COSC 264 Problem Set
Physical Layer

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1 Questions

Problem 1.1 (Baseband modulation/encoding)**.**

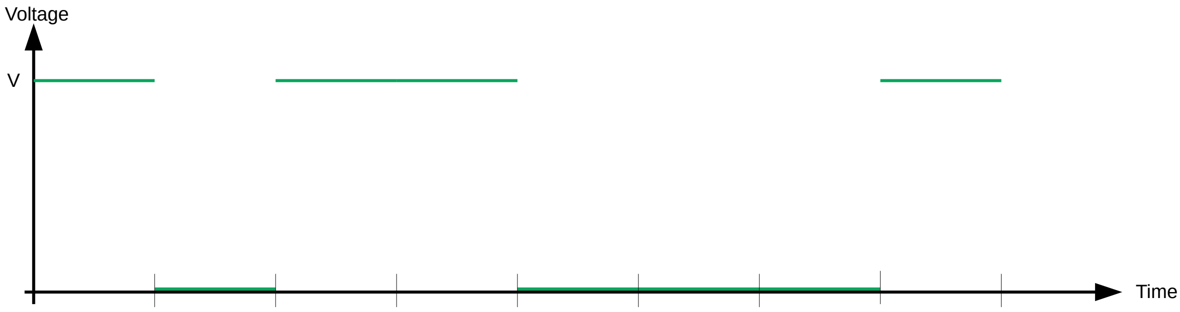
We are given the data bit sequence 1011 0001.

1. Draw the unipolar-NRZ-encoded signal for the given data sequence.
2. Draw the Manchester-encoded signal for the given data sequence.

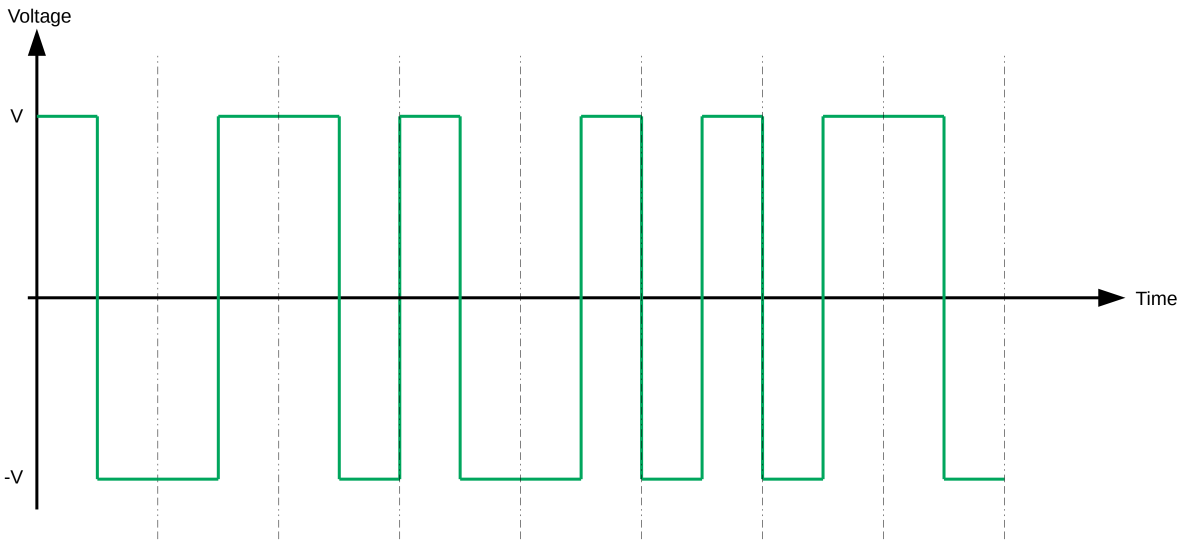
Do not forget axis labels.

Solution 1.1.

The NRZ-encoded signal looks like this:



and the Manchester-encoded signal looks like this:



Problem 1.2 (Passband modulation/encoding)**.**

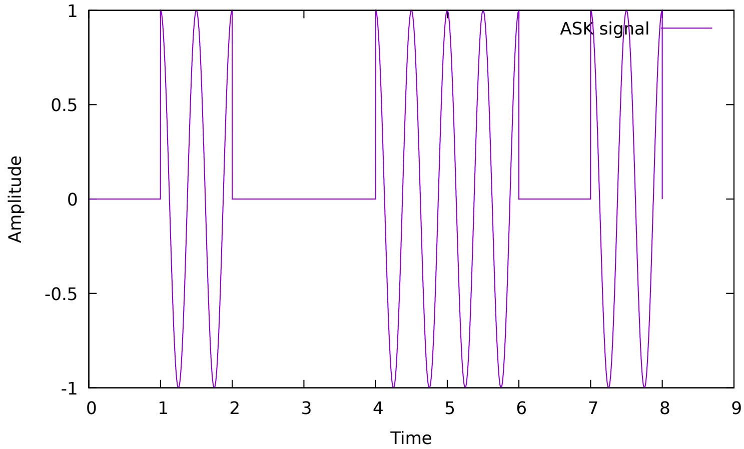
We are given the data bit sequence 0100 1101. Draw the waveforms of this sequence for the following passband modulation schemes.

1. ASK: Assume $f_c = 4\pi$, $T = 1$, $A_0 = 0$ and $A_1 = 1$.
2. FSK: Assume $f_c = 4\pi$, $T = 1$, $f_0 = 0$ and $f_1 = 8\pi$.
3. PSK: Assume $f_c = 2\pi$, $T = 1$, $\phi_0 = 0$ and $\phi_1 = \pi$.

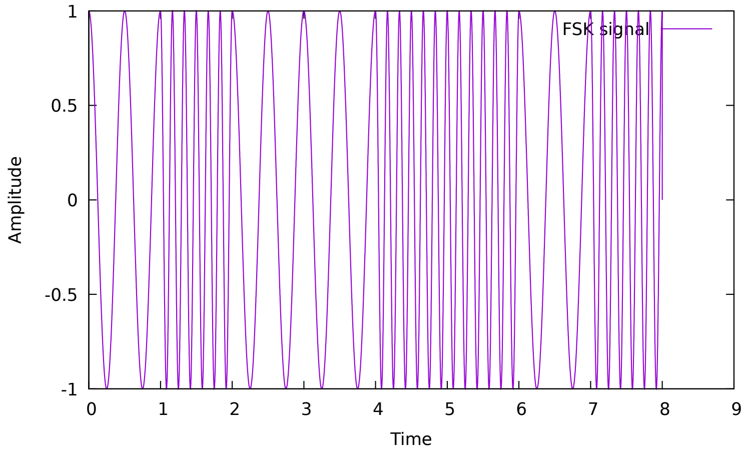
Do not forget axis labels.

Solution 1.2.

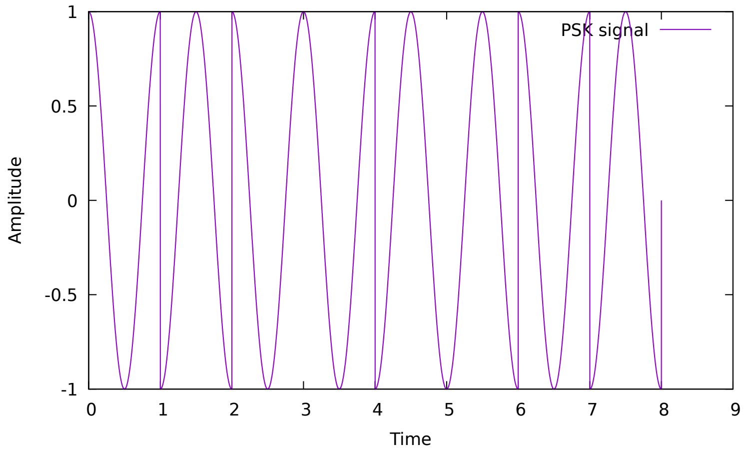
The ASK waveform looks as follows:



The FSK waveform is:



and for PSK it is:



Problem 1.3 (Natural numbers and Decibel numbers)**.**

1. We have discussed how to convert "normal" numbers η into their Decibel (dB) value η_{DB}:
$$\eta_{DB} = 10 \cdot \log_{10} \eta$$
Please give the formula for converting dB values back to normal values and use this to:
   a) express 95 dB as a normal value
   b) express -95 dB as a normal value
2. According to `https://en.wikipedia.org/wiki/Optical_fiber` an optical fiber has a signal attenuation of as little as 0.2 dB per kilometer. Approximately how many kilometers long is an optical cable that loses half the signal power?

Solution 1.3.

1. The formula is
$$\eta = 10^{\frac{\eta_{DB}}{10}}$$
and plugging in the requested values gives:
   a) $\approx 3.16 \cdot 10^9$
   b) $\approx 3.16 \cdot 10^{-10}$

2. We are asking to get an attenuation by a factor of $\eta = 2$, which in Decibel is $\eta_{DB} = 3.01029996$ and which for simplicity we take just to be 3 dB. Realising that each one-kilometer piece of the cable attenuates its input (whatever its power) by a fixed factor of 0.2 dB (i.e. a factor of ≈ 1.0471), the attenuation by successive kilometer-pieces acts "geometrically", i.e. after two kilometers we have an attenuation by 1.0471^2 and after k kilometers the attenuation is 1.0471^k. Multiplications in the normal domain translate into additions in the dB domain, so we need to have k kilometers such that $k \cdot 0.2 = 3$, which gives a length of 15 km.
