

Data Transmission over Bandlimited Channels

Exercise 1: Draw a square pulse of duration T and amplitude 1. Draw the output if the channel stretches pulses to a duration of $1.5T$. Draw the output for an input pulse of the opposite polarity. Use the principle of superposition to draw the output of the channel for a positive input pulse followed by a negative input pulse. Has the signal been distorted?

Exercise 2: What is the impulse response of a channel that does not alter its input? Does this impulse response meet the Nyquist condition? Will it result in ISI?

Exercise 3: Draw the impulse response of a channel that meets the Nyquist condition but is composed of straight lines. Note that there are many such impulse responses.

Exercise 4: What causes the $\text{sinc}()$ function to have periodic zero-crossings? What causes the amplitude to decay?

Exercise 5: Draw the magnitude of a raised-cosine transfer function that would allow transmission of impulses at a rate of 800 kHz with no interference between the impulses.

Exercise 6: Draw the impulse response of a filter that converts input impulses to pulses of duration T ? Draw the signal after the pulse-shaping filter in the diagram above.

Exercise 7: A “brickwall” channel has a 3 kHz bandwidth and meets the Nyquist non-ISI conditions. How many levels are required to transmit 24 kb/s over this channel using multi-level signalling?

Exercise 8: The 802.11g WLAN standard uses OFDM with a sampling rate of 20 MHz, with $N = 64$ and guard interval of $0.8\mu s$. What is the total duration of each OFDM block, including the guard interval? How long is the guard time?

Exercise 9: What is capacity of a binary channel with a BER of $\frac{1}{8}$ (assuming the same BER for 0's and 1's)? *Hint:* $\log_2\left(\frac{7}{8}\right) \approx -0.2$.

Exercise 10: What is the channel capacity of a 4 kHz channel with an SNR of 30dB?

Exercise 11: Can we use compression to transmit information faster than the (Shannon) capacity of a channel? To transmit data faster than capacity? Explain.

Exercise 12: What do the Nyquist no-ISI criteria and the Shannon Capacity Theorem limit? What channel parameters determine these limits?