7-36	7.27.8	Challenges for 5G Networks	7-48
7.23.3	Advantages of MIMO	7-36	7.28	Security Issues in Wireless Networks	7-48
7.23.4	Disadvantages of MIMO	7-36	7.28.1	Security Issues of Wireless Networks	7-49
7.23.5	Applications of MIMO	7-36	7.28.2	Attacks	7-49
7.24	Software Defined Radio (SDR)	7-36	7.28.3	Attacks on Confidentiality	7-49
7.24.1	Features/ Advantages of SDR	7-37	7.28.4	Attacks on Integrity	7-49
7.24.2	Problems in SDR Communications	7-38	7.28.5	Attacks on Availability	7-50
7.24.3	Applications of SDR	7-39	7.29	Security Issues in 5G and Above Technologies	7-50
7.25	UWB Radio	7-39	7.30	University Questions and Answers.....	7-52
7.25.1	UWB Radio Specifications	7-40		• Review Questions.....	7-51
7.25.2	UWB Features	7-41			
7.25.3	Antenna Systems in UWB	7-41			
7.25.4	UWB Advantages	7-41			

□□□