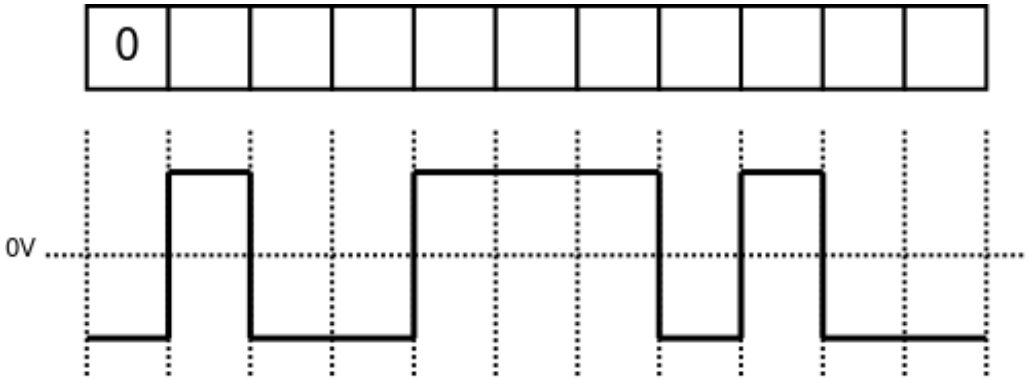
ITS323 – Quiz 3 Answers

Name: _____

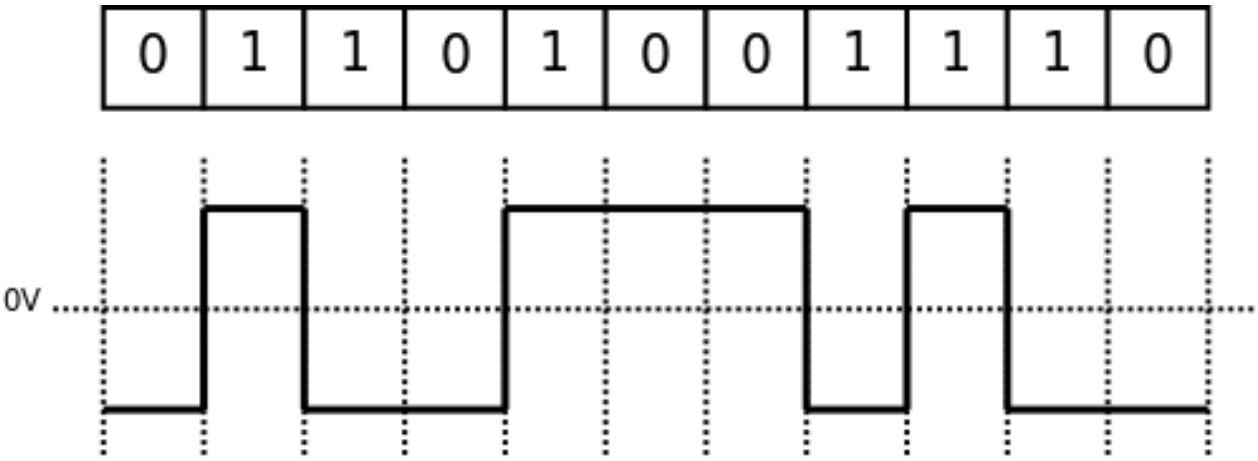
ID: _____ Mark: _____ (out of 10)

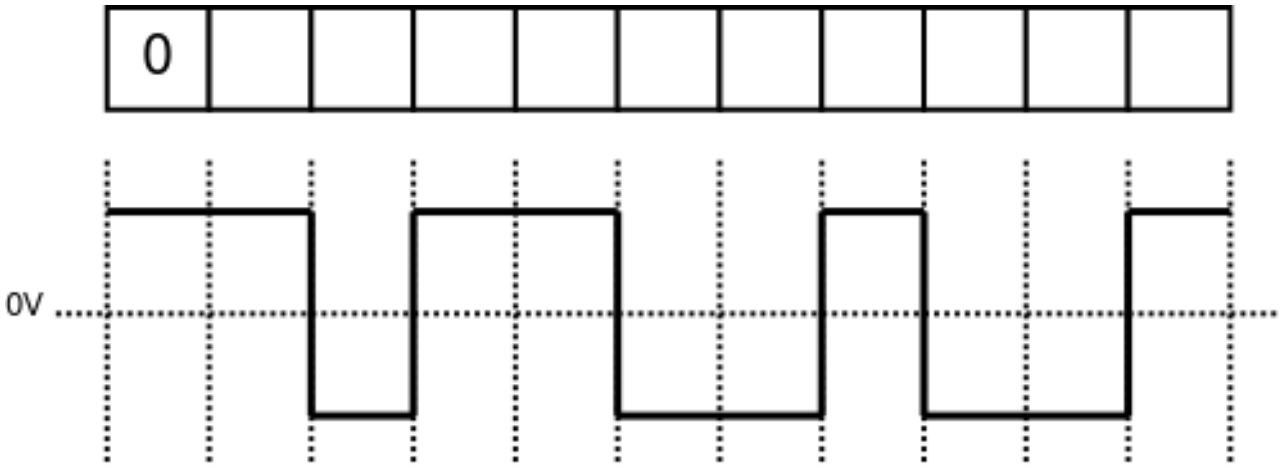
Question 1 [2 marks]

The following signal was created using NRZ-Invert-on-ones. Fill in the boxes to indicate the received bits.

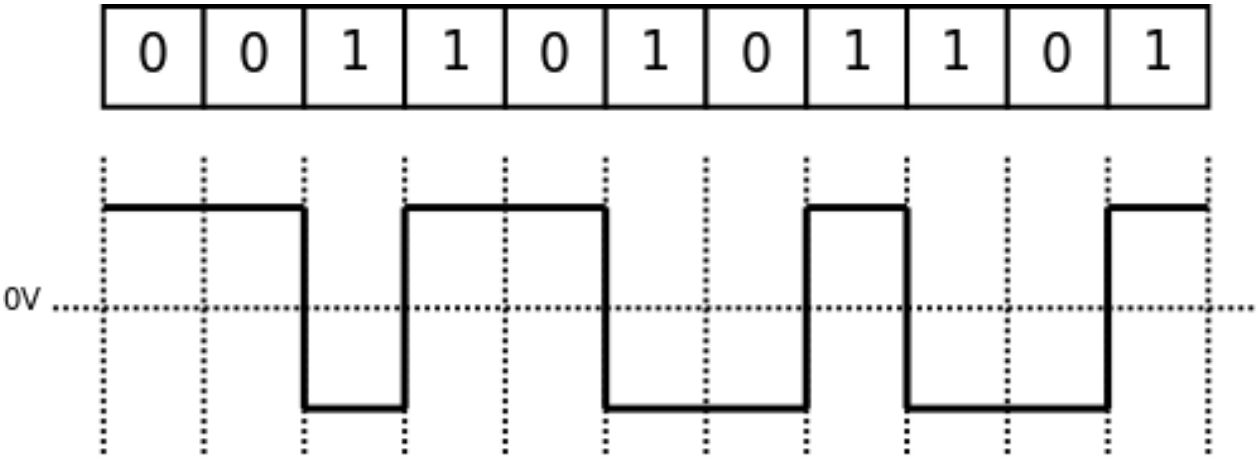


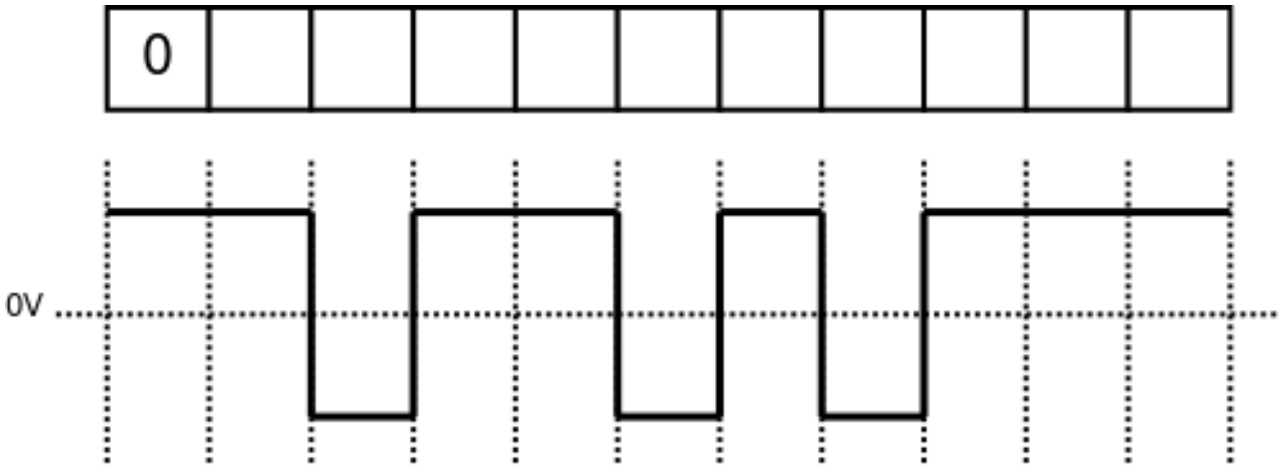
Answer



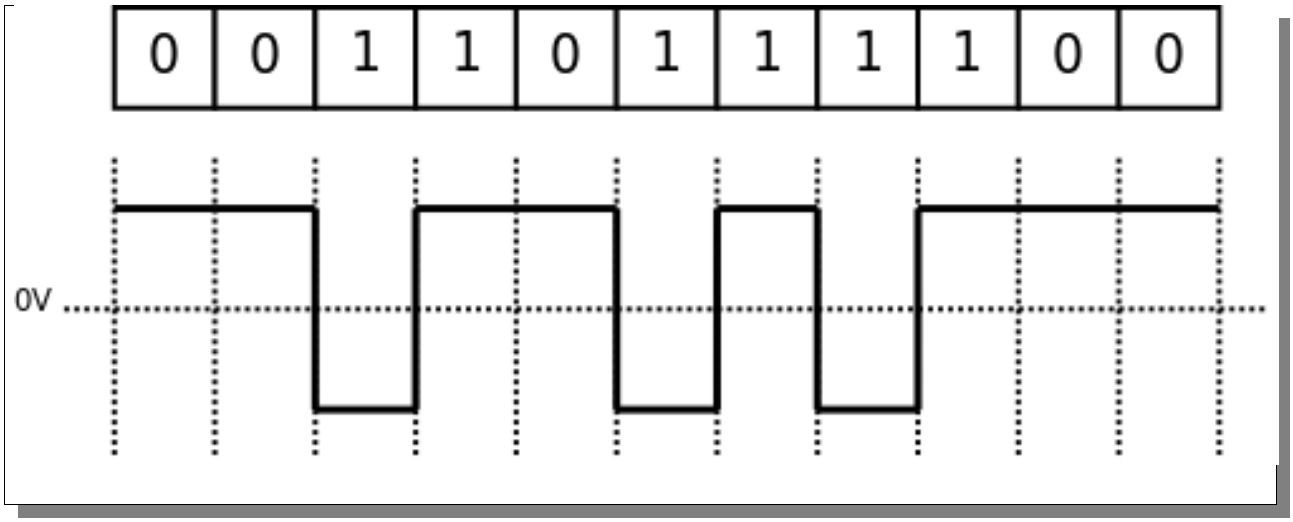


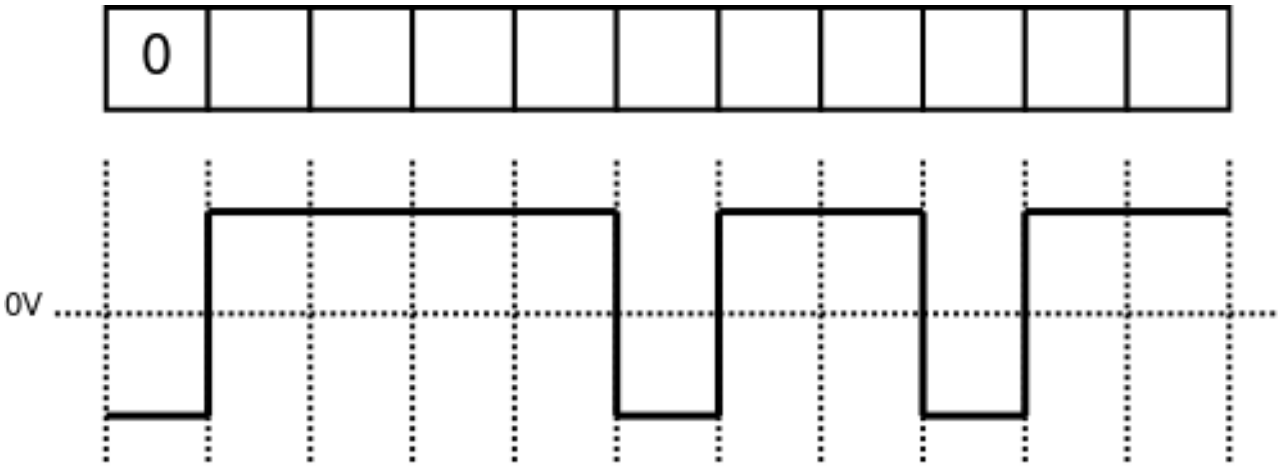
Answer



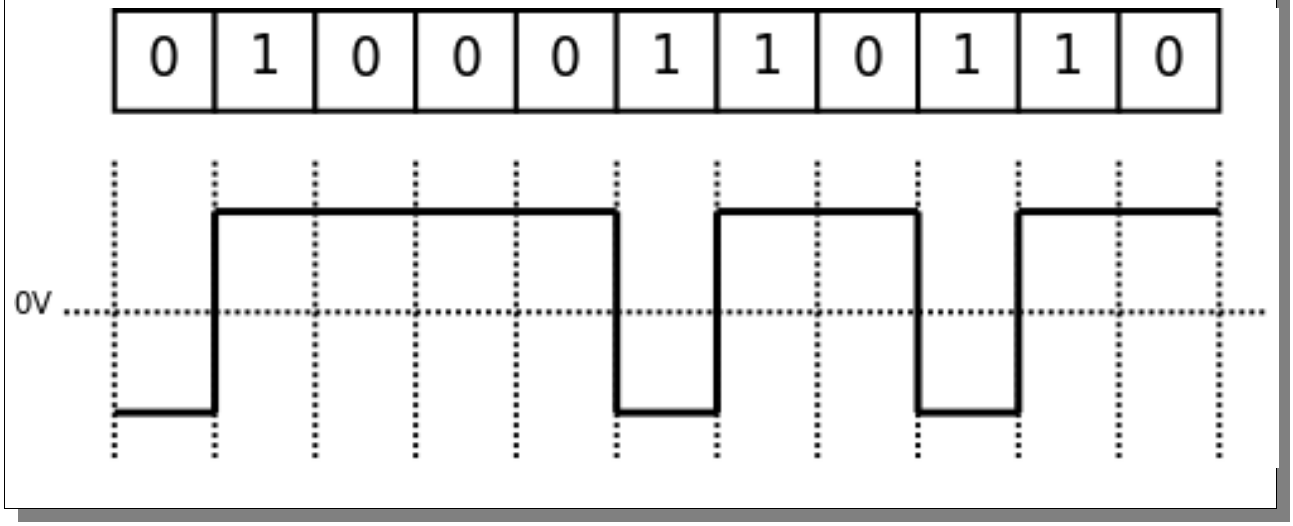


Answer





Answer



Question 2 [4 marks]

Consider the following digital data.

001001101101

001001101101

010011100101

010011100101

111000101001

111000101001

a) Draw the signal produced if Binary FSK/ASK/PSK is used to modulate the data. [2 marks]

Answer

There are many possible answers, however for simplicity I have used a mapping of bit 0 being the simplest signal (e.g. A=0, f=1, p=0) and bit 1 being the next simplest (e.g. A=1, f=2, p=pi).

b) Assuming the frequency of the lowest frequency signal in the above analog signal is 100KHz/200KHz/400KHz/100MHz/200MHz/400MHz, what is the data rate? [1 mark]

Answer

With Binary FSK/ASK/PSK, in my solutions there is one sine wave representing one bit. The period of the sine wave is the inverse of the frequency, and therefore the number of bits per second can be calculated:

f = 100KHz, T = 0.01ms; Data rate = 100Kb/s

f = 200KHz, T = 0.005ms; Data rate = 200Kb/s

f = 400kHz, T = 0.0025ms; Data rate = 400Kb/s

f = 100MHz, T = 0.01us; Data rate = 100Mb/s

f = 200MHz, T = 0.005us; Data rate = 200Mb/s

f = 400MHz, T = 0.0025us; Data rate = 400Mb/s

c) If you double the number of signal levels compared to binary ASK/FSK/PSK, what would the answer of part (b) be? [1 mark]

Answer

We have 4 levels, each level representing 2 bits. Following on from part (b), we would transmit 2 bits per period, doubling the data rates in part (b).

Question 3 [4 marks]

Consider the Hamming-distance based forward error correction scheme with codewords in the table below.

Data	*Codeword*
00	001100
01	010101
10	110011
11	101110

The source has the data 00/01/10/11/01/10 to send.

a) What is received codeword if the last two/three bits are in error? [1 mark]

Answer

Tx Data: 00	Tx Codeword: 001100	Rx Codeword: 001111	(2-bit error)
Tx Data: 01	Tx Codeword: 010101	Rx Codeword: 010110	(2-bit error)
Tx Data: 10	Tx Codeword: 110011	Rx Codeword: 110000	(2-bit error)
Tx Data: 11	Tx Codeword: 101110	Rx Codeword: 101001	(3-bit error)
Tx Data: 01	Tx Codeword: 010101	Rx Codeword: 010010	(3-bit error)
Tx Data: 10	Tx Codeword: 101110	Rx Codeword: 101001	(3-bit error)

b) Explain the outcome at the received. E.g. error detected, corrected, data received, is the received data correct. Why? [2 marks]

Answer

Rx Codeword: 001111 Error detected, no unique minimum Hamming distance (001100,

101110). Therefore no attempt at error correction. No data received

Rx Codeword: 010110 Error detected, unique min. Hamming distance with 010101, therefore error corrected and correct data received. (01)

Rx Codeword: 110000 Error detected, unique min. Hamming distance with 110011, therefore error corrected and correct data received. (10)

Rx Codeword: 101001 Error detected, no unique minimum Hamming distance . Therefore no attempt at error correction. No data received

Rx Codeword: 010010 Error detected, unique min. Hamming distance with 110011. Therefore error corrected but incorrect data received (10)

Rx Codeword: 101001 Error detected, no unique minimum Hamming distance . Therefore no attempt at error correction. No data received

c) Assuming no bit errors on a link with data rate 1.2Mb/s / 18Mb/s / 150kb/s, what is the throughput using the above FEC scheme? [1 mark]

Answer

2 bits of original data, 6 bits transmitted. Efficiency of 2/6 and throughput of:

Data rate: 1.2Mb/s Throughput: 400Kb/s

Data rate: 18Mb/s Throughput: 6Mb/s

Data rate: 150Kb/s Throughput: 50Kb/s