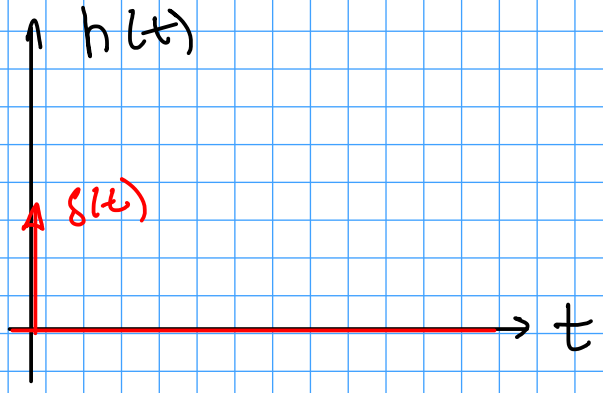
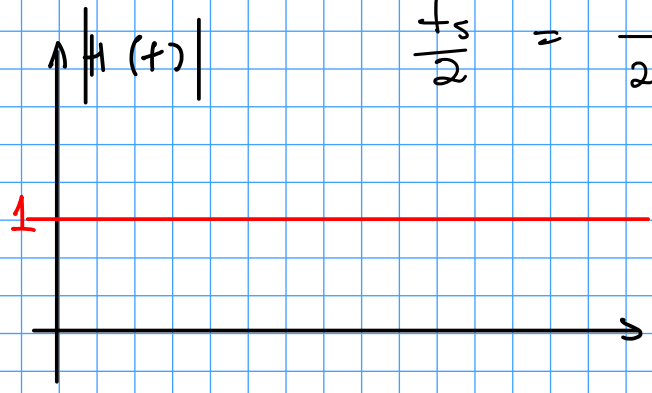
ELEX 3525 Lecture 5 Notes

Exercise 1: What is the impulse response of a channel with infinite bandwidth? The transfer function? Does this channel meet the Nyquist no-ISI conditions?

$$\frac{1}{T} = f_s$$

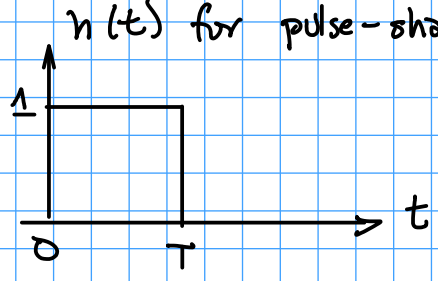
$$\frac{f_s}{2} = \frac{1}{2T}$$





doesn't meet Nyquist in f (no symmetry)?

does meet Nyquist in time ($h(t) = 0$ at $\frac{n}{T}$)

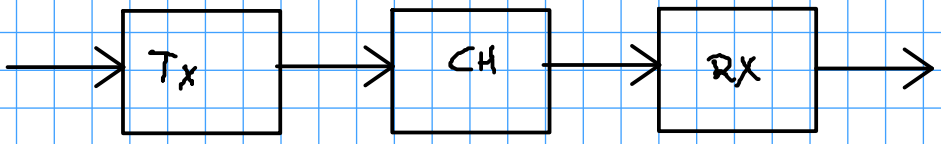


Exercise 2: What is the possible range of values of α?

$$\alpha \in \{0, 1\}$$

α is between 0 and 1.

Exercise 3: Could equalization be done at the receiver only? At the transmitter only? Why or why not?



$$H(f) = H_{TX}(f) \cdot H_{CH}(f) \cdot H_{RX}(f)$$

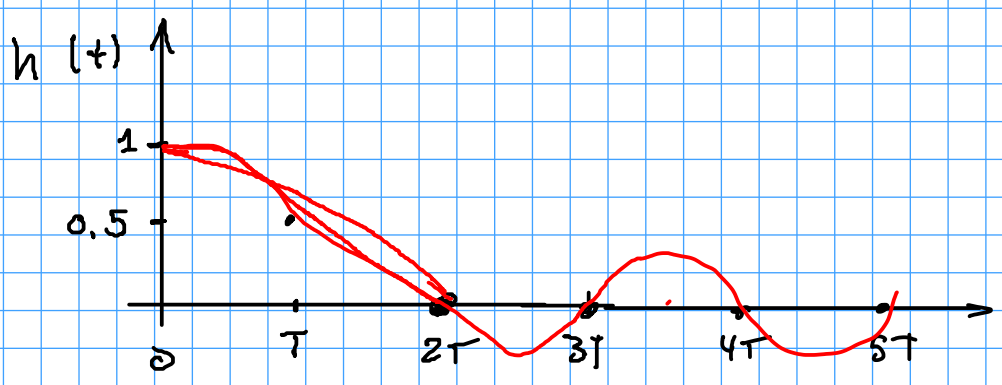
Q: can we force $H(f)$ to the desired value by changing only $H_{TX}(f)$?

A: $$H_{TX}(f) = \frac{H(f)}{H_{CH}(f) \cdot H_{RX}(f)}$$

then there is a solution if $H_{CH}(f)$ and $H_{RX}(f)$ are both known and non-zero.

same argument can be made for $H_{RX}(f)$.

Example of PR impulse response



Exercise 4: ~~Assuming the initial output is zero~~, what waveform would result from transmitting +1, +1, +1, -1, +1, -1, 1?

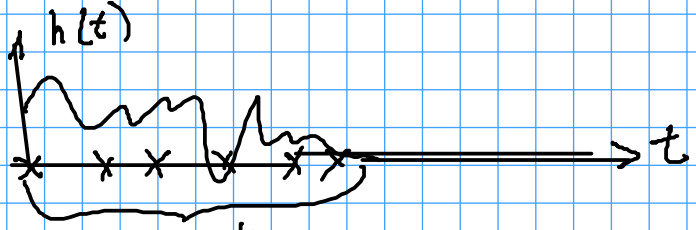
ASSUMED, NOT GIVEN

input	previous input	output = input + $\frac{\text{previous}}{2}$
+1	+1	1 + 0.5 = 1.5
+1	+1	1 + 0.5 = 1.5
+1	+1	1 + 0.5 = 1.5
−1	+1	−1 + 0.5 = −0.5
+1	−1	1 − 0.5 = 0.5
−1	+1	−1 + 0.5 = −0.5
+1	−1	+1 − 0.5 = 0.5
	+1	

Exercise 5: How many symbols does the DFE have to 'know' before it can completely correct ISI on subsequent symbols?

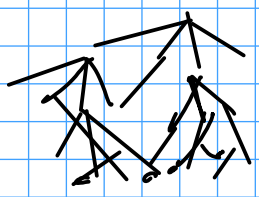
As many symbols as the ~~[illegible]~~ duration of the channel impulse response.

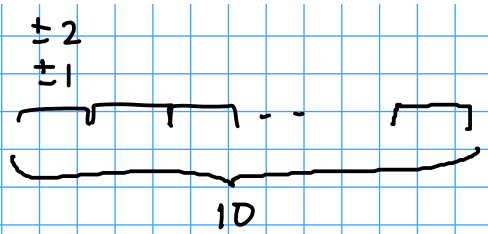
e.g.



duration of ISI

Exercise 6: How many possible transmitted waveforms could be received if a sequence of 10 symbols is transmitted, each symbol being chosen from 4 possible symbols?

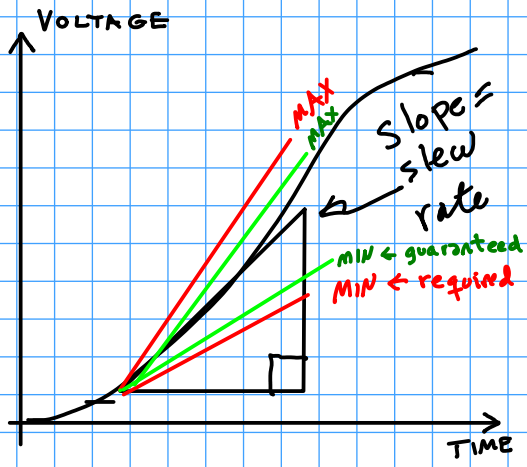




$2^{10} \approx 10^3$ (1k)

$4 \times 4 \times 4 \cdots \times 4 = (4)^{10} = (2^2)^{10} = 2^{20} \approx 10^6$ (1M).

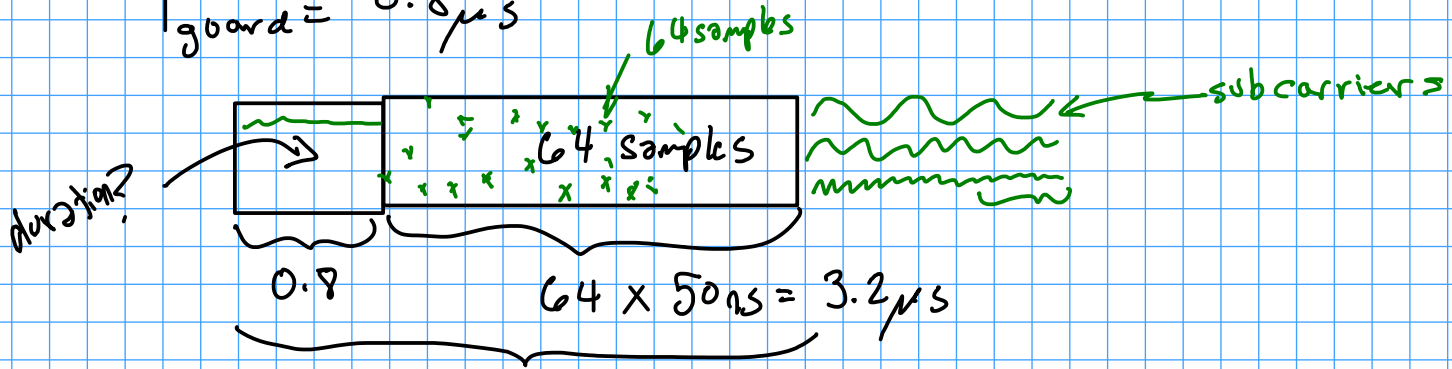
Exercise 7: The 802.11g WLAN standard uses OFDM with a sampling rate of 20 MHz, with $N = 64$ and guard interval of $0.8\mu s$. What is the total duration of each OFDM block, including the guard interval? How many guard samples are used?



$N = 64$ samples

$f_s = 20\,MHz \quad T_s = \frac{1}{f_s} = 50\,ns$

$T_{guard} = 0.8\,\mu s$



total $= 4\,\mu s$

$N_{guard} = \frac{0.8\,\mu s}{50\,ns/sample} = 16$

Exercise 8: What is the channel capacity of a 3 kHz channel with an SNR of 20dB?

$B = 3\,kHz$

$SNR = 20\,dB$

$C = ? = B \log_2\left(1 + \frac{S}{N}\right) = 3 \times 10^3 \log_2\left(1 + 10^{\left(\frac{20}{10}\right)}\right)$

$= 3 \times 10^3 \log_2(1 + 100) \simeq 3000 \cdot 6.5 \simeq 20\,kb/s$