Solutions to Quiz 3

Question 1

A signal is received at a mean signal level of +1V. The channel adds noise that has an RMS voltage of 0.33V. The receiver makes an error if the signal plus noise is negative (less than zero) or greater than 2V.
What is the probability of error? Show how you arrived at your answer and specify the units.

The probability of error is the probability that the signal plus noise is a voltage less than zero or greater than 2 V. The mean of the signal plus noise is $\mu = 1$ V and the standard deviation is $\sigma = 0.33$ V.

The first normalised threshold is at zero volts:

$$t = \frac{v - \mu}{\sigma} = \frac{0 - 1}{0.33} = -3.03$$

and the probability that the signal is less than this is the value of the Gaussian CDF, $P(-3.03) \approx 1.22 \times 10^{-3}$.

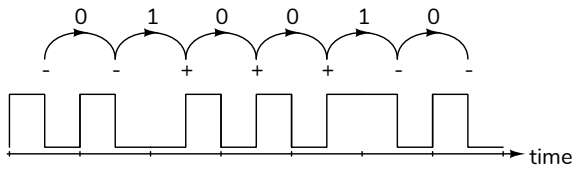
The second normalized threshold is at 2 V:

$$t = \frac{v - \mu}{\sigma} = \frac{2 - 1}{0.33} = +3.03$$

and the probability that the signal is *greater* than this is 1 minus the value of the Gaussian CDF, $1 - P(3.03) \approx 1.22 \times 10^{-3}$.

The overall probability of error is the sum of these two probabilities (areas under the curve), or 2.44×10^{-3}.

Question 2



The waveform above is a signal encoded using a differential Manchester code.
Assuming the same line coding convention described in the lectures, what sequence of bits was transmitted? Omit the bit transmitted during the first bit interval.

In the lecture notes a bit interval containing a different transition direction indicates a '1' bit when *differential* Manchester encoding is used.

The diagram above is labelled with the edges for each bit (+ for rising edge, - for falling edge) and with a 0 when adjacent edges are the same and 1 when the differ. We omit the first bit because we don't know what transition was used for the previous bit. The bit sequence is 010010.

Question 3

The byte value 0x96 is transmitted least-significant-bit-first (the sequence 0110, 1001) over a channel encoded using the IEEE 802.3 4B5B line code described in the lectures. Only 4B5B encoding is used, not MLT-3.
What sequence of bits is transmitted over the channel? Assume the encoded bits are also transmitted l.s.b.-first (the bit numbered 0 is transmitted first).

The eight bits are grouped into two sets of 4 bits and each is converted to 5 bits using the 4B5B encoding table. For the MII (media independent interface) value 1001 (9 decimal) the corresponding PCS (physical coding sublayer) value is 10011 (m.s. to l.s. bit). Similarly, for 0110 (6) the encoded value is 01110.

If these bits are transmitted l.s. bit first, the sequence of bits transmitted will be 01110 11001.