Quiz 2

Student Name: _____

Student Number: _____

1. [4 point]

Assume that the number of code levels used for PCM in a telephone system is 16. The following sequence of bits are the PCM encoded digital data received by a destination telephone (assume no errors).

<div align="center">

0101001100110010010001111010101010111100

</div>

On the figure below draw the output (i.e., recovered) analog audio signal at the destination telephone. The horizontal dotted lines should be used as the levels, and the vertical dashed lines as the sample points.

Answer:
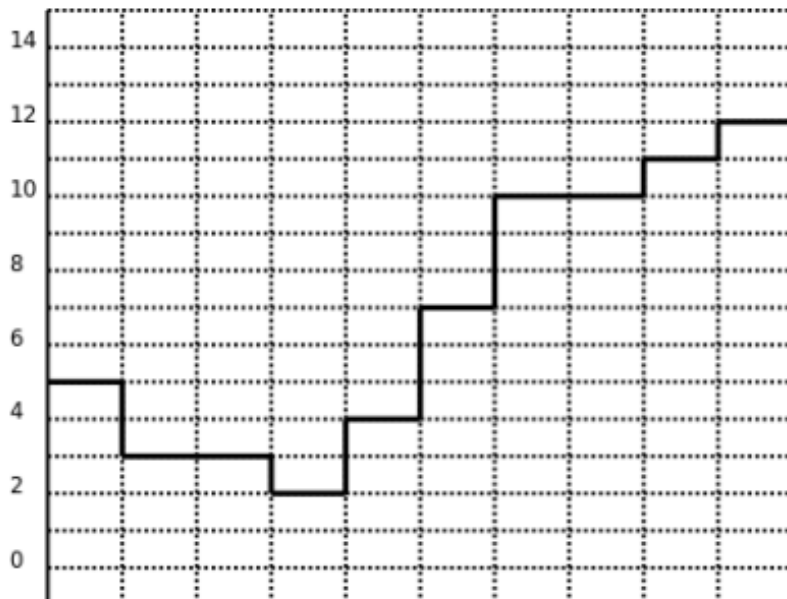
2. [6 point]

Table 1 shows the list of codewords for a Hamming-distance based Forward Error Correction (FEC) scheme.

Data	Codeword
000	011011
001	100110
010	100111
011	010000
100	111100
101	001010
110	100101
111	001011

Table 1: Hamming-based FEC

(Recall: in a receiver using Hamming-distance based FEC, the received codeword is compared to the set of valid codewords using Hamming-distance metric. The valid codeword from Table 1 closes to the received codeword is, subsequently, assumed to be the codeword actually sent.)

For the following two cases, explain the steps taken by the receiver - showing any calculations where necessary - and summarize the respective outcome.

a) The data **010** is to be sent from transmitter to receiver. The 1st bit transmitted is in error. Steps taken by receiver:

Codeword received by receiver: **000111**

Error detected by receiver: [YES] NO (circle the right answer)

Data received: **010** (if applicable)

Is the correct data received? [YES] NO (circle the right answer)

Answer

Data 010 maps to codeword 100111. The codeword is transmitted, however because of the single bit error the receive codeword is 000111.

The receiver detects an error, and compares the received codeword to the valid codewords. The valid codeword with unique minimum Hamming distance to 000111 is 100111 (distance = 1). Therefore the receiver assumes the data received is 010. This is the correct assumption.

b) The data **001** is to be sent from transmitter to receiver. The last bit transmitted is in error. Steps taken by receiver:

Codeword received by receiver: **100111**

Error detected by receiver: YES   NO   (circle the right answer)

Data received: **010**   (if applicable)

Is the correct data received?   YES   NO   (circle the right answer)

Answer

Data 001 maps to codeword 100110. The codeword is transmitted, however because of the bit error the receive codeword is 100111.

The receiver has received a valid codeword (and hence no error detected). It assumes the received data is 010, which is incorrect.