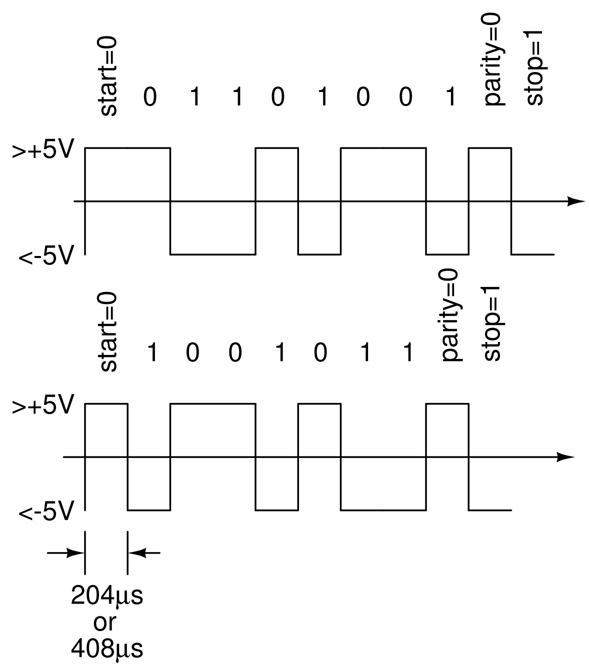
Solutions to Mid-Term Exams

Exam 1, Question 1

The sequences of bits 1001 0110 and 0110 1001, each contain an even number of 1's, so the parity bit should be zero for even parity. For bit rates of 2400 kbps and 4800 kbps the bit periods would be the reciprocals of these or approximately 417 ns and 208 ns per bit. Typical bit rates three orders of magnitude less (2400 and 4800 bps) so values of 417 μs and 208 μs were also marked as being correct. At the transmitter the voltages levels should be $> \pm 5$ V.

The diagrams below show the two possible waveforms:



Exam 1, Question 2

24 AWG wire is 0.5 mm in diameter. The wire diameter doubles for each decrease in gauge of 6, so 12 AWG wire would be four times the diameter of 24 AWG wire or $2 \times 2 \times 0.5 = 2$ mm in diameter.

We could also use the formula given in the notes:

$$d \approx 8 \times 2^{-\frac{n}{6}} = 8 \times 2^{-\frac{12}{6}} = \frac{8}{4} = 2 \text{ mm}$$

The characteristic impedance of a twisted-pair transmission line can be estimated from the formula:

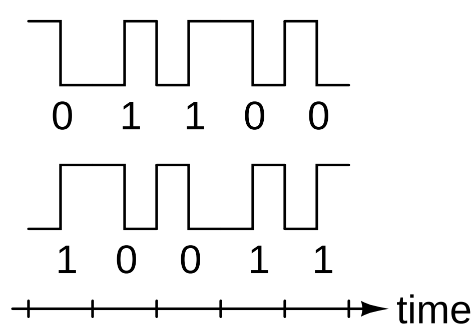
$$Z_0 \approx \frac{120}{\sqrt{\varepsilon_r}} \ln\left(\frac{2S}{D}\right) \quad \Omega$$

where S is the spacing between conductor centers and D is the wire diameter. The relative permittivity, ε_r is assumed to be that of polyethylene, 2.2. In this case $D = 2$ mm. S is twice the wire radius plus twice the insulation radius. This is equal to the diameter of the wire plus insulation which is given as $S = 3.5$ mm. Thus

$$Z_0 \approx \frac{120}{\sqrt{2.2}} \ln\left(\frac{2 \times 3.5}{2}\right) \approx 101\ \Omega$$

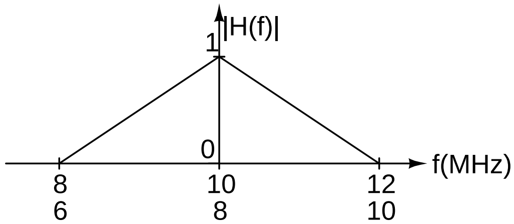
Exam 2, Question 1

The waveforms below would transmit the sequence of bits 10011 and 01100 using a Manchester line code using the conventions used in the lecture notes. The time interval used to transmit each of the bits and the value (0 or 1) of the bit being transmitted in each interval are shown.

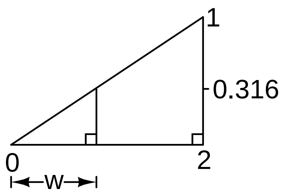


Exam 2, Question 2

The diagram below shows the magnitude of the transfer function of a channel, $H(f)$. There were two possible frequency ranges, but the span was the same in both.



The -10 dB bandwidth is the span of frequencies where $|H(f)|$ is less than -10 dB below its peak value (1). A level of -10 dB (in voltage, since $|H(f)|$ is a voltage ratio) is $10^{\frac{-10}{20}} \approx 0.316$. Using the following similar triangles:



using the height:width ratios of the triangles we can obtain:

$$\frac{0.316}{1} = \frac{w}{2}$$

or $w = 0.632$ and the -10 dB bandwidth as $2 \times (2 - w) = 2 \times (2 - 0.632) = 2.73$ MHz.