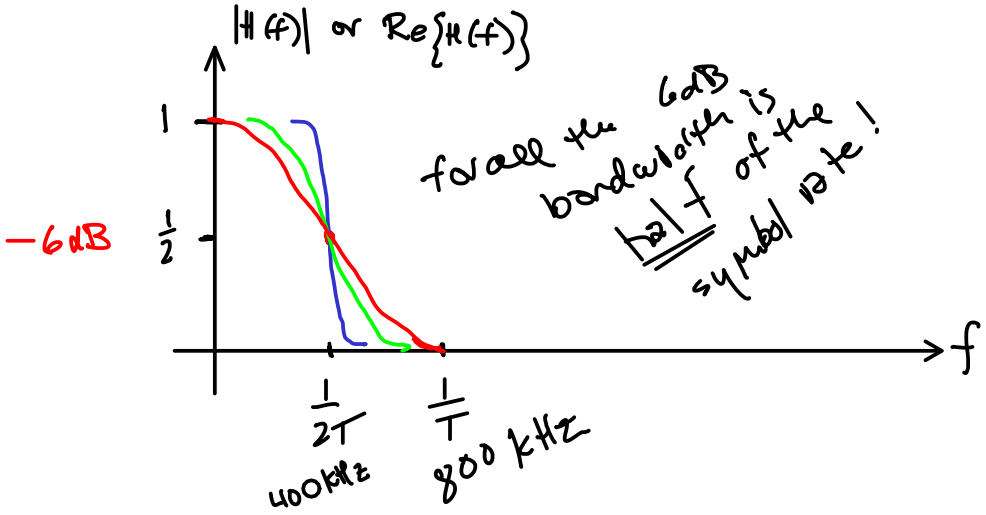
Lecture 5 - Data Transmission over Band-Limited Channels

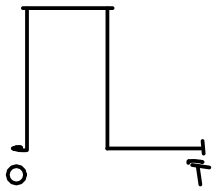
Exercise 1: Draw the (real portion of) a raised-cosine transfer function that would allow transmission of impulses at a rate of 800 kHz with no interference between the impulses.

$$f_{symbol} = 800\ kHz$$

$$\frac{1}{T} = \frac{1}{800 \times 10^3}$$

$$= 1.25\ \mu s.$$





Exercise 2: What is the impulse response of a filter than converts input impulses to pulses of duration T? What is the shape of the frequency response of this filter? *Hint: the Fourier transform of a pulse of duration T is* $\frac{sin(\pi T)}{\pi T}$. What is the "bandwidth" of this filter (when is it first zero)? How does this compare to the "bandwidth" of the raised-cosine filter above?

Exercise 3: What is the possible range of values of α?

Exercise 4: Could equalization be done at the receiver only?
At the transmitter only? Why or why not?

Exercise 5: 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 many guard samples are used?

Exercise 6: What is the channel capacity of a 3 kHz channel with an SNR of 20dB?

$$C = B \log_2\left(1 + \frac{S}{N}\right)$$

$B = 3\text{kHz}$

$\text{SNR} = 20\,\text{dB}$.

$$= 3\times10^3 \log_2(1 + 100)$$

$$\approx 3\times10^3 \times 6.5$$

$$\approx 19.5 \text{ kb/s}$$

$\log_2 64 = 6$

$\log_2 128 = 7$

$$20 = 10 \log \frac{S}{N}$$

$$\frac{S}{N} = 10^{\frac{20}{10}} = 100$$

$$\log_a b = \frac{\log b}{\log a}$$

$$2^3 = 8$$

$$\log_2 8 = 3$$

Exercise 7: What are some differences between the signalling rate limit imposed by the Nyquist no-ISI criteria and the Shannon Capacity Theorem?