

CHAPTER 3

Data and Signals

Solutions to Review Questions and Exercises

Review Questions

1. **Frequency** and **period** are the inverse of each other. $T = 1/f$ and $f = 1/T$.
2. The **amplitude** of a signal measures the value of the signal at any point. The **frequency** of a signal refers to the number of periods in one second. The phase describes the position of the waveform relative to time zero.
3. Using Fourier analysis. **Fourier series** gives the frequency domain of a periodic signal; **Fourier analysis** gives the frequency domain of a nonperiodic signal.
4. Three types of transmission impairment are **attenuation**, **distortion**, and **noise**.
5. **Baseband transmission** means sending a digital or an analog signal without modulation using a low-pass channel. **Broadband transmission** means modulating a digital or an analog signal using a band-pass channel.
6. A **low-pass channel** has a bandwidth starting from zero; a **band-pass** channel has a bandwidth that does not start from zero.
7. The **Nyquist theorem** defines the maximum bit rate of a noiseless channel.
8. The **Shannon capacity** determines the theoretical maximum bit rate of a noisy channel.
9. **Optical signals** have very high frequencies. A high frequency means a short wave length because the wave length is inversely proportional to the frequency ($\lambda = v/f$), where v is the propagation speed in the media.
10. A signal is **periodic** if its frequency domain plot is **discrete**; a signal is **nonperiodic** if its frequency domain plot is **continuous**.
11. The frequency domain of a voice signal is normally **continuous** because voice is a **nonperiodic** signal.
12. An alarm system is normally **periodic**. Its frequency domain plot is therefore **discrete**.
13. This is **baseband transmission** because no modulation is involved.
14. This is **baseband transmission** because no modulation is involved.
15. This is **broadband transmission** because it involves modulation.

CHAPTER 4

Digital Transmission

Solutions to Review Questions and Exercises

Review Questions

1. The three different techniques described in this chapter are **line coding**, **block coding**, and **scrambling**.
 2. A **data element** is the smallest entity that can represent a piece of information (a bit). A **signal element** is the shortest unit of a digital signal. Data elements are what we need to send; signal elements are what we can send. Data elements are being carried; signal elements are the carriers.
 3. The **data rate** defines the number of data elements (bits) sent in 1s. The unit is bits per second (bps). The **signal rate** is the number of signal elements sent in 1s. The unit is the baud.
 4. In decoding a digital signal, the incoming signal power is evaluated against the **baseline** (a running average of the received signal power). A long string of 0s or 1s can cause **baseline wandering** (a drift in the baseline) and make it difficult for the receiver to decode correctly.
 5. When the voltage level in a digital signal is constant for a while, the spectrum creates very low frequencies, called **DC components**, that present problems for a system that cannot pass low frequencies.
 6. A **self-synchronizing** digital signal includes timing information in the data being transmitted. This can be achieved if there are transitions in the signal that alert the receiver to the beginning, middle, or end of the pulse.
 7. In this chapter, we introduced **unipolar**, **polar**, **bipolar**, **multilevel**, and **multitransition** coding.
 8. **Block coding** provides redundancy to ensure synchronization and to provide inherent error detecting. In general, block coding changes a block of m bits into a block of n bits, where n is larger than m.
 9. **Scrambling**, as discussed in this chapter, is a technique that substitutes long zerolevel pulses with a combination of other levels without increasing the number of bits.
- 2
10. Both **PCM** and **DM** use sampling to convert an analog signal to a digital signal. PCM finds the value of the signal amplitude for each sample; DM finds the change between two consecutive samples.
 11. In **parallel transmission** we send data several bits at a time. In **serial transmission** we send data one bit at a time.
 12. We mentioned **synchronous**, **asynchronous**, and **isochronous**. In both synchronous and asynchronous transmissions, a bit stream is divided into independent frames. In synchronous transmission, the bytes inside each frame are synchronized; in asynchronous transmission, the bytes inside each frame are also independent. In isochronous transmission, there is no independency at all. All bits in the whole stream must be synchronized.

CHAPTER 5

Analog Transmission

Solutions to Review Questions and Exercises

Review Questions

1. Normally, **analog transmission** refers to the transmission of analog signals using a band-pass channel. Baseband digital or analog signals are converted to a complex analog signal with a range of frequencies suitable for the channel.
2. A **carrier** is a single-frequency signal that has one of its characteristics (amplitude, frequency, or phase) changed to represent the baseband signal.
3. The process of changing one of the characteristics of an analog signal based on the information in digital data is called **digital-to-analog conversion**. It is also called modulation of a digital signal. The baseband digital signal representing the digital data modulates the carrier to create a broadband analog signal.
4.
 - a. ASK changes the **amplitude** of the carrier.
 - b. FSK changes the **frequency** of the carrier.
 - c. PSK changes the **phase** of the carrier.
 - d. QAM changes both the **amplitude** and the **phase** of the carrier.
5. We can say that the most susceptible technique is **ASK** because the amplitude is more affected by noise than the phase or frequency.
6. A **constellation diagram** can help us define the amplitude and phase of a signal element, particularly when we are using two carriers. The diagram is useful when we are dealing with multilevel ASK, PSK, or QAM. In a constellation diagram, a signal element type is represented as a dot. The bit or combination of bits it can carry is often written next to it. The diagram has two axes. The horizontal X axis is related to the in-phase carrier; the vertical Y axis is related to the quadrature carrier.
7. The two components of a signal are called **I** and **Q**. The I component, called inphase, is shown on the horizontal axis; the Q component, called quadrature, is shown on the vertical axis.
8. The process of changing one of the characteristics of an analog signal to represent the instantaneous amplitude of a baseband signal is called **analog-to-analog conversion**. It is also called the modulation of an analog signal; the baseband analog signal modulates the carrier to create a broadband analog signal.
9.
 - a. AM changes the **amplitude** of the carrier
 - b. FM changes the **frequency** of the carrier
 - c. PM changes the **phase** of the carrier
10. We can say that the most susceptible technique is **AM** because the amplitude is more affected by noise than the phase or frequency.

