

Chapter 7: Digital Communications

MULTIPLE CHOICE

1. The first digital code was the:
- a. ASCII code
 - b. Baudot code
 - c. Morse code
 - d. none of the above

ANS: C

2. In digital transmission, signal degradation can be removed using:
- a. an amplifier
 - b. a filter
 - c. a regenerative repeater
 - d. all of the above

ANS: C

3. TDM stands for:
- a. Time-Division Multiplexing
 - b. Time-Domain Multiplexing
 - c. Ten-Digital Manchester
 - d. Ten Dual-Manchester

ANS: A

4. Hartley's Law is:
- a. $I = ktB$
 - b. $C = 2B \log_2 M$
 - c. $C = B \log_2(1 + S/N)$
 - d. $SR = 2f_{max}$

ANS: A

5. The Shannon-Hartley theorem is:
- a. $I = ktB$
 - b. $C = 2B \log_2 M$
 - c. $C = B \log_2(1 + S/N)$
 - d. $SR = 2f_{max}$

ANS: B

6. The Shannon Limit is given by:
- a. $I = ktB$
 - b. $C = 2B \log_2 M$
 - c. $C = B \log_2(1 + S/N)$
 - d. $SR = 2f_{max}$

ANS: C

7. The Nyquist Rate can be expressed as:
- a. $I = ktB$
 - b. $C = 2B \log_2 M$
 - c. $C = B \log_2(1 + S/N)$
 - d. $SR = 2f_{max}$

ANS: D

8. Natural Sampling does not use:
- a. a sample-and-hold circuit
 - b. true binary numbers
 - c. a fixed sample rate
 - d. an analog-to-digital converter

ANS: A

9. Which is true about aliasing and foldover distortion?
- a. They are two types of sampling error.
 - b. You can have one or the other, but not both.
 - c. Aliasing is a technique to prevent foldover distortion.
 - d. They are the same thing.

ANS: D

10. Foldover distortion is caused by:
- a. noise
 - b. too many samples per second
 - c. too few samples per second
 - d. all of the above

ANS: C

11. The immediate result of sampling is:
- a. a sample alias
 - b. PAM
 - c. PCM
 - d. PDM

ANS: B

12. Which of these is not a pulse-modulation technique:
- a. PDM
 - b. PWM
 - c. PPM
 - d. PPS

ANS: D

13. Quantizing noise (quantization noise):
- a. decreases as the sample rate increases
 - b. decreases as the sample rate decreases
 - c. decreases as the bits per sample increases
 - d. decreases as the bits per sample decreases

ANS: C

14. The dynamic range of a system is the ratio of:
- a. the strongest transmittable signal to the weakest discernible signal
 - b. the maximum rate of conversion to the minimum rate of conversion
 - c. the maximum bits per sample to the minimum bits per sample
 - d. none of the above

ANS: A

15. Companding is used to:
- a. compress the range of base-band frequencies
 - b. reduce dynamic range at higher bit-rates
 - c. preserve dynamic range while keeping bit-rate low
 - d. maximize the useable bandwidth in digital transmission

ANS: C

16. In North America, companding uses:
- a. the Logarithmic Law
 - b. the A Law
 - c. the α Law (alpha law)
 - d. the μ Law (mu law)

ANS: D

17. In Europe, companding uses:

- a. the Logarithmic Law
- b. the A Law
- c. the α Law (alpha law)
- d. the μ Law (mu law)

ANS: B

18. Codec stands for:

- a. Coder-Decoder
- b. Coded-Carrier
- c. Code-Compression
- d. none of the above

ANS: A

19. A typical codec in a telephone system sends and receives:

- a. 4-bit numbers
- b. 8-bit numbers
- c. 12-bit numbers
- d. 16-bit numbers

ANS: B

20. Compared to PCM, delta modulation:

- a. transmits fewer bits per sample
- b. requires a much higher sampling rate
- c. can suffer slope overload
- d. all of the above

ANS: D

21. In delta modulation, "granular noise" is produced when:

- a. the signal changes too rapidly
- b. the signal does not change
- c. the bit rate is too high
- d. the sample is too large

ANS: B

22. Compared to PCM, adaptive delta modulation can transmit voice:

- a. with a lower bit rate but reduced quality
- b. with a lower bit rate but the same quality
- c. only over shorter distances
- d. only if the voice is band-limited

ANS: B

23. Which coding scheme requires DC continuity:

- a. AMI
- b. Manchester
- c. unipolar NRZ
- d. bipolar RZ

ANS: C

24. Manchester coding:

- a. is a biphasic code
- b. has a level transition in the middle of every bit period
- c. provides strong timing information
- d. all of the above

ANS: D

25. The number of framing bits in DS-1 is:

- a. 1
- b. 2
- c. 4
- d. 8

ANS: A

26. Framing bits in DS-1 are used to:

- a. detect errors
- b. carry signaling
- c. synchronize the transmitter and receiver
- d. all of the above

ANS: C

27. So-called "stolen" bits in DS-1 are used to:

- a. detect errors
- b. carry signaling
- c. synchronize the transmitter and receiver
- d. all of the above

ANS: B

28. The number of bits per sample in DS-1 is:

- a. 1
- b. 2
- c. 4
- d. 8

ANS: D

29. The number of samples per second in DS-1 is:

- a. 8 k
- b. 56 k
- c. 64 k
- d. 1.544×10^6

ANS: A

30. The bit rate for each channel in DS-1 is:

- a. 1.544 Mb/s
- b. 64 kb/s
- c. 56 kb/s
- d. 8 kb/s

ANS: B

31. In DS-1, bits are transmitted over a T-1 cable at:

- a. 1.544 MB/s
- b. 64 kb/s
- c. 56 kb/s
- d. 8 kb/s

ANS: A

32. A T-1 cable uses:

- a. Manchester coding
- b. bipolar RZ AMI coding
- c. NRZ coding
- d. pulse-width coding

ANS: B

33. The number of frames in a superframe is:

- a. 6
- b. 12
- c. 24
- d. 48

ANS: B

34. A typical T-1 line uses:

- a. twisted-pair wire
- b. coaxial cable
- c. fiber-optic cable
- d. microwave

ANS: A

35. "Signaling" is used to indicate:

- a. on-hook/off-hook condition
- b. busy signal
- c. ringing
- d. all of the above

ANS: D

36. A vocoder implements compression by:

- a. constructing a model of the transmission medium
- b. constructing a model of the human vocal system
- c. finding redundancies in the digitized data
- d. using lossless techniques

ANS: B

37. Compared to standard PCM systems, the quality of the output of a vocoder is:

- a. much better
- b. somewhat better
- c. about the same
- d. not as good

ANS: D

COMPLETION

1. Digitizing a signal often results in _____ transmission quality.

ANS:
improved
better

2. To send it over an analog channel, a digital signal must be _____ onto a carrier.

ANS: modulated

3. To send it over a digital channel, an analog signal must first be _____.

ANS: digitized

4. In analog channels, the signal-to-noise ratio of an analog signal gradually _____ as the length of the channel increases.

ANS:
decreases
gets worse

5. The _____ value of a pulse is the only information it carries on a digital channel.

ANS: binary

6. A _____ repeater is used to restore the shape of pulses on a digital cable.

ANS: regenerative

7. There are techniques to detect and _____ some errors in digital transmission.

ANS: correct

8. Converting an analog signal to digital form is another source of _____ in digital transmission systems.

ANS:
error
noise

9. _____-division multiplexing is easily done in digital transmission.

ANS: Time

10. All practical communications channels are band-_____.

ANS: limited

11. _____ Law gives the relationship between time, information capacity, and bandwidth.

ANS: Hartley's

12. Ignoring noise, the _____ theorem gives the maximum rate of data transmission for a given bandwidth.

ANS: Shannon-Hartley

13. The _____ limit gives the maximum rate of data transmission for a given bandwidth and a given signal-to-noise ratio.

ANS: Shannon

14. _____ sampling is done without a sample-and-hold circuit.

ANS: Natural

15. The _____ Rate is the minimum sampling rate for converting analog signals to digital format.

ANS: Nyquist

16. _____ distortion occurs when an analog signal is sampled at too slow a rate.

ANS: Foldover

17. _____ means that higher frequency baseband signals from the transmitter "assume the identity" of low-frequency baseband signals at the receiver when sent digitally.

ANS: Aliasing

18. The output of a sample-and-hold circuit is a pulse-_____ modulated signal.

ANS: amplitude

19. _____ modulation is the most commonly used digital modulation scheme.

ANS: Pulse-code

20. _____ noise results from the process of converting an analog signal into digital format.

ANS: Quantizing

21. _____ is used to preserve dynamic range using a reasonable bandwidth.

ANS: Comanding

22. In North America, compression is done using the _____-law equation.

ANS:

μ
mu

23. In Europe, compression is done using the _____-law equation.

ANS: A

24. A _____ is an IC that converts a voice signal to PCM and vice versa.

ANS: codec

25. In a PCM system, the samples of the analog signal are first converted to _____ bits before being compressed to 8 bits.

ANS: 12

26. The number of bits per sample transmitted in delta modulation is _____.

ANS:

1
one

27. Delta modulation requires a _____ sampling rate than PCM for the same quality of reproduction.

ANS: higher

28. _____ noise is produced by a delta modulator if the analog signal doesn't change.
ANS: Granular
29. In delta modulation, _____ overload can occur if the analog signal changes too fast.
ANS: slope
30. The _____ size varies in adaptive delta modulation.
ANS: step
31. Adaptive delta modulation can transmit PCM-quality voice at about _____ the bit rate of PCM.
ANS: half
32. Unipolar NRZ is not practical because most channels do not have _____ continuity.
ANS: DC
33. In AMI, binary ones are represented by a voltage that alternates in _____.
ANS: polarity
34. Long strings of _____ should be avoided in AMI.
ANS: zeros
35. Manchester code has a level _____ in the center of each bit period.
ANS: transition
36. Manchester coding provides _____ information regardless of the pattern of ones and zeros.
ANS: timing
37. There are _____ channels in a DS-1 frame.
ANS: 24
38. DS-1 uses a _____ bit to synchronize the transmitter and receiver.
ANS: framing
39. In DS-1, each channel is sampled _____ times per second.
ANS: 8000
40. Data is carried over a T-1 line at a rate of _____ bits per second.

ANS: 1.544×10^6

41. A group of 12 DS-1 frames is called a _____.

ANS: superframe

42. From a group of twelve frames, signaling bits are "stolen" from every _____ frame.

ANS: sixth

43. _____ compression transmits all the data in the original signal but uses fewer bits to do it.

ANS: Lossless

SHORT ANSWER

1. Use Hartley's Law to find how much time it would take to send 100,000 bits over a channel with a bandwidth of 2,000 hertz and a channel constant of $k = 10$.

ANS:
5 seconds

2. Use the Shannon-Hartley theorem to find the bandwidth required to send 12,000 bits per second if the number of levels transmitted is 8.

ANS:
2000 hertz

3. What is the Shannon Limit of a channel that has a bandwidth of 4000 hertz and a signal-to-noise ratio of 15?

ANS:
16 kbps

4. What is the minimum required number of samples per second to digitize an analog signal with frequency components ranging from 300 hertz to 3300 hertz?

ANS:
6600 samples/second

5. What is the approximate dynamic range, in dB, of a linear PCM system that uses 12 bits per sample?

ANS:
74 dB

6. What is the approximate data rate for a system using 8 bits per sample and running at 8000 samples per second?

ANS:
64 kbps

7. If bits were "stolen" from every DS-1 frame, what would the useable data-rate be for each channel in the frame?

ANS:
56 kbps

8. Assuming maximum input and output voltages of 1 volt, what is the output voltage of a μ -law compressor if the input voltage is 0.388 volt?

ANS:
0.833 volt