Design and Engineering of Modern Beam Diagnostics
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Exercises for:

- **Frequency and time domain beam signals**
- **Digital signal processing**

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Exercise 1

The signal s(t) is the sum of two harmonics with close frequencies $f_1 = 10Hz$, and $f_2 = 12Hz$. Consider a sampling frequency $f_s = 1kHz$

(1) Calculate the parameters to resolve frequency resolution $\Delta f < 2Hz$

(2) Calculate Fmax

(3) Open the MATLAB file and DSPex1.m and validate your results. To better visualize the data, consider a frequency resolution of 1Hz.

Exercise 2

(1) Calculate the Q for $V_{ref} = 2\,V,\ N = 16\,bit$

(2) How does the maximum SQNR improve from a 10-bit to a 14-bit ADC?

(3)

$$s(t) = cos(2\pi f_0 t)$$

frequency $f_0 = 0.5Hz$

Consider two ADCs frequencies and verify the quantization resolution.

ADC1: $f_s = 1MHz$. ADC2: $f_s \rightarrow \frac{f_s}{16}$

Question: Does the Q change? Why?

Exercise 3

Open the MATLAB file DSPex.2

The file creates a signal $s(t) = \sum_{i=1}^{O} \sin sin\, 2(i \times f_0)t$, with O=5.

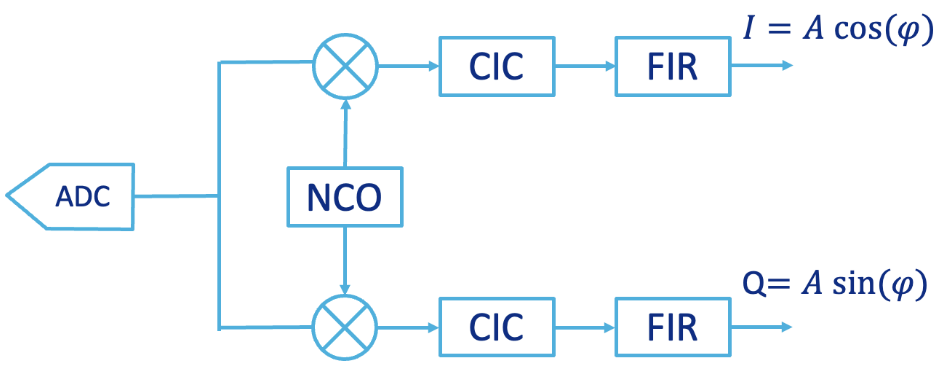
(1) Increase the signal length (T) to visualize the FFT

(2) Compare the FFT with and without window. What is changing?

(3) Optional: Increase T, add a gaussian function and compare the results.

Exercise 4 (tutorial)

Design the following digital system.



- $s(t) = 0.75 \cos cos \left(2\pi f_0 + \varphi_0\right) + 0.25 sin(2\pi f_1)$
- $f_s = 100\ MHz$
- $f_0 = 800\ Hz$
- $f_1 = 1.3\ kHz$