CHAPTER 5

Analog Transmission

Solutions to Odd-Numbered 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.
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.
5. We can say that the most susceptible technique is ***ASK*** because the amplitude is more affected by noise than the phase or frequency.
7. The two components of a signal are called ***I*** and ***Q***. The I component, called in-phase, is shown on the horizontal axis; the Q component, called quadrature, is shown on the vertical axis.
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

Exercises

11. We use the formula **S = (1/r) × N**, but first we need to calculate the value of r for each case.

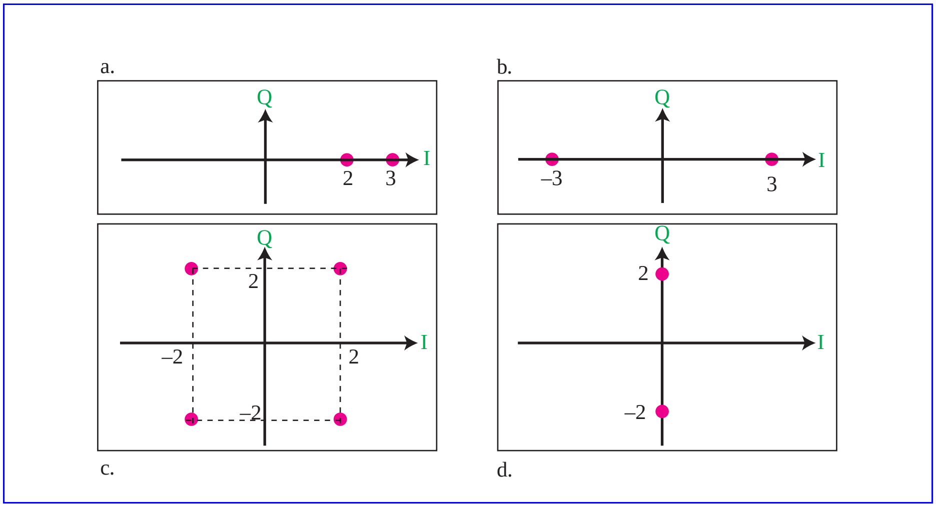
a. $r = \log_2 2 = 1 \rightarrow S = (1/1) \times (2000 \text{ bps}) =$ **2000 baud**
b. $r = \log_2 2 = 1 \rightarrow S = (1/1) \times (4000 \text{ bps}) =$ **4000 baud**
c. $r = \log_2 4 = 2 \rightarrow S = (1/2) \times (6000 \text{ bps}) =$ **3000 baud**
d. $r = \log_2 64 = 6 \rightarrow S = (1/6) \times (36{,}000 \text{ bps}) =$ **6000 baud**

13. We use the formula $\mathbf{r = log_2L}$ to calculate the value of r for each case.

a. $\log_2 4$ = 2
b. $\log_2 8$ = 3
c. $\log_2 4$ = 2
d. $\log_2 128$ = 7

15. See Figure 5.1

Figure 5.1 *Solution to Exercise 15*



a. This is ASK. There are two peak amplitudes both with the same phase (0 degrees). The values of the peak amplitudes are A_1 = 2 (the distance between the first dot and the origin) and A_2= 3 (the distance between the second dot and the origin).
b. This is BPSK, There is only one peak amplitude (3). The distance between each dot and the origin is 3. However, we have two phases, 0 and 180 degrees.
c. This can be either QPSK (one amplitude, four phases) or 4-QAM (one amplitude and four phases). The amplitude is the distance between a point and the origin, which is $(2^2 + 2^2)^{1/2} = 2.83$.
d. This is also BPSK. The peak amplitude is 2, but this time the phases are 90 and 270 degrees.

17. We use the formula $\mathbf{B = (1 + d) \times (1/r) \times N}$, but first we need to calculate the value of r for each case.

a. r = 1 → B= (1 + 1) × (1/1) × (4000 bps) = **8000 Hz**
b. r = 1 → B = (1 + 1) × (1/1) × (4000 bps) + 4 KHz = **8000 Hz**
c. r = 2 → B = (1 + 1) × (1/2) × (4000 bps) = **2000 Hz**
d. r = 4 → B = (1 + 1) × (1/4) × (4000 bps) = **1000 Hz**

19.

First, we calculate the bandwidth for each channel = (1 MHz) / 10 = 100 KHz. We then find the value of r for each channel:

$$B = (1 + d) \times (1/r) \times (N) \rightarrow r = N / B \rightarrow r = (1\ \text{Mbps}/100\ \text{KHz}) = 10$$

We can then calculate the number of levels: $L = 2^r = 2^{10} =$ **1024.** This means that that we need a **1024-QAM** technique to achieve this data rate.

21.

a. $B_{AM} = 2 \times B = 2 \times 5$ = **10 KHz**
b. $B_{FM} = 2 \times (1 + \beta) \times B = 2 \times (1 + 5) \times 5$ **= 60 KHz**
c. $B_{PM} = 2 \times (1 + \beta) \times B = 2 \times (1 + 1) \times 5$ = **20 KHz**