1. What is wireless communication?
Communication without physical wire, using electromagnetic waves.

2. Name two types of wireless communication.
Radio Communication, Satellite Communication.

3. What is modulation?
Modulation is the process of varying a carrier signal with the information signal.

4. Types of modulation?
AM (Amplitude), FM (Frequency), PM (Phase).

5. What is bandwidth?
The range of frequencies used to transmit a signal.

6. What is frequency?
The number of wave cycles per second, measured in Hz.

7. What is a repeater?
A device that amplifies and retransmits signals to extend coverage.

8. What is fading?
Variation or loss of signal strength over time or distance.

9. What is antenna?
A device to transmit or receive electromagnetic waves.

10. What is Bluetooth?
A short-range wireless communication technology (10 meters approx.).

11. What is Wi-Fi?
Wireless local area network (WLAN) technology.

12. What is cellular communication?
Dividing an area into cells, each with a base station, for mobile communication.

13. What is handoff?
Switching a mobile call from one cell tower to another.

14. What is a base station?
A fixed point of communication for mobile devices in a cell.

15. What is GSM?
Global System for Mobile Communication — 2G standard.

16. What is CDMA?
Code Division Multiple Access — each user gets a unique code.

17. What is 4G?
Fourth generation wireless — faster internet & better coverage.

18. What is 5G?
Fifth generation — ultra-fast speed, low latency, massive connectivity.

19. What is latency?
Delay between sending and receiving data.

20. What is noise?
Unwanted signal interfering with the actual signal.

21. What is spectrum?
The range of electromagnetic frequencies used for communication.

22. What is line-of-sight communication?
Signal travels directly between transmitter and receiver without obstruction.

23. Example of line-of-sight system?
Microwave, Infrared.

24. What is multipath propagation?
Signal reaches receiver via multiple paths causing interference.

25. What is ISM band?
Industrial, Scientific, Medical band — license-free frequency band (e.g., 2.4 GHz).

26. What is propagation delay?
Time taken for signal to travel from sender to receiver.

27. What is modulation index?
It indicates the extent of modulation applied to the carrier.

28. What is path loss?
Reduction in power density of signal during transmission.

29. What is the role of the transceiver?
It transmits and receives signals (both transmitter and receiver).

30. What is beamforming?
Technique to focus signal in a specific direction using multiple antennas.

31. What is the use of satellites in communication?
For long-distance communication, TV, internet, GPS, etc.

32. What is a geostationary satellite?
Satellite that stays fixed over a point on Earth.

33. Frequency range of Bluetooth?
2.4 GHz (same as Wi-Fi but different protocol).

34. What is full duplex?
Both sender and receiver can communicate at the same time.

35. What is half duplex?
Sender and receiver communicate but not at the same time.

36. What is TDM (Time Division Multiplexing)?
Each user gets time slots on the same frequency.

37. What is FDM (Frequency Division Multiplexing)?
Each user gets a separate frequency band.

38. What is the range of FM radio?
88 MHz – 108 MHz.

39. What is infrared communication?
Short-range wireless using IR light (like TV remote).

40. What is a mobile switching center (MSC)?
Controls multiple base stations and manages calls, handoffs.

41. What is cellular network?
A wireless network divided into small cells, each with its own tower.

42. What is the main advantage of cellular networks?
Frequency reuse and large area coverage.

43. What is frequency reuse?
Same frequency used in different cells that are far enough apart.

44. What is QoS (Quality of Service)?
Performance level of a service like speed, delay, jitter, etc.

45. What is jitter?
Variation in packet arrival time — affects voice/video quality.

46. What is LTE?
Long Term Evolution — a 4G standard for fast mobile data.

47. What is MIMO?
Multiple Input Multiple Output — uses multiple antennas for better performance.

48. What is OFDM?
Orthogonal Frequency Division Multiplexing — splits signal over many frequencies for better transmission.

49. What is roaming?
Using network services outside the user's home network.

50. What is IMEI?
International Mobile Equipment Identity — unique ID for every mobile device.

51. What is MAC address?
Unique ID assigned to network interfaces for communication.

52. What is Handover Delay?
Delay that occurs during switching from one cell to another.

53. What is cell splitting?
Dividing a large cell into smaller cells to increase capacity.

54. What is an access point (AP)?
Device that connects wireless devices to a wired network (e.g., Wi-Fi router).

55. What is GSM full form?
Global System for Mobile Communications.

56. Which modulation is used in GSM?
GMSK (Gaussian Minimum Shift Keying).

57. What is the range of Wi-Fi?
Typically 50-100 meters indoors.

58. What is a satellite footprint?
The area on Earth where signals from a satellite can be received.

59. What is uplink and downlink?
Uplink: Earth to satellite.
Downlink: Satellite to Earth.

60. What is VSAT?
Very Small Aperture Terminal — small satellite dish for data communication.

61. What is 2G?
Second-generation mobile network; digital voice communication (e.g., GSM).

62. What is 3G?
Third-generation; supports voice + mobile internet (e.g., video call).

63. What is 4G?
High-speed mobile internet with low latency (e.g., LTE).

64. What is 5G?
Ultra-fast data, very low latency, supports IoT, automation, etc.

65. 5G uses which frequency bands?
Low-band (<1 GHz), mid-band (1–6 GHz), mmWave (>24 GHz).

66. What is latency in 5G?
~1 millisecond (very low).

67. What is the full form of IoT?
Internet of Things.

68. What is WLAN?
Wireless Local Area Network (e.g., Wi-Fi).

69. What is MANET?
Mobile Ad-hoc Network — self-configuring, no fixed infrastructure.

70. What is NFC?
Near Field Communication — short-range (4 cm), used in contactless payment.

71. What is Zigbee?
Low-power wireless communication for IoT and automation.

72. What is Li-Fi?
Light Fidelity — wireless communication using visible light.

73. What is a carrier signal?
A high-frequency wave that carries information signal.

74. What is modulation used for?
To transmit signals over long distances with less loss.

75. What is the main disadvantage of wireless communication?
Signal interference, noise, security risk.

76. What is the Doppler Effect?
Frequency change due to relative motion between source and receiver.

77. What is shadowing?
Signal blocked by obstacles (like buildings), causing low signal strength.

78. What is the role of a mobile antenna?
Transmits and receives wireless signals from/to tower.

79. Why is encryption important in wireless communication?
To secure the data from unauthorized access.

80. What is a smart antenna?
It adjusts its pattern to improve signal strength and reduce interference.

◆ Equalizer Related Short Questions and Answers:

81. What is an equalizer?
A device or algorithm that removes or reduces distortion from the received signal.

82. Why is equalizer used?
To combat intersymbol interference (ISI) caused by multipath fading.

83. What is ISI (Intersymbol Interference)?
When multiple symbols overlap in time at the receiver and cause distortion.

84. Where is equalizer used?
In the receiver section of wireless communication systems.

85. What causes ISI?
Multipath propagation and limited bandwidth of the channel.

86. Types of equalizers?

1. **Linear Equalizer**
2. **Decision Feedback Equalizer (DFE)**
3. **Adaptive Equalizer**
4. **Zero-Forcing Equalizer**
5. **MMSE Equalizer (Minimum Mean Square Error)**

87. What is a Linear Equalizer?
Uses a fixed linear filter to reduce distortion, simple but may not handle noise well.

88. What is DFE (Decision Feedback Equalizer)?
Uses past decisions to cancel ISI more effectively than linear equalizer.

89. What is Adaptive Equalizer?
Automatically adjusts its parameters based on changing channel conditions.

90. What is the Zero Forcing Equalizer?
It inverts the channel effect but can amplify noise.

91. What is MMSE Equalizer?
It balances between reducing ISI and minimizing noise impact — more practical.

92. Which modulation schemes suffer most from ISI?
Higher-order modulations like QAM and PSK.

93. Is equalization needed in optical fiber communication?
Usually not, because fiber causes less multipath interference.

94. What is channel estimation?
It's the process of analyzing the channel so the equalizer can work effectively.

95. Equalizer is part of which OSI layer?
Physical layer.

96. What is the difference between equalizer and filter?
Equalizer compensates for channel distortion, filter selects desired frequencies.

◆ Diversity

97. What is diversity?
Technique to improve signal quality by using multiple versions of the signal.

98. Types of diversity?

- **Time diversity**
- **Frequency diversity**
- **Spatial (Antenna) diversity**

99. Why is diversity used?
To reduce fading and improve reliability.

100. What is spatial diversity?
Using multiple antennas at different locations.

◆ Multiuser System

101. What is a multiuser system?
A system that supports multiple users simultaneously.

102. Example of multiuser techniques?

- **TDMA (Time Division Multiple Access)**
- **FDMA (Frequency Division Multiple Access)**
- **CDMA (Code Division Multiple Access)**
- **OFDMA (Orthogonal Frequency Division Multiple Access)**

103. Why is multiuser system important?
Efficient use of bandwidth and supports many users.

◆ **Multi-carrier Modulation**

104. What is multi-carrier modulation?
Data is divided and sent over multiple carrier frequencies.

105. Most popular multi-carrier modulation technique?
OFDM (Orthogonal Frequency Division Multiplexing)

106. Advantage of multi-carrier modulation?
Reduces ISI, more robust to frequency-selective fading.

◆ **Traffic Routing**

107. What is traffic routing in wireless communication?
Deciding the path data packets take to reach the destination.

108. Purpose of routing?
Efficient data delivery, reduce congestion, avoid failure paths.

109. Common wireless routing protocols?

- **AODV (Ad hoc On-demand Distance Vector)**
- **DSR (Dynamic Source Routing)**
- **OLSR (Optimized Link State Routing)**

◆ **ISDN (Integrated Services Digital Network)**

110. What is ISDN?
A circuit-switched telephone network system that also supports digital data.

111. Services provided by ISDN?
Voice, video, text, data over the same line.

112. ISDN basic rate interface (BRI)?
2B + D = 2 Bearer channels + 1 Data channel.

113. ISDN primary rate interface (PRI)?
30B + D (in Europe) or 23B + D (in USA).

◆ AWGN (Additive White Gaussian Noise)

114. What is AWGN?
A basic noise model with constant power over frequency and Gaussian distribution.

115. Why is AWGN model used?
To simulate real-life random noise in channels.

116. What does "white" mean in AWGN?
Equal power across all frequencies.

◆ CPFSK (Continuous Phase Frequency Shift Keying)

117. What is CPFSK?
A type of frequency shift keying where phase is continuous — smooth signal.

118. Advantage of CPFSK?
Lower bandwidth, better spectral efficiency.

119. CPFSK is used in which systems?
Bluetooth, GFSK (Gaussian Filtered FSK) is a form of CPFSK.

◆ MIMO (Multiple Input Multiple Output)

120. What is MIMO?
Wireless technology using multiple antennas at both transmitter and receiver.

121. Where is MIMO used?
4G LTE, 5G, Wi-Fi (802.11n/ac/ax)

122. Advantage of MIMO?

- **Higher data rate**
- **Better reliability**
- **Spatial diversity**

◆ OFDM (Orthogonal Frequency Division Multiplexing)

123. What is OFDM?
A multicarrier modulation technique that uses orthogonal subcarriers.

124. Where is OFDM used?
Wi-Fi, LTE, 5G, DVB (Digital TV), ADSL

125. Main advantage of OFDM?
Resistant to ISI and multipath fading.

◆ **SC-FDMA (Single Carrier FDMA)**

126. What is SC-FDMA?
It's a single-carrier modulation used in uplink of LTE.

127. Where is SC-FDMA used?
Uplink in LTE (from mobile to tower).

128. Why SC-FDMA used in uplink?
Lower Peak-to-Average Power Ratio (PAPR) → saves mobile battery.

◆ **MC-CDMA (Multi-Carrier CDMA)**

129. What is MC-CDMA?
Combines OFDM and CDMA — spreads signal over multiple subcarriers.

130. Where is MC-CDMA used?
Used in research, 4G/5G prototypes, military systems.

131. Benefit of MC-CDMA?

- **Multiuser access**
- **High data rate**
- **Combats fading**

◆ **Threshold Detection**

132. What is threshold detection?
A method to decide 0 or 1 by comparing signal to a fixed value (threshold).

133. Where is threshold detection used?
In digital receivers to detect bits in ASK, FSK, PSK.

134. Why is threshold important?
It helps in error-free detection under noise.

◆ ZF (Zero Forcing Equalizer)

135. What is Zero Forcing?
An equalization method that tries to cancel channel effects by inverting the channel.

136. Where is ZF used?
In MIMO receivers and wireless equalizers.

137. Disadvantage of ZF?
It amplifies noise when the channel has deep fades.

138. When is ZF effective?
When channel is well-conditioned and noise is low.

◆ Aloha

139. What is ALOHA?
A random access protocol for wireless communication.

140. Types of ALOHA?

- **Pure ALOHA**
- **Slotted ALOHA**

141. Where is ALOHA used?
Used in early satellite and wireless LAN systems.

◆ Cyclic Prefix

142. What is a cyclic prefix?
A copy of the end of OFDM symbol added to the beginning to reduce ISI.

143. Why is cyclic prefix used?
To eliminate inter-symbol interference caused by multipath.

144. In which system is cyclic prefix used?
OFDM-based systems like LTE, Wi-Fi.

◆ Unicast, Multicast, Broadcast

145. What is Unicast?
One-to-one communication.

146. What is Multicast?
One-to-many (selected group) communication.

147. What is Broadcast?
One-to-all communication in the network.

◆ **Spread Spectrum**

148. What is Spread Spectrum?
A technique where signal is spread over a wide frequency band.

149. Types of Spread Spectrum?

- DSSS (Direct Sequence Spread Spectrum)
- FHSS (Frequency Hopping Spread Spectrum)

150. Why is Spread Spectrum used?
Provides resistance to interference and eavesdropping.

◆ **Multipath Fading**

151. What is multipath fading?
Signal arrives via multiple paths causing interference and fading.

152. Causes of multipath fading?
Reflection, diffraction, scattering.

153. How to reduce multipath fading?
Using diversity techniques and equalization.

◆ **Fading**

154. What is fading?
Variation in signal strength over time due to environmental factors.

155. Types of fading?

- Fast fading
- Slow fading
- Flat fading
- Frequency-selective fading

156. What causes fading?
Movement, obstacles, interference.

◆ **M-PSK (M-ary Phase Shift Keying)**

157. What is MPSK?
A modulation scheme where data is represented by phase shifts.

158. Examples of MPSK?
BPSK, QPSK, 8-PSK.

159. Advantage of MPSK?
Good spectral efficiency.

◆ **M-QAM (M-ary Quadrature Amplitude Modulation)**

160. What is MQAM?
A modulation that combines amplitude and phase modulation.

161. Where is MQAM used?
Wi-Fi, 4G LTE, cable modems.

162. Advantage of MQAM?
Higher data rates using the same bandwidth.

◆ **Wireless Topologies**

163. What is a wireless topology?
Structure of how wireless devices are connected.

164. Types of wireless topologies?

- **Star**
- **Mesh**
- **Tree**
- **Point-to-point**
- **Point-to-multipoint**

165. Which topology is used in Wi-Fi?
Mostly star or mesh.

◆ **Point-to-Point Communication**

166. What is point-to-point communication?
It is direct communication between only two devices (one sender, one receiver).

167. Example of point-to-point communication?
Bluetooth headset to mobile, USB cable between PC and printer.

◆ **Pure ALOHA**

168. What is Pure ALOHA?
A random access protocol where data is sent at any time without checking the channel.

169. Drawback of Pure ALOHA?
High collision rate → max throughput is only 18.4%.

◆ **Slotted ALOHA**

170. What is Slotted ALOHA?
Improved ALOHA where time is divided into slots; transmission starts only at beginning of a slot.

171. Advantage of Slotted ALOHA?
Lower collision → max throughput is 36.8%.

◆ **Common Channel Signaling (CCS)**

172. What is common channel signaling?
Control/signaling information is sent through a separate dedicated channel, not mixed with voice/data.

173. Example of CCS?
SS7 (Signaling System 7) in telephone networks.

◆ **SS7 (Signaling System No. 7)**

174. What is SS7?
A set of signaling protocols used to set up and tear down telephone calls in PSTN and mobile networks.

175. Functions of SS7?
Call setup, SMS routing, billing, roaming.

◆ **PCS (Personal Communication Services)**

176. What is PCS?
A wireless communication system that provides mobile and personal communication.

177. Where is PCS used?
Mainly in North America for cellular and paging services.

178. Frequency band of PCS?
1.9 GHz band.

◆ MRC (Maximal Ratio Combining)

179. What is MRC?
A diversity technique where multiple received signals are combined in proportion to their SNR for best result.

180. Why is MRC used?
To maximize received SNR and reduce fading effects.

◆ EGC (Equal Gain Combining)

181. What is EGC?
Combines multiple received signals with equal gain, unlike MRC which uses weights.

182. Advantage of EGC?
Simpler than MRC, but not as effective in all conditions.

◆ MMSE Equalizer (Minimum Mean Square Error)

183. What is MMSE Equalizer?
It balances between removing ISI and limiting noise enhancement.

184. Advantage of MMSE over ZF?
MMSE reduces both ISI and noise, while ZF only removes ISI but may increase noise.

◆ Channel Capacity

185. What is channel capacity?
Maximum data rate that can be transmitted over a communication channel without error.

186. Formula of channel capacity?
Shannon's Formula:
$C = B \times \log_2(1 + S/N)$
Where C = capacity, B = bandwidth, S/N = signal-to-noise ratio.

◆ Roaming (Romar)

187. What is roaming?
When a mobile user moves outside their home network but still gets service using another network.

188. Types of roaming?

- National roaming
- International roaming

◆ **Hopped Field (Hopping Field)**

189. What is frequency hopping?
A method where signal frequency changes rapidly according to a pattern (used in spread spectrum).

190. What is a hopping field?
The range of frequencies used in frequency hopping communication.

◆ **Selection Combining**

191. What is selection combining?
A diversity technique where the strongest signal among multiple received copies is selected.

192. Advantage of selection combining?
Simple and reduces effect of fading.

◆ **Outage Probability**

193. What is outage probability?
Probability that the received signal falls below a certain threshold (cannot maintain communication).

194. What affects outage probability?
Fading, noise, path loss.

◆ **Average Probability (Average Error Probability)**

195. What is average error probability?
The average chance of bit or symbol error under varying channel conditions.

196. Why important?
It measures overall system performance in noisy/fading environment.

◆ **Noise**

197. What is noise?
Unwanted signals that interfere with the desired signal.

198. Types of noise?

- **Thermal noise**
- **Interference**
- **AWGN (Additive White Gaussian Noise)**

◆ Spread Spectrum (Repeat from earlier for clarity)

199. What is spread spectrum?
Technique to spread the signal over a wider bandwidth than necessary.

200. Purpose of spread spectrum?

- **Security**
- **Interference resistance**
- **Multipath protection**

201.What is a router?
A network device that connects two or more networks and forwards data packets to the correct destination.

202. What is the function of a router?
To manage network traffic and forward data on the correct path.

203.What is a hub?
A simple device that broadcasts data signals to all connected devices in a network.

204.What is the problem with a hub?
Data goes to all devices without filtering or routing, causing network slowdown.

205.What is broadcast?
Sending data from one device to all devices at once.

206.Give an example of broadcast.
TV broadcast, Wi-Fi broadcast messages.

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1. **What is convolutional coding?**
   A coding technique to correct errors in transmitted data.

2. **What is a 1/2 rate convolutional code?**
   A code producing 2 output bits for every input bit.

3. **What is DS-CDMA?**
   Direct Sequence Code Division Multiple Access.

4. **What does AWGN stand for?**
   Additive White Gaussian Noise.

5. **What is the effect of AWGN on signals?**
   It adds random noise to the signal.

6. **What is Rayleigh fading?**
   Signal fading caused by multipath without line-of-sight.

7. **What is Rician fading?**
   Signal fading with a strong direct path.

8. **Why simulate DS-CDMA in fading channels?**
   To study real wireless channel effects on performance.

9. **What is OQPSK?**
   Offset Quadrature Phase Shift Keying modulation.

10. **What is differential encoding?**
    Encoding information as phase changes between symbols.

11. **What is FEC in communication?**
    Forward Error Correction to fix errors at the receiver.

12. **What is interleaving?**
    Rearranging data bits to reduce burst errors.

13. **What is BPSK modulation?**
    Binary Phase Shift Keying with two phase states.

14. **What is QPSK modulation?**
    Quadrature Phase Shift Keying with four phase states.

15. **What is 4-QAM?**
    Quadrature Amplitude Modulation with 4 symbols.

16. **What is 16-QAM?**
    Quadrature Amplitude Modulation with 16 symbols.

17. **Why use interleaved FEC with modulation?**
    To improve error performance over noisy channels.

18. **What does simulating waveforms in MATLAB show?**
    Signal changes at various stages of communication.

19. What does 'encoded DS-CDMA system' mean?
     DS-CDMA system with error correcting codes applied.

20. What is the purpose of convolutional encoding?
     To add redundancy for error correction.

21. Why compare AWGN and fading channel results?
     To see how fading degrades system performance.

22. What does differential OQPSK help with?
     Reducing phase ambiguity at the receiver.

23. What kind of errors can FEC correct?
     Random and burst errors.

24. What is the advantage of multi-level QAM?
     Higher data rate transmission.

25. How does interleaving help in FEC?
     Spreads errors so FEC can correct them easily.

26. What is the significance of simulating multiple modulation schemes?
     To compare their error performance.

27. What is a channel model in simulation?
     Mathematical representation of real-world channel behavior.

28. What role does MATLAB play in communication simulations?
     It provides tools to model and analyze systems.

29. How is convolutional coding implemented in MATLAB?
     Using built-in functions like 'convenc'.

30. Why is performance evaluation important in wireless systems?
     To design reliable and efficient communication.