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18b-129-se

Assignment 1

16C:
T = 1 / f = 1 / (140 KHz) = 0.00000714 s = 7.14×10^{-6} s = 7.14 μs

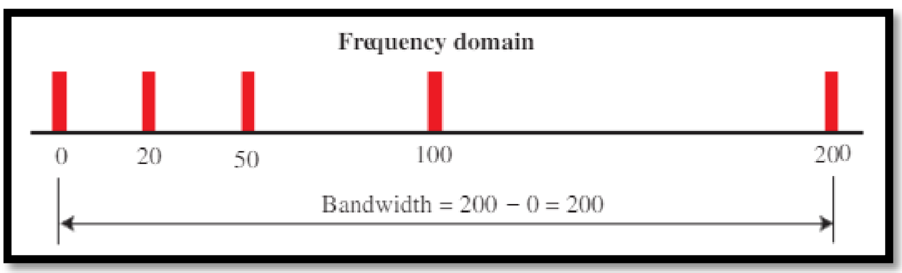
17B:

f = 1 / T = 1 / (12 μs) =83333 Hz = 83.333×10^{3} Hz = 83.333 KHz

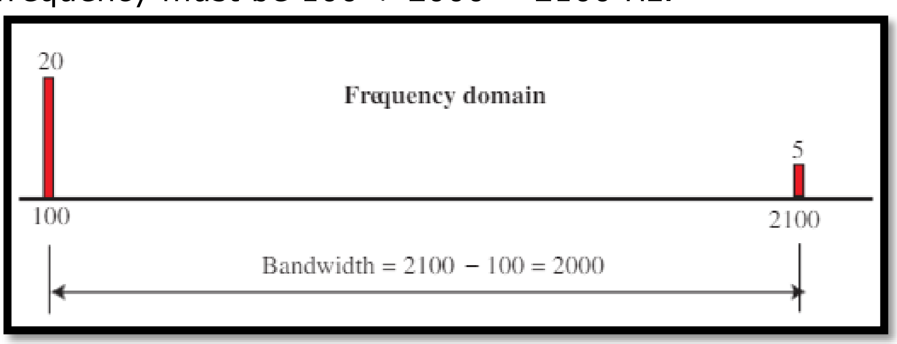
18C:

90 degrees (π/2 radian)

19.



20. We know the lowest frequency, 100. We know the bandwidth is 2000. The highest frequency must be 100 + 2000 = 2100 Hz.



21. Each signal is a simple signal in this case. The bandwidth of a simple signal is zero. So the bandwidth of both signals are the same.

24. There are 8 bits in 16 ns. Bit rate is
= 8 / (16 × 10^$^{-9}$) = 0.5 × 10^$^{-9}$
= 500 Mbps

26. The bandwidth is

$= 5 \times 5 \Rightarrow 25$ Hz.

29.
Using the first harmonic, data rate = 2 × 6 MHz = 12 Mbps
Using three harmonics, data rate = (2 × 6 MHz) /3 = 4 Mbps
Using five harmonics, data rate = (2 × 6 MHz) /5 = 2.4 Mbps

30. $\text{dB} = 10 \log_{10} (90 / 100) = -0.46$ dB

32. The total gain is 3 × 4 = 12 dB. The signal is amplified by a factor $10^{1.2} = 15.85$.

37. We have $4{,}000 \log_2 (1 + 10 / 0.005) = 43{,}866$ bps

38. The file contains 2,000,000 × 8 = 16,000,000 bits. With a 56-Kbps channel, it takes
16,000,000/56,000 = 289 s. With a 1-Mbps channel, it takes 16 s.

42. We can approximately calculate the capacity as
a. $C = B \times (SNR_{dB}/3) = 20 \text{ KHz} \times (40 /3) = 267$ Kbps
b. $C = B \times (SNR_{dB}/3) = 200 \text{ KHz} \times (4 /3) = 267$ Kbps
c. $C = B \times (SNR_{dB}/3) = 1 \text{ MHz} \times (20 /3) = 6.67$ Mbps

43.
a. The data rate is doubled (C2= 2 × C1).
b. When the SNR is doubled, the data rate increases slightly. We can say that, approximately, (C2= C1+ 1).

47.
a. Number of bits = bandwidth × delay = 1 Mbps × 2 ms = 2000 bits
b. Number of bits = bandwidth × delay = 10 Mbps × 2 ms = 20,000 bits
c. Number of bits = bandwidth × delay = 100 Mbps × 2 ms = 200,000 bits

48.
We have
Latency = processing time + queuing time +
Transmission time + propagation time
Processing time = 10 × 1 μs = 10 μs = 0.000010 s
Queuing time = 10 × 2 μs = 20 μs = 0.000020 s
Transmission time = 5,000,000 / (5 Mbps) = 1 s
Propagation time = (2000 Km) / (2 × 10^8) = 0.01 s
Latency = 0.000010 + 0.000020 + 1 + 0.01 = 1.01000030 s
The transmission time is dominant here because the packet size is huge.

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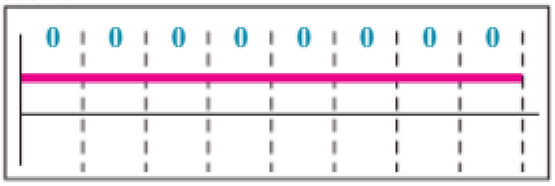
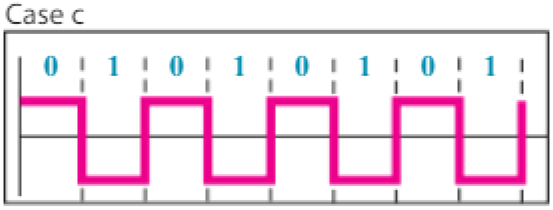
Chap#4:

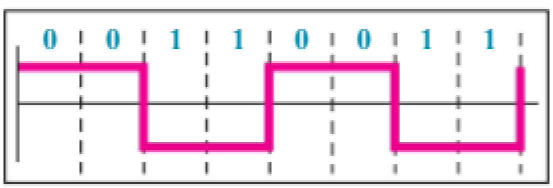
15.

Case a



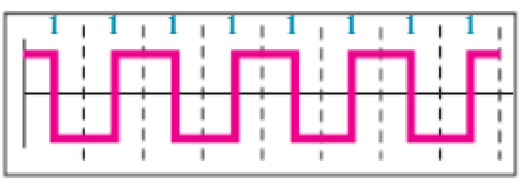
Case c





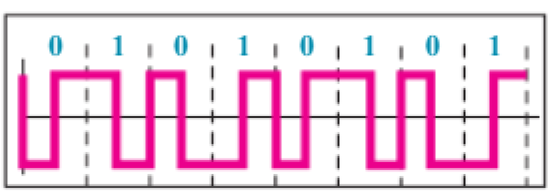
Case d

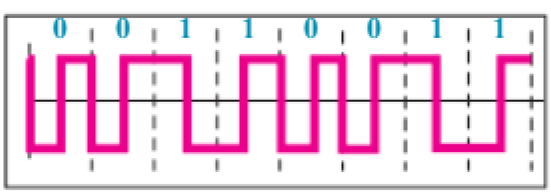
18.



Case b

Case c





Case d

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21.
The data stream can be found as
a. NRZ-I: 10011001.
b. Differential Manchester: 11000100.
c. AMI: 01110001.

28.

a. In a low pass signal, the minimum frequency is 0. Therefore, we can say
f_{max}= 0 + 200 = 200 KHz → f_s
= 2 × 200,000 = 400,000 samples/s
The number of bits per sample and the bit rate are
n_b= $\log_2 1024$ = 10 bits/sample N = 400 KHz × 10 = 4 Mbps

b. The value of n_b= 10. We can easily calculate the value of SNR_{dB}
SNR_{dB}= 6.02 × n_b+ 1.76 = 61.96

c. The value of n_b= 10. The minimum bandwidth can be calculated as
B_{PCM} = n_b× B_{analog}= 10 × 200 KHz = 2 MHz

30. We can first calculate the sampling rate (fs) and the number of bits per sample (nb)
f_{max}= 0 + 4 = 4 KHz → f_s
= 2 × 4 = 8000 sample/s

We then calculate the number of bits per sample.
→ n_b= 30000 / 8000 = 3.75

We need to use the next integer n_b= 4. The value of SNR_{dB} is SNR_{dB}
= 6.02 × n_b+ 1.72 = 25.8

32.
a. For synchronous transmission, we have 1000 × 8 = 8000 bits.
b. For asynchronous transmission, we have 1000 × 10 = 10000 bits. Note that we assume only one stop bit and one start bit. Some systems send more start bits.
c. For case a, the redundancy is 0%. For case b, we send 2000 extra for 8000 required bits. The redundancy is 25%.

Chap#5:
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 → S = (1/1) × (2000 bps) = 2000 baud
b. r = $\log_2 2$ = 1 → S = (1/1) × (4000 bps) = 4000 baud
c. r = $\log_2 4$ = 2 → S = (1/2) × (6000 bps) = 3000 baud

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d. $r = \log_2 64 = 6 \rightarrow S = (1/6) \times (36{,}000 \text{ bps}) = 6000$ baud

13. We use the formula $r = \log_2 L$ 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.
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 $B = (1 + d) \times (1/r) \times N$, but first we need to calculate the value of r for each case.

a. $r = 1 \rightarrow B = (1 + 1) \times (1/1) \times (4000 \text{ bps}) = 8000$ Hz
b. $r = 1 \rightarrow B = (1 + 1) \times (1/1) \times (4000 \text{ bps}) + 4$ KHz $= 8000$ Hz
c. $r = 2 \rightarrow B = (1 + 1) \times (1/2) \times (4000 \text{ bps}) = 2000$ Hz
d. $r = 4 \rightarrow B = (1 + 1) \times (1/4) \times (4000 \text{ bps}) = 1000$ Hz

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