



Digital Filtering

preparing for the exam - part 1, FIR filters

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Theoretical Examples

1. Derive the FRF (Frequency Response Function) of a FIR (Finite Impulse Response) filter with filter coefficients $\mathbf{b} = [1, 0, 0, 1]$ and draw its absolute value as a function of normalized angular frequency between 0 and π .

2. Find the amplitude of the output signal $y[n]$ of a FIR (Finite Impulse Response) filter with filter coefficients $\mathbf{b} = [1, 0, 0, 0, 1]$ if the input signal is $x[n] = \cos(2\pi kn)$ for :
- a) $k = 1/8$
 - b) $k = 1/4$.
- hint: $\cos(a + b) = \cos(a)\cos(b) - \sin(a)\sin(b)$

Practical Examples

3. Write a Python code that implements a FIR (Finite Impulse Response) filter. Use a circular buffer and sample-by-sample approach (no matrix or vector multiplication). Do not use the `lfilter` function. Continue the following code where `h` contains filter coefficients and `x` contains the input signal. Get the output signal `y`.

```
import numpy as np

h = ... # filter coefficients
x = ... # input signal

# prepare an empty array for the output signal
y = np.zeros_like(x)

# complete the code here to get the output signal y
```

4. Implement a FIR (Finite Impulse Response) filter with filter coefficients $\mathbf{b} = [1, 0.3, 0.1]$ in Sigma Studio without using Filter block. You can use Multiply, Add, Gain, Delay, and T-connection.