Solutions to Quiz 2

Question 1

A communication system operates over an "additive white Gaussian noise" or AWGN channel that adds zero-mean Gaussian noise. The noise voltage is measured as 400 (or 300) mV (rms). The receiver makes an error if the noise voltage exceeds +1 V. What is the probability that the receiver makes an error?

Solution

The noise has zero mean ($\mu = 0$) and a standard deviation of $\sigma = 0.4$ (or $\sigma = 0.3$). We can compute the probability that the noise (x) is *less* than a threshold v as $P(x < v)$ using the normalized Gaussian CDF, $P(t)$, where

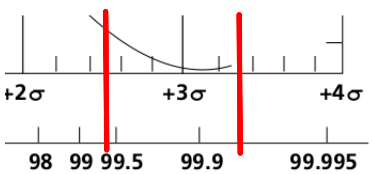
$$t = \frac{v - \mu}{\sigma}$$

We can find the probability that the noise is *greater* than that threshold as $1 - P(t)$.

In this case

$$t = \frac{1 - 0}{0.4 \text{ (or } 0.3)} = 2.5 \text{ (or } 3.33).$$

$P(t)$ can be found from the graph in Lecture 3:



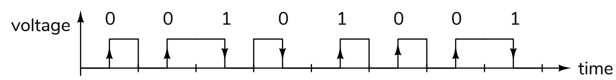
as approximately 0.994 or 0.9993 or using a calculator as 0.9938 or 0.99957. The probability that the wnoise exceeds 1 V will thus be approximately $\boxed{6.2 \times 10^{-3}}$ or $\boxed{4.3 \times 10^{-4}}$.

Question 2

The waveform below represents data encoded using a *differential* Manchester line code using the conventions described in the lecture notes. If the first bit transmitted was a zero (0) as shown, write the value of rest of the bits on the diagram. Each tick mark indicates one symbol period.

Solution

For differential coding a different symbol indicates transmission of a 1 bit, otherwise the bit is 0. For Manchester we can differentiate between two symbols depending on the "edge" in the middle of the symbol. The diagram below shows the decoded sequence:



Question 3

Draw the waveform that would be used to encode the following data sequence:

`0 0 1 1 0 0 0 0 0 0 0 1 0 1`

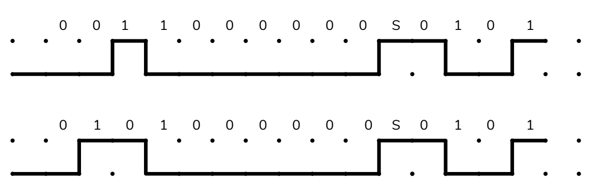
or:

`0 1 0 1 0 0 0 0 0 0 0 1 0 1`

on the section of graph paper below using an NRZI line code with bit-stuffing after every 6 zero bits. Assume the previous bit was transmitted as a low level as shown. Write in the bits transmitted in each interval and indicate any stuffed bits.

Solution

The diagram below shows the two sequences encoded using NRZI (a change for a 1 and no change for 0) with the bit-stuffed bit indicated with an S:



Note that many standards (including USB 2 as used in the examples) do bit stuffing after 5 zero bits. This was also marked correct.