Chapter 13: Multiplexing and Multiple-Access Techniques

MULTIPLE CHOICE

1. TDMA stands for:
   a. Time Domain Multiple Access  
   b. Time-Division Multiple Access  
   c. Tone Division Multiple Access  
   d. none of the above

   ANS: B

2. CDMA stands for:
   a. Code-Division Multiple Access  
   b. Carrier Division Multiple Access  
   c. Compact Digital Multiplex Arrangement  
   d. none of the above

   ANS: A

3. TDMA is used instead of TDM when:
   a. all the signals come from the same source  
   b. the signals come from different sources  
   c. TDM is used in RF communications  
   d. they mean the same thing

   ANS: B

4. When calculating the maximum number of users, a limiting factor in FDM is:
   a. the type of media used  
   b. the length of the channel  
   c. the bandwidth of each signal  
   d. all of the above

   ANS: C

5. A DS-1 signal contains:
   a. 12 channels  
   b. 24 channels  
   c. 32 channels  
   d. 64 channels

   ANS: B

6. The bit-rate of a DS-1 signal over a T-1 line is:
   a. 64 kbps  
   b. 256 kbps  
   c. 1.536 Mbps  
   d. 1.544 Mbps

   ANS: D

7. Besides data bits, a DS-1 frame contains a:
   a. timing bit  
   b. T-bit  
   c. signaling bit  
   d. framing bit

   ANS: D

8. In DS-1, a bit is "stolen" out of each channel:
   a. every frame  
   b. every other frame  
   c. every sixth frame  
   d. every twelfth frame
9. Moving signals from one line to another is called:
   a. time switching  
   b. space switching  
   c. line switching  
   d. cross-point switching
   **ANS: B**

10. Moving PCM samples from one time-slot to another is called:
    a. time switching  
    b. space switching  
    c. signal switching  
    d. crosspoint switching
    **ANS: A**

11. A digital space switch is a:
    a. multiplexer  
    b. TDM switch  
    c. computerized Strowger switch  
    d. crosspoint switch
    **ANS: D**

12. Spread-spectrum can be done by using:
    a. computer-controlled frequency reuse  
    b. frequency-hopping  
    c. direct-sequence method  
    d. all of the above
    **ANS: D**

13. The term "chip rate" is used in describing:
    a. computer-controlled frequency reuse  
    b. frequency-hopping  
    c. direct-sequence method  
    d. all of the above
    **ANS: C**

14. For a given data rate, direct-sequence systems, compared to standard RF systems, use:
    a. about the same bandwidth  
    b. much more bandwidth  
    c. much less bandwidth  
    d. approximately double the bandwidth
    **ANS: B**

15. "Processing gain" is another term for:
    a. RF gain  
    b. computer speed  
    c. spreading gain  
    d. improved signal-to-noise ratio
    **ANS: C**

16. To calculate processing gain, divide the transmitted RF bandwidth by:
    a. the digital data bit rate  
    b. bandwidth of original baseband  
    c. the S/N ratio  
    d. the chip size
    **ANS: B**

17. A receiver for frequency-hopping spread-spectrum would be:
    a. a narrowband receiver  
    b. a wideband receiver  
    c. a direct-conversion receiver  
    d. a CDMA receiver
18. A receiver for direct-sequence spread-spectrum would be:
   a. a narrowband receiver  
   b. a wideband receiver  
   c. a direct-conversion receiver  
   d. a "chip-rate" receiver  
   ANS: B

19. CDMA:
   a. cannot be used with frequency-hopping spread-spectrum  
   b. cannot be used with direct-sequence spread-spectrum  
   c. cannot be used on an RF channel  
   d. allows many transmitters to use a band simultaneously  
   ANS: D

20. For optimal performance, CDMA requires the use of:
   a. orthogonal PN sequences  
   b. non-orthogonal PN sequences  
   c. true-random PN sequences  
   d. none of the above  
   ANS: A

COMPLETION

1. Multiplexing allows many signals to ____________________ a channel.
   ANS: share

2. Three methods of multiple access are FDMA, TDMA, and ____________________.
   ANS: CDMA

3. In FDM, each signal uses part of the bandwidth ____________________ of the time.
   ANS: all

4. In TDM, each signal uses all of the bandwidth ____________________ of the time.
   ANS: part

5. Using CDMA on a radio channel, all signals can transmit ____________________ of the time.
   ANS: all

6. DS-1 is an example of ____________________-division multiplexing.
   ANS: time

7. The AM radio band is an example of ____________________-division multiplexing.
   ANS: frequency
8. A DS-1 frame contains one sample from each of _____________ channels.
   ANS: 24

9. T1 uses the _____________ line code.
   ANS: AMI

10. Each DS-1 frame contains a total of _____________ bits.
    ANS: 193

11. A DS-1 frame is transmitted at a rate of _____________ bits per second.
    ANS: 1.544 Meg

12. Each sample in a DS-1 frame contains _____________ bits.
    ANS: 8

13. A group of twelve DS-1 frames is called a _____________.
    ANS: superframe

14. Switching signals from one line to another is called _____________ switching.
    ANS: space

15. Moving PCM samples from one time slot to another is called _____________ switching.
    ANS: time

16. The deep fades caused by signal-cancellation due to reflection are called _____________ fading.
    ANS: Rayleigh

17. A PN sequence is a _____________-random noise sequence.
    ANS: pseudo

18. One method of spread-spectrum is frequency _____________
    ANS: hopping

19. It is _____________ to jam a spread-spectrum signal.
    ANS: difficult

20. It is _____________ to eavesdrop on a spread-spectrum signal.
ANS: difficult

21. The extra bits added to the data in direct-sequence spread-spectrum are called ________________.
ANS: chips

22. A chipping-rate of at least ________________ times the bit rate of the data is common.
ANS: ten

23. The 'C' in CDMA stands for ________________.
ANS: code

24. In a frequency-hopping CDMA system, when no two transmitters use the same frequency at the same time the PN sequences are said to be ________________.
ANS: orthogonal

SHORT ANSWER

1. What does Hartley's Law tell us about the relationship between time and bandwidth for digital transmission?
ANS: The more bandwidth, the less time it takes to send a given amount of information. So the more bandwidth available, the higher the possible bit rate.

2. How many signals could fit into 1 MHz of bandwidth if each signal required 100 kHz of bandwidth and the separation between adjacent channels was 10 kHz?
ANS: 9

3. Why is it difficult to jam a spread-spectrum signal?
ANS: Jamming requires an interference signal of sufficient power in the same part of the spectrum the information signal occupies. Because a spread-spectrum signal is, by definition, spread out over a very wide bandwidth, jamming can interfere with only a small fraction of the total signal.

4. Why is it difficult to eavesdrop on a spread-spectrum signal?
ANS: In a spread-spectrum transmission, the signal power at any given frequency in its band is so low that it is virtually indistinguishable from noise. An eavesdropper would not know a signal was being sent. And without knowing the exact sequence being used, it is virtually impossible to "de-spread" the signal.

5. Why is autocorrelation used to receive direct-sequence spread-spectrum signals?
ANS:
Autocorrelation allows a signal to be "pulled out of" the noise even when the signal-to-noise ratio is less than one, as it is in spread-spectrum.

6. What is meant by "orthogonal sequences" in CDMA?

ANS:
During transmission, the PN sequences determine which parts of the available bandwidth the spread-spectrum signal will occupy. Assume you have two PN sequences: PN1 and PN2. At some point in time, suppose PN1 would cause a transmission to occupy frequencies f11, f12, f13, and so forth. Now suppose PN2 would cause the transmission to occupy frequencies f21, f22, f23, and so forth. If the two sets of frequencies, (f11, f12, f13, ...) and (f21, f22, f23, ...), have no frequencies in common, then the two PN sequences are said to be orthogonal.