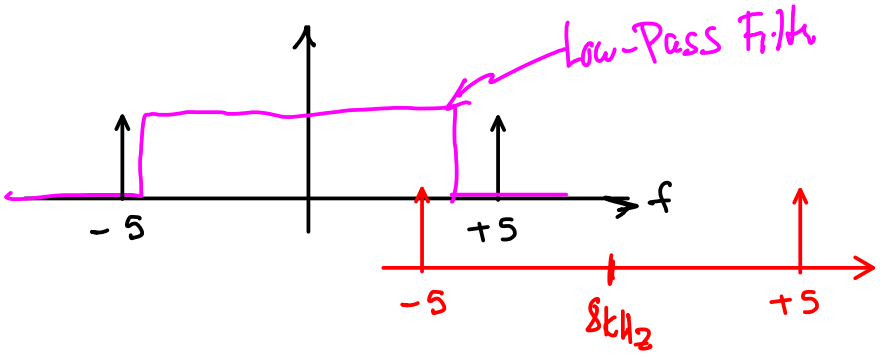
Lecture 10

Exercise 1: Give some examples of legacy analog speech communications and very simple analog speech communication systems.

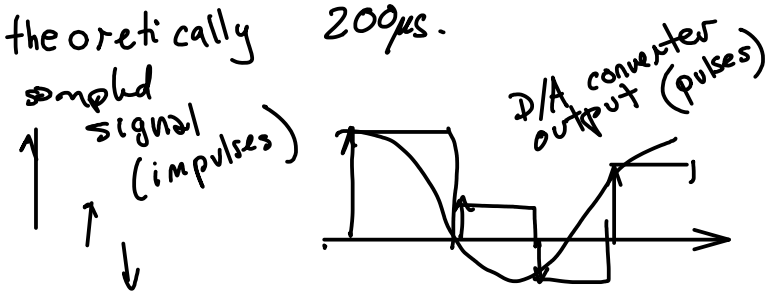
- legacy: AM broadcasting (CB radio)
- short range: intercoms, "walkie talkie".

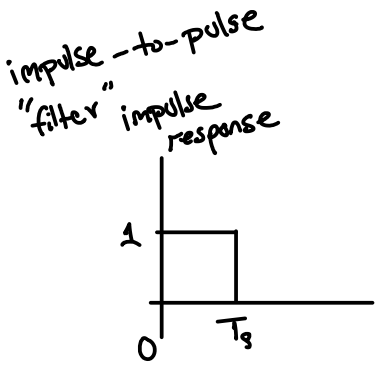
Exercise 2: A 5 kHz signal is sampled at 8 kHz. What are the positive and negative frequency components of the 5 kHz signal before sampling? What is the frequency of the aliased component falling into the 0-4 kHz range?

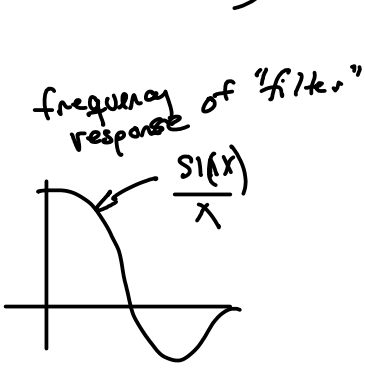


aliasing component at 8 kHz (sampling freq.) − 5 kHz (negative of sampled frequency)

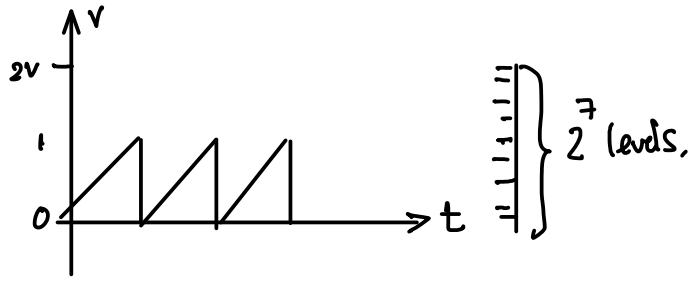
$= 3\,\text{kHz}$







Exercise 3: What is the quantization SNR for a sawtooth wave varying from 0 to 1V if a 7 bit A/D converter is used with an input range of 0 to 2 V?

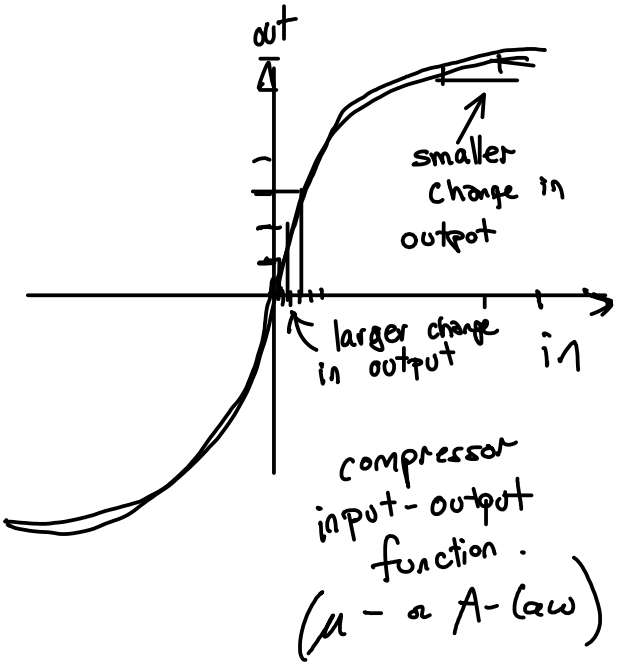


- only half the input range is used (64 levels = 2^6)
- assuming quantization SNR is 6b ← number of bits
  then 6b = 6×6 = 36 dB

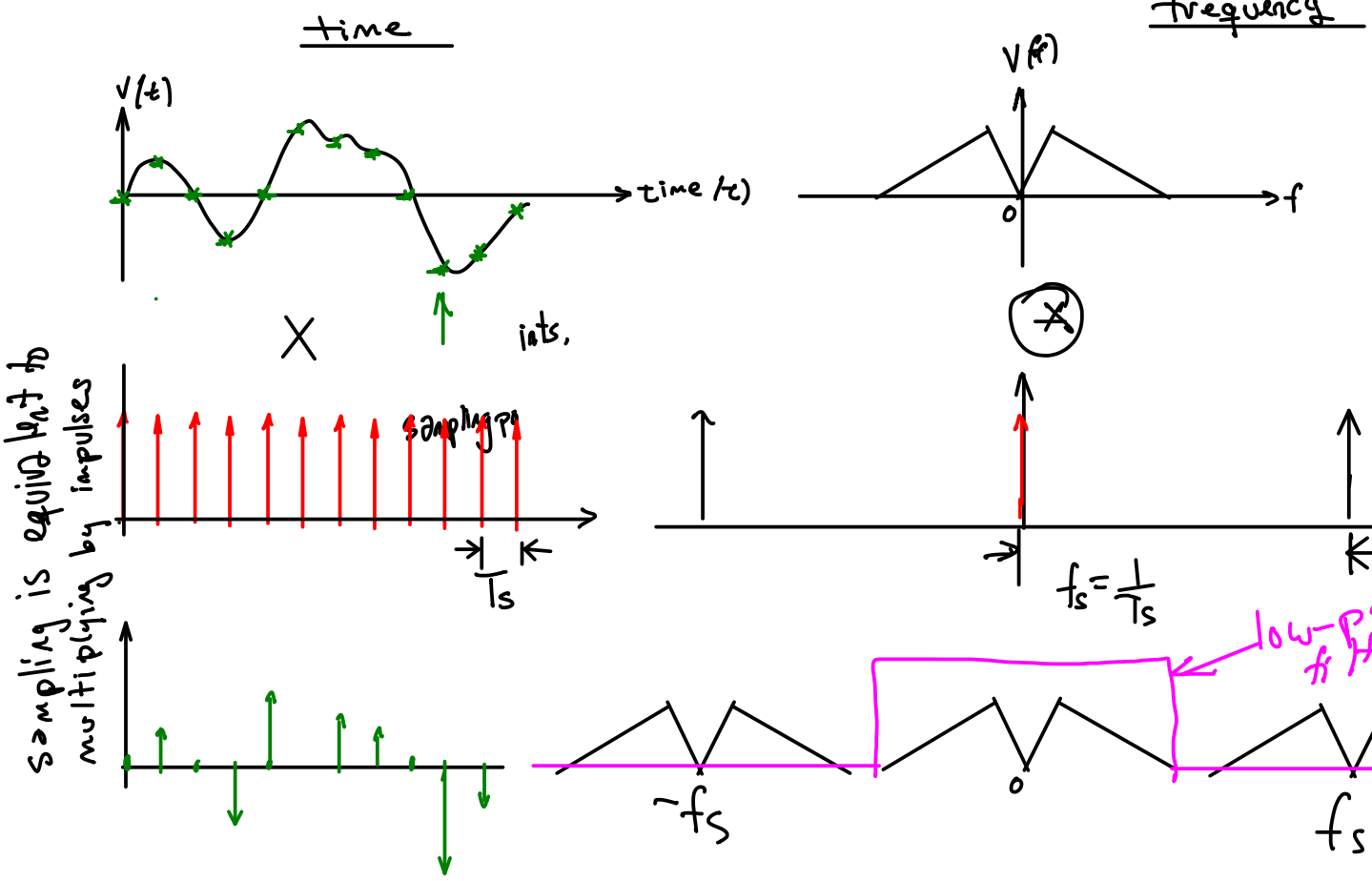
Exercise 4: If the sampling rate is 8 kHz and there are 8 bits per sample, what is the data rate in each direction? How many bytes per minute are transmitted for a two-way connection?

8 kHz × 8 bits/sample = 64 kb/s.

$$\frac{128\ \text{kb/s}}{8\ \text{bit/byte}} \times 60\ \text{s/minute} \approx 1\ \text{MByte/minute}$$



Relationship between time-domain & frequency domain for sampling & reconstruction



→ sampling causes the signal spectrum to be replicated at multiples of the sampling frequency.

→ to be able to recover the original signal from the sampled signal:

- f_s must be 2X highest frequency (because of negative frequency components)
- low-pass filter at $f_s/2$ (to remove replicated versions of the signal)