A decorative graphic on the left side of the slide consisting of two overlapping parallelograms. The front one is blue and the back one is light green. Both are tilted at an angle.

Filter design using window function method

Varun Balaji and Ajay Shrihari



Problem Statement

- Design a band-pass filter using window function method in MATLAB
- Apply designed filter to mixed sine wave signal
- Establish simulation model using MATLAB
- Observe and verify performance of simulation model from waveforms using oscilloscope in SIMULINK



Mathematics used

- Impulse response: $h(n)$
- Number of points on filter: N
- Transfer function of filter:

$$H(z) = \sum_{n=0}^{N-1} h(n)z^{-n}$$

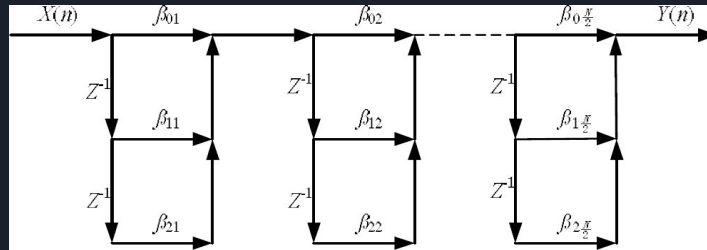
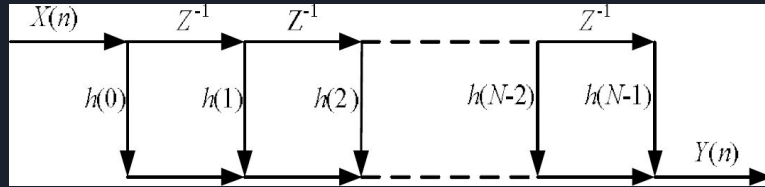
- Taking z transform:

$$y(n) = \sum_{m=0}^{N-1} h(m)x(n-m)$$

Math

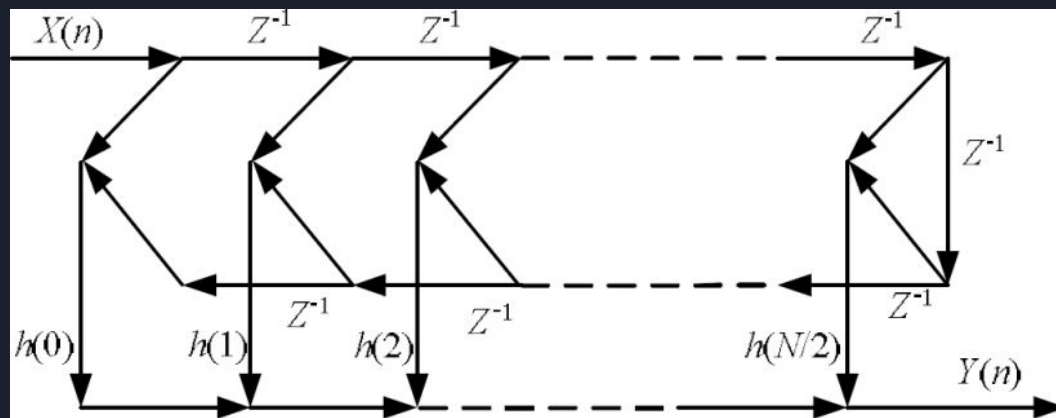
Based on this, we have 3 ways of representing the convolution sum expressions:

- Direct Form
- Cascade Form

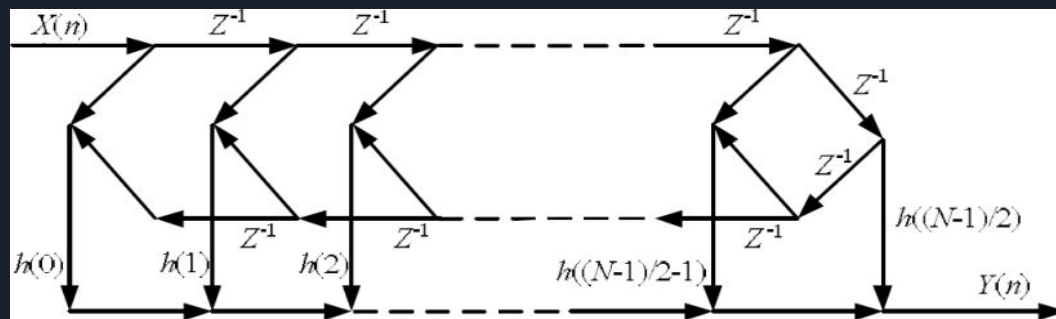


Math

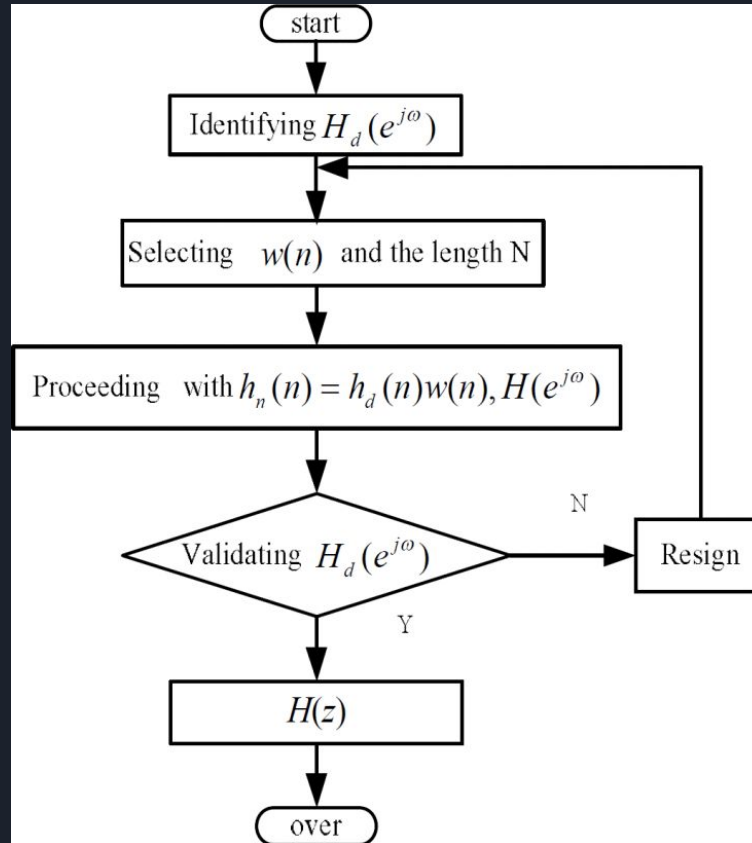
- Linear structure
- Even



- Odd



Math (continued)

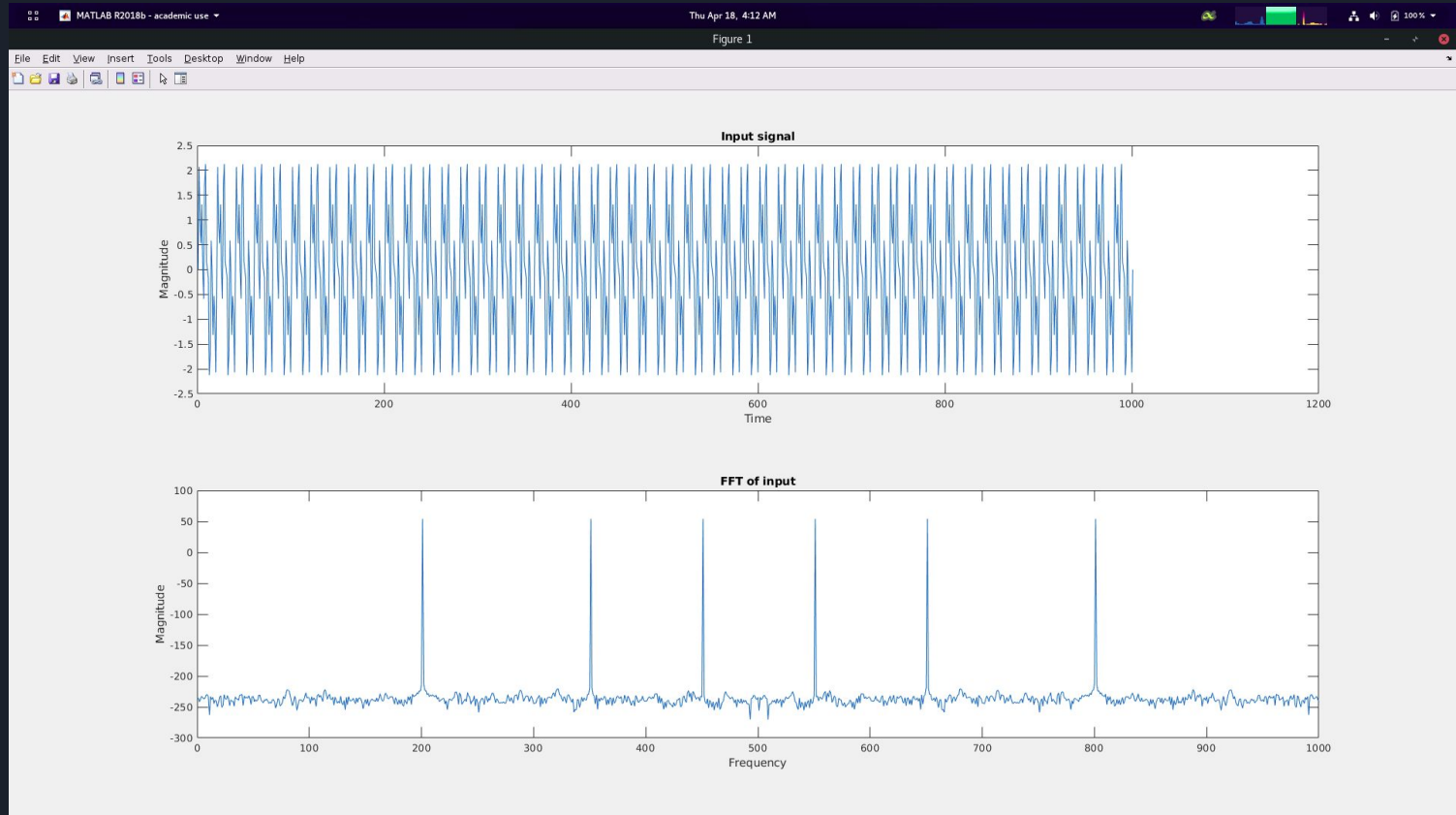




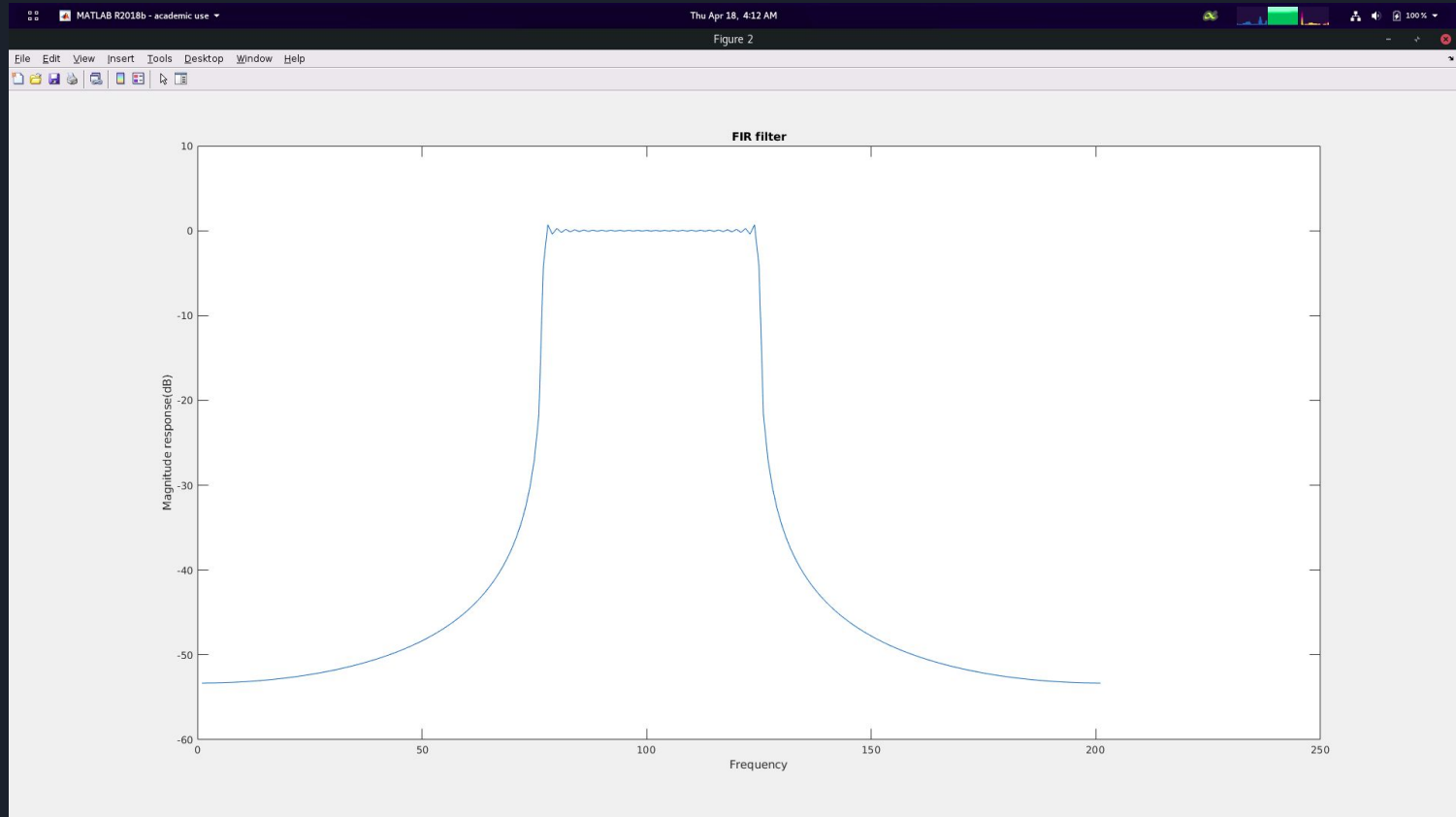
Requirements of project

- Implement the FIR filter with Kaiser Window with given specs using the Filter Designer tool in MATLAB to serve as a baseline. (completed)
- Code the Windows from scratch and experiment with different windows using different filter orders.
- Perform a comparative analysis of the different windows and their uses like the table given below. Plot graphs of each.

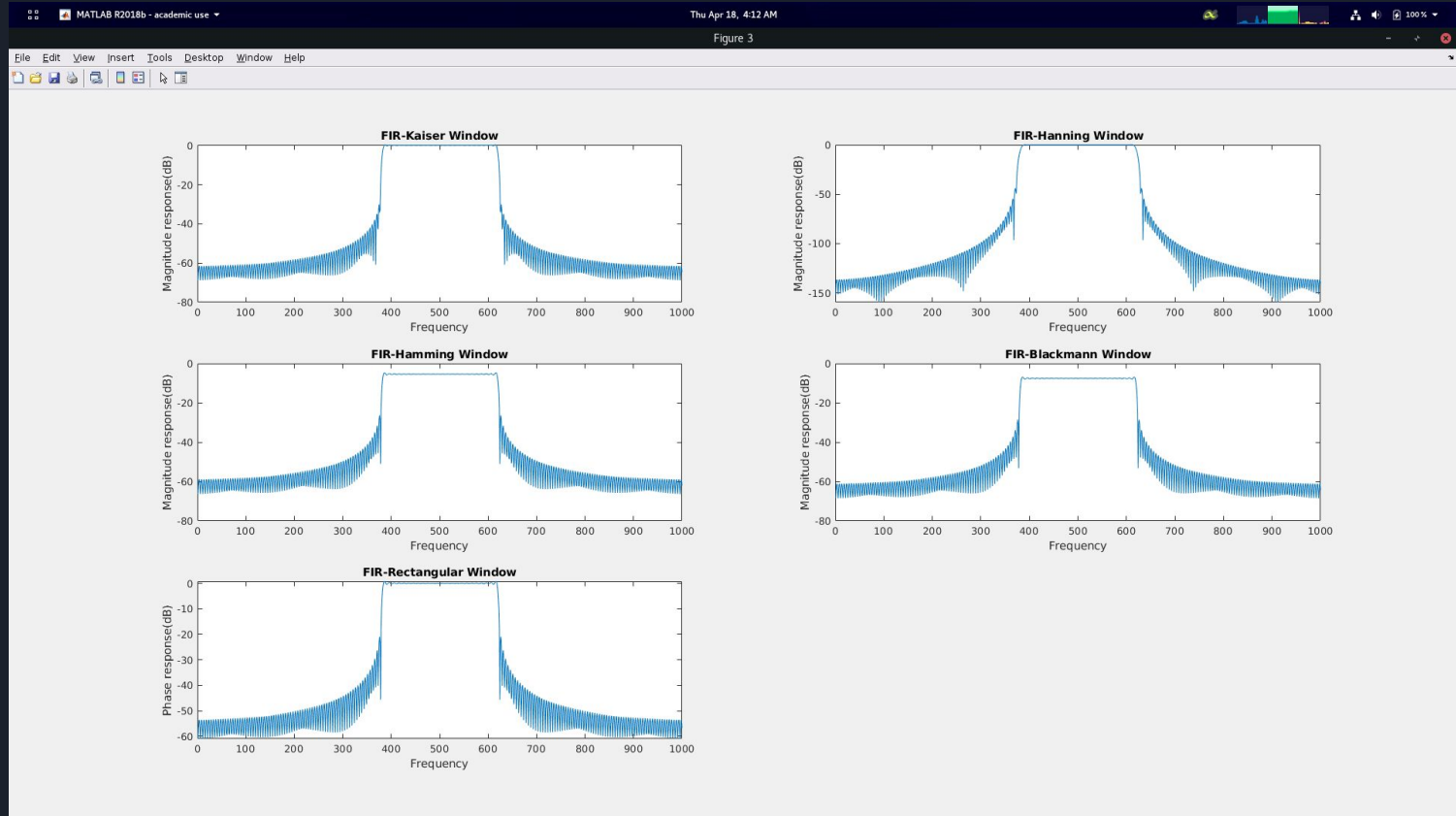
Window function	Over band width (P/N)	Minimum stopband attenuation (dB)	Sidelobe peak amplitude (dB)
Rectangle	4	21	13
Triangle	8	25	25
Hann	8	44	31
Hamming	8	53	41
Kaiser ($\beta=5.6$)	7.442	60	51
Blackman	12	74	71



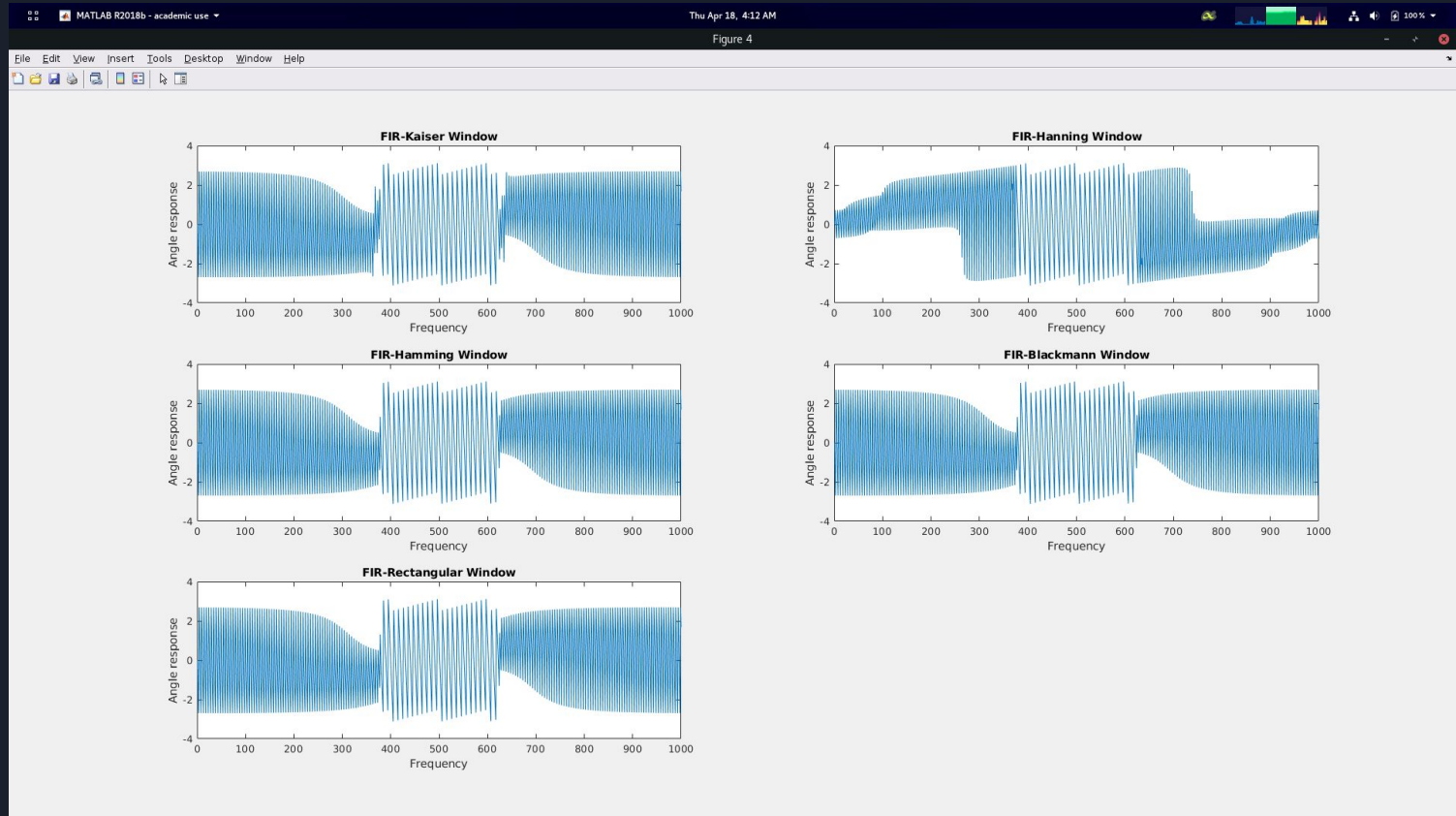
Input signal and its FFT



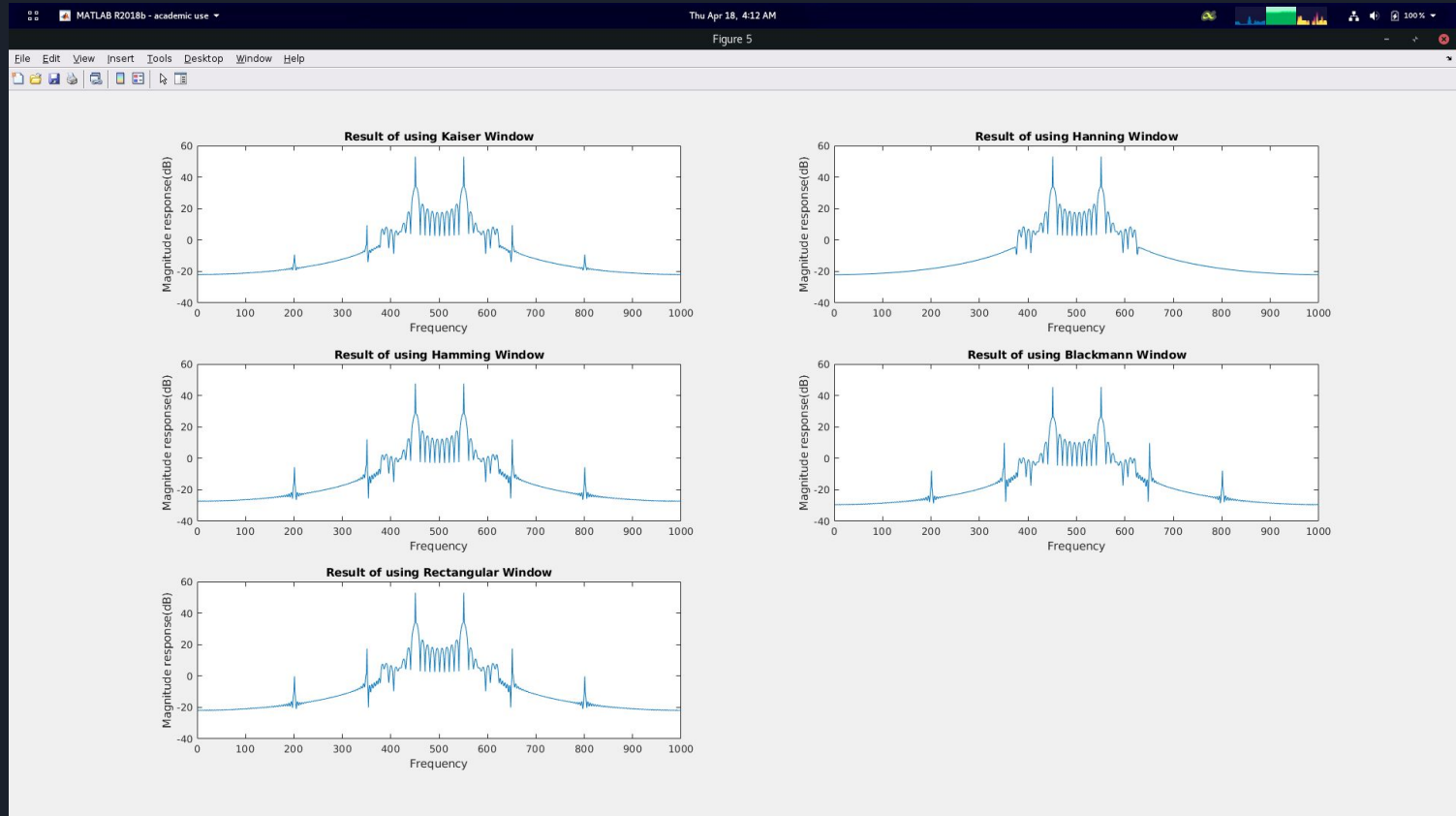
Low pass FIR filter frequency response



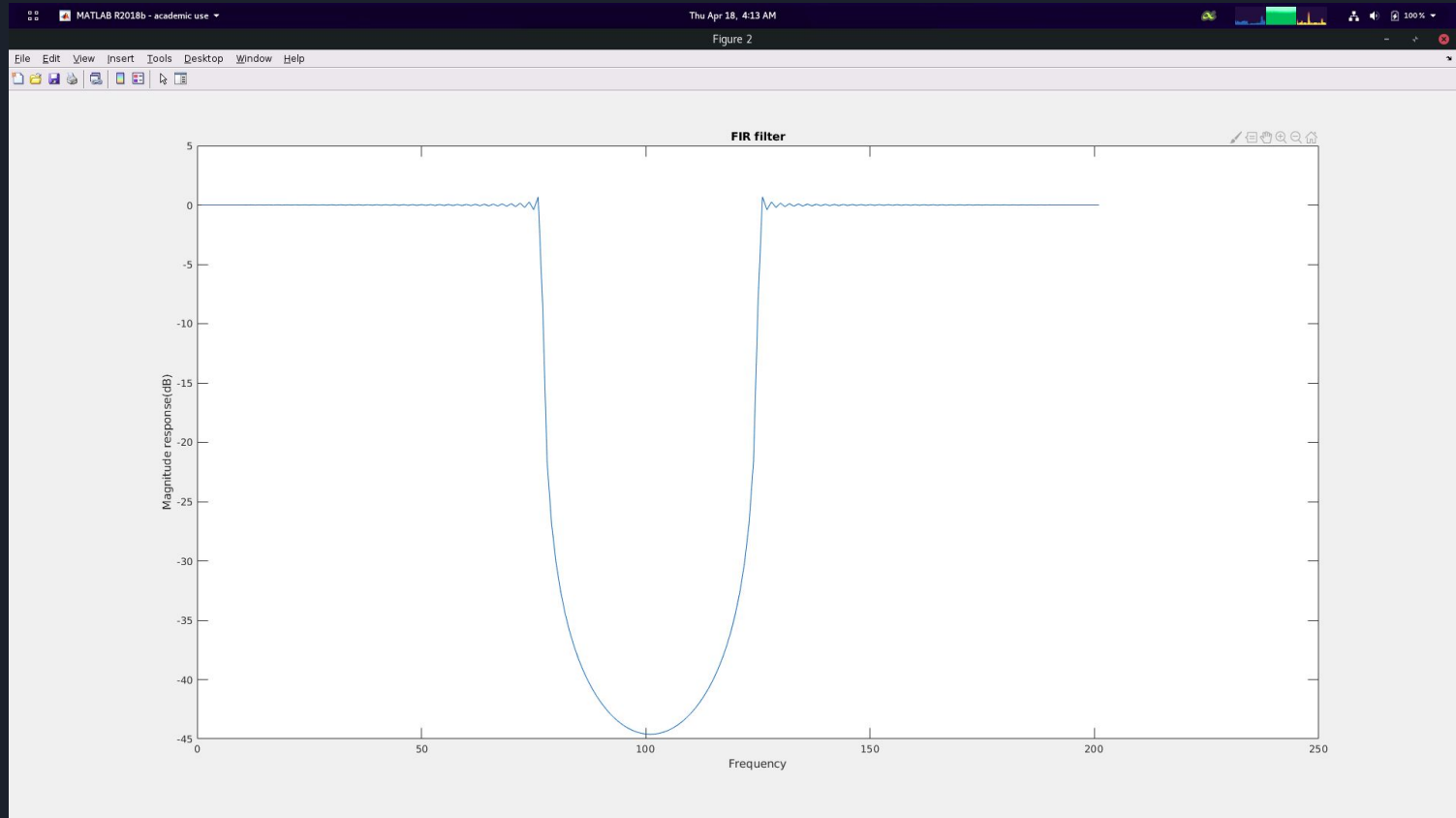
Frequency responses of low pass FIR filter with windows



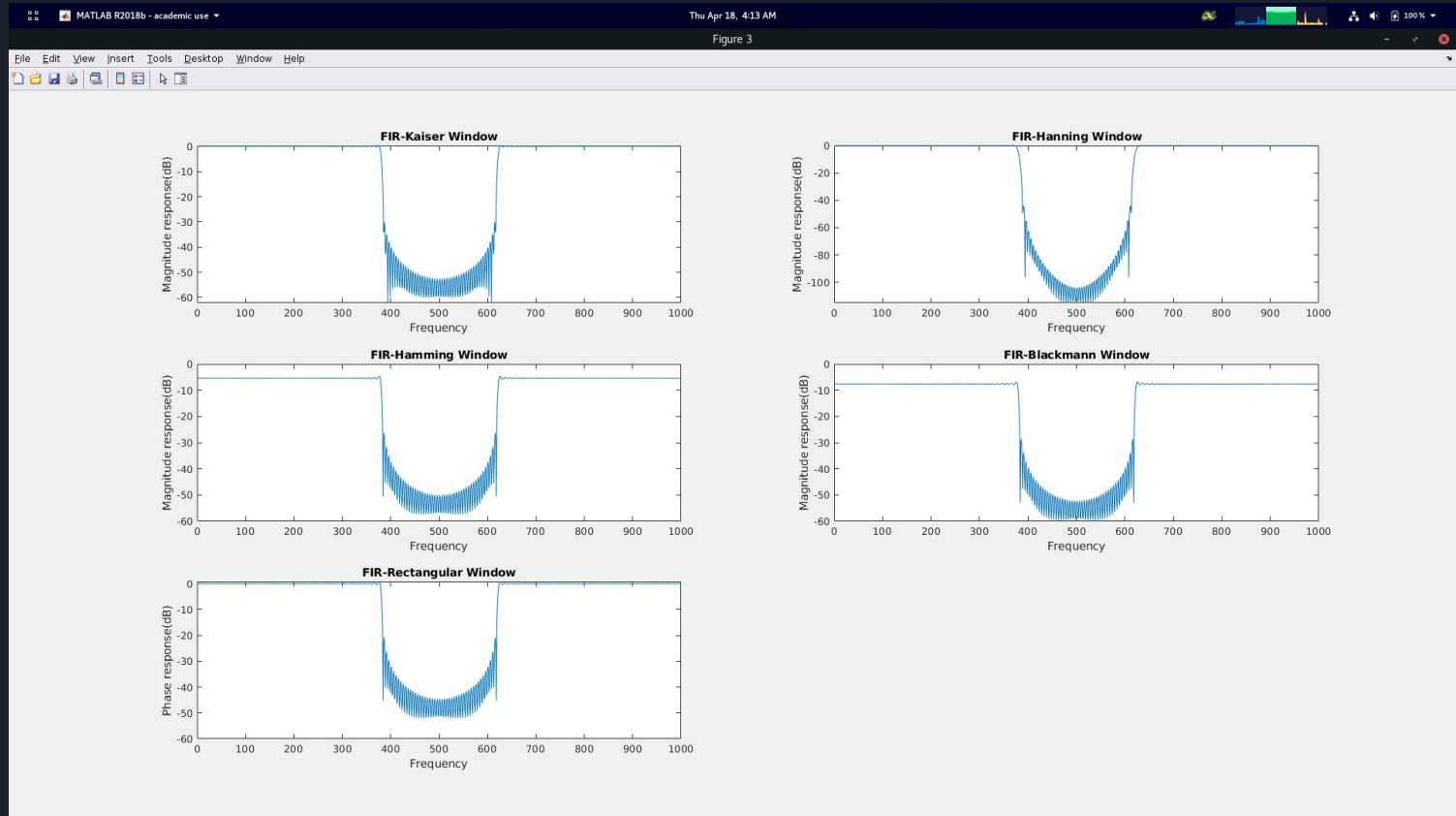
Angle responses of low pass FIR filter with windows



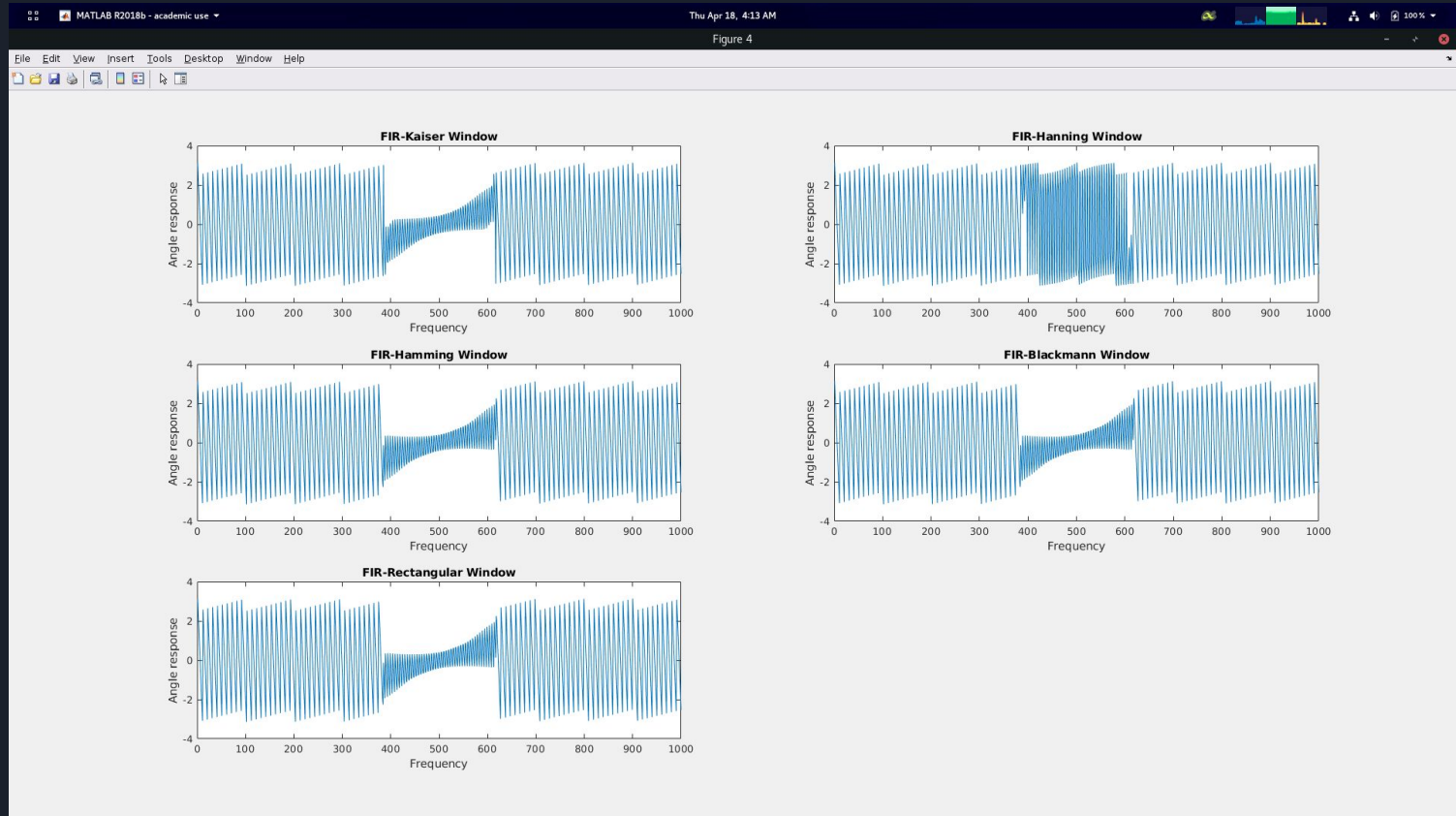
FFT of filtered signals



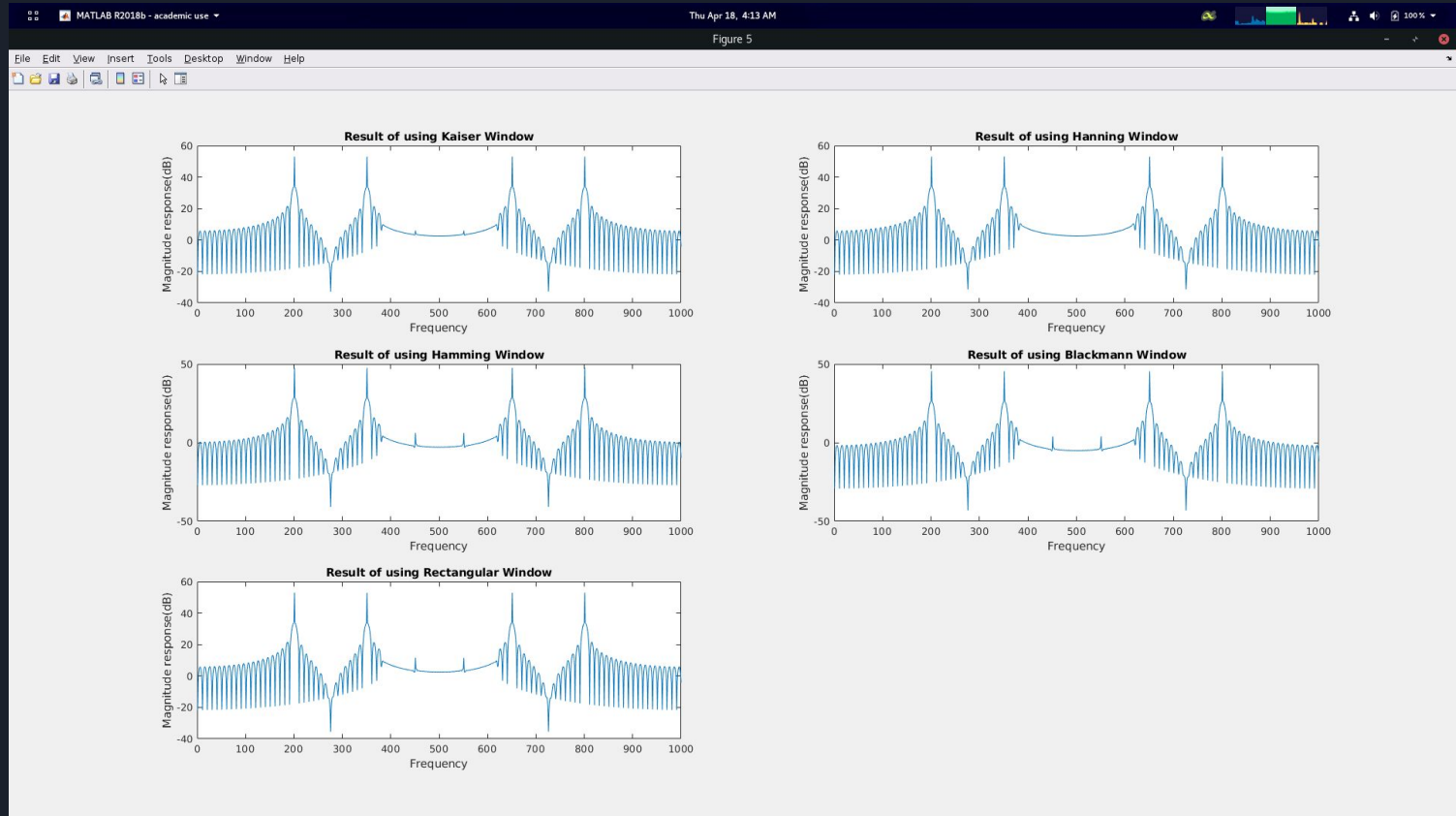
High pass FIR filter frequency response



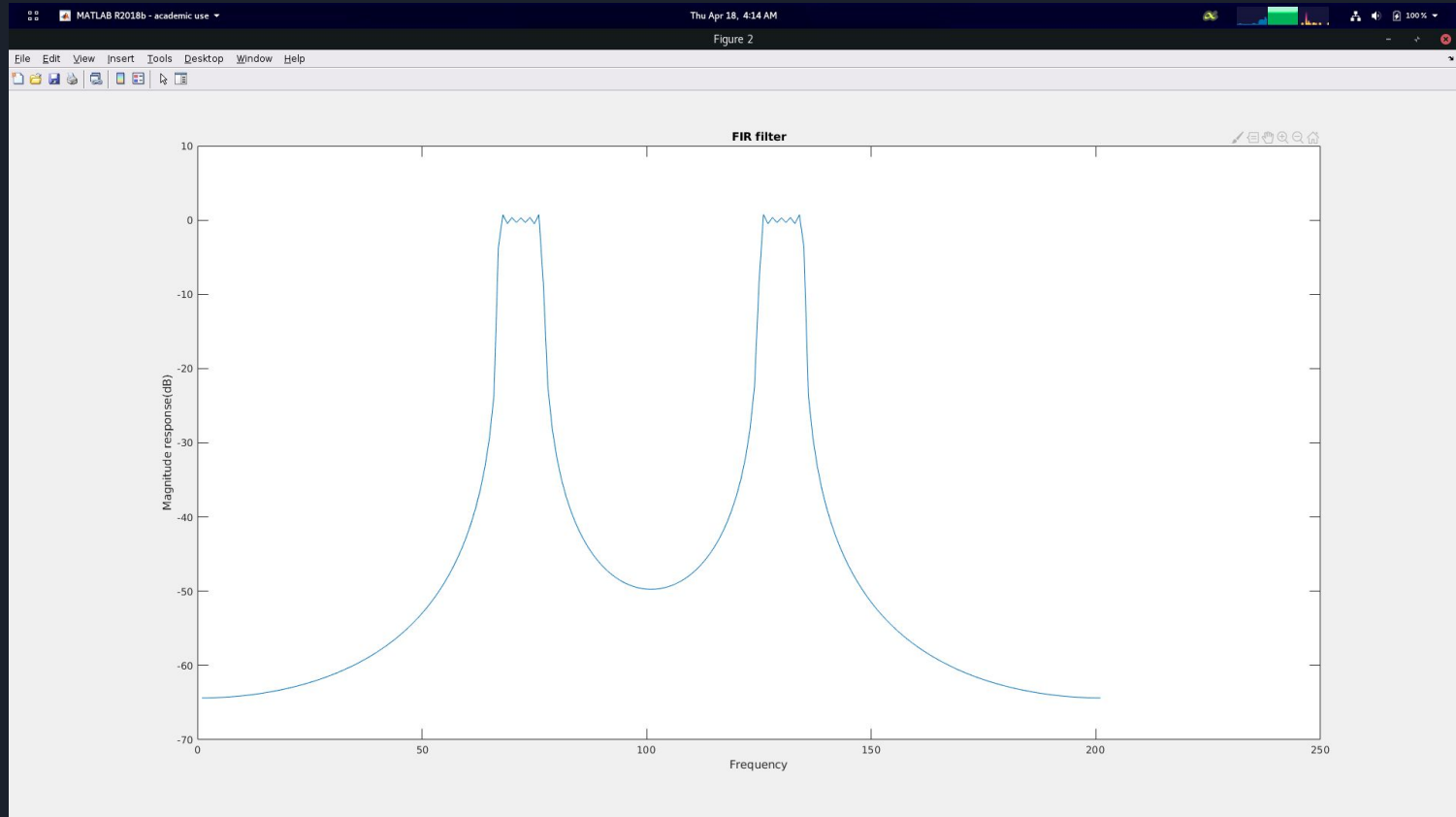
Frequency responses of high pass FIR filter with windows



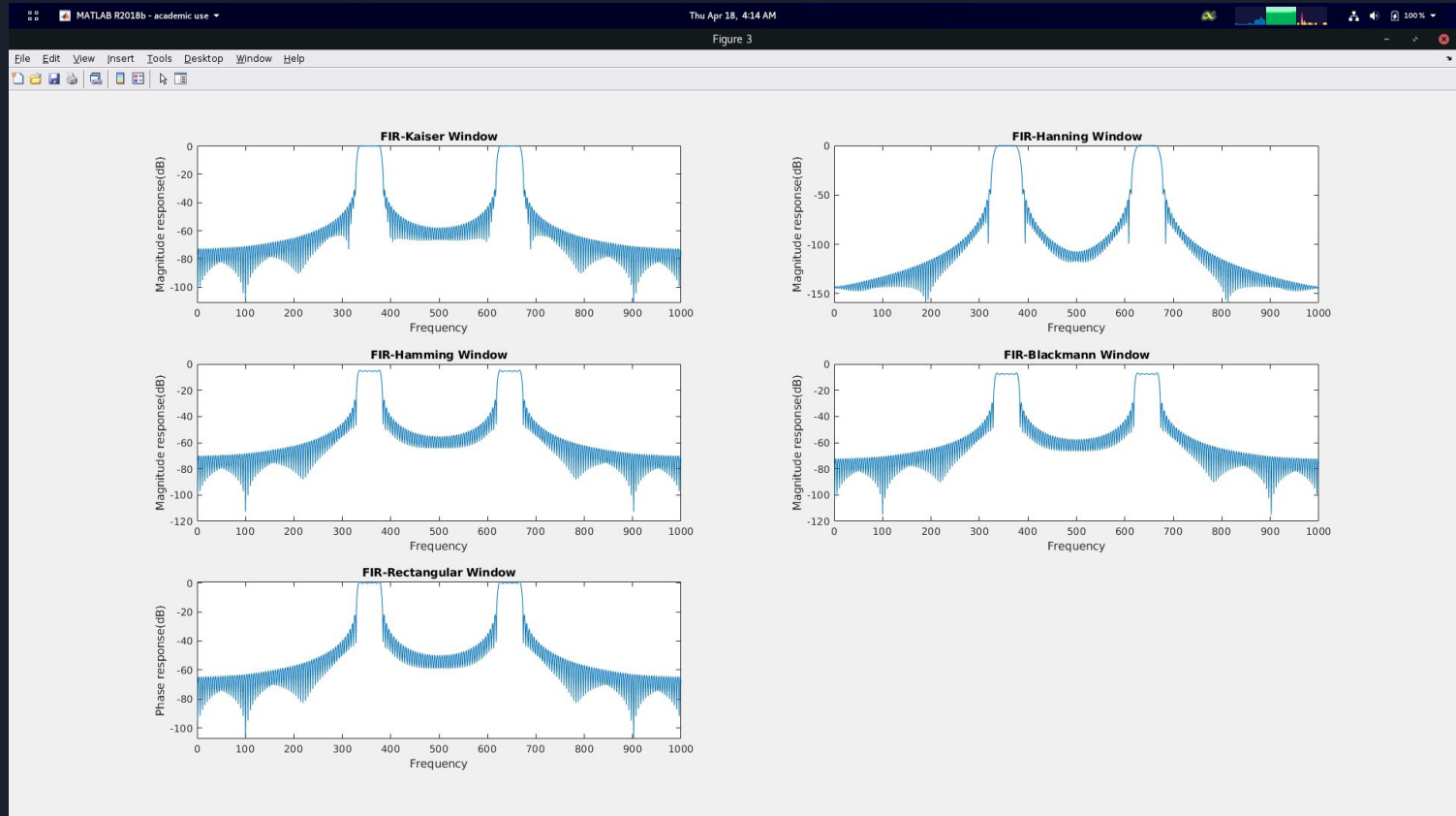
Angle responses of high pass FIR filter with windows



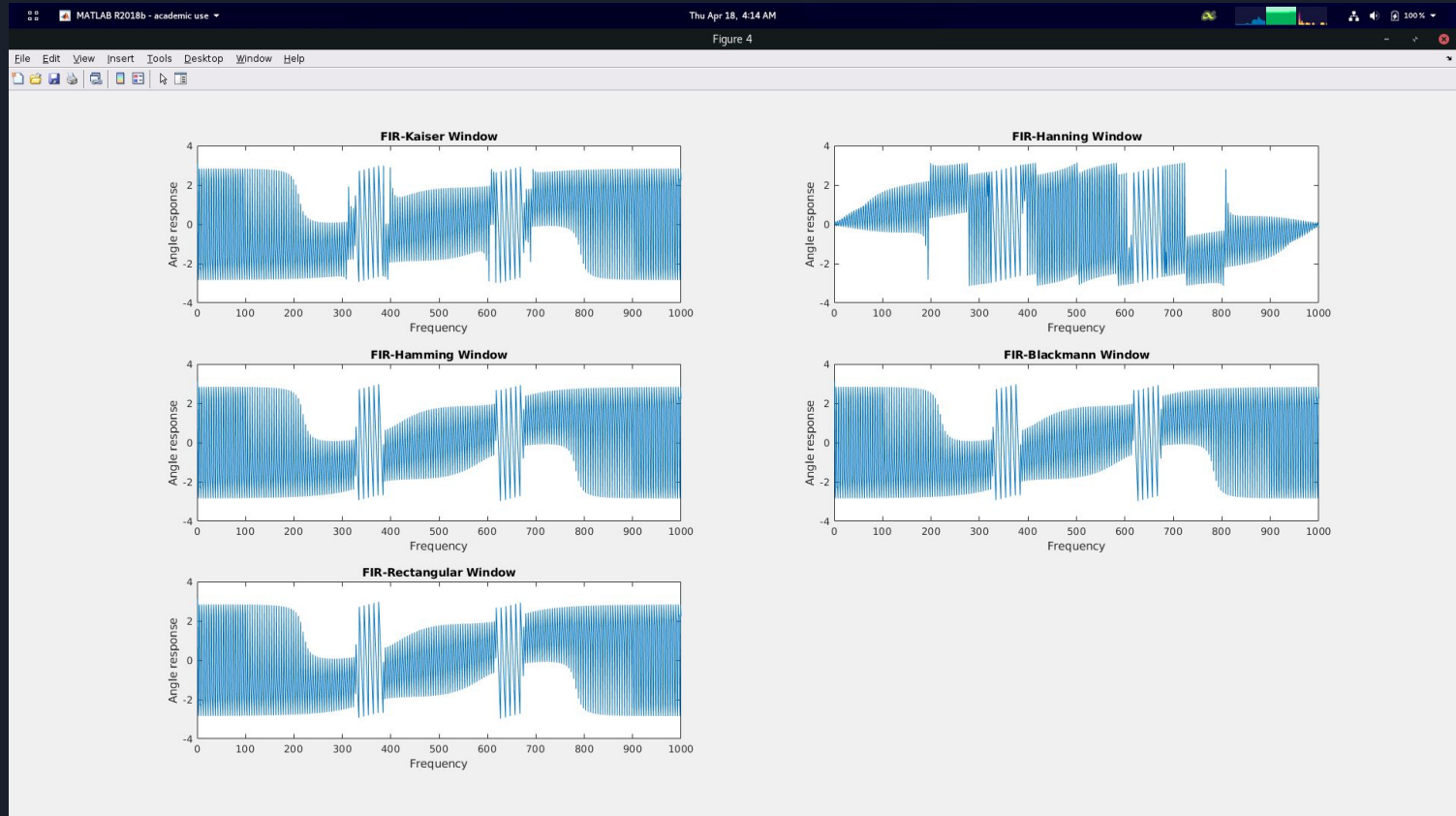
FFT of filtered signals



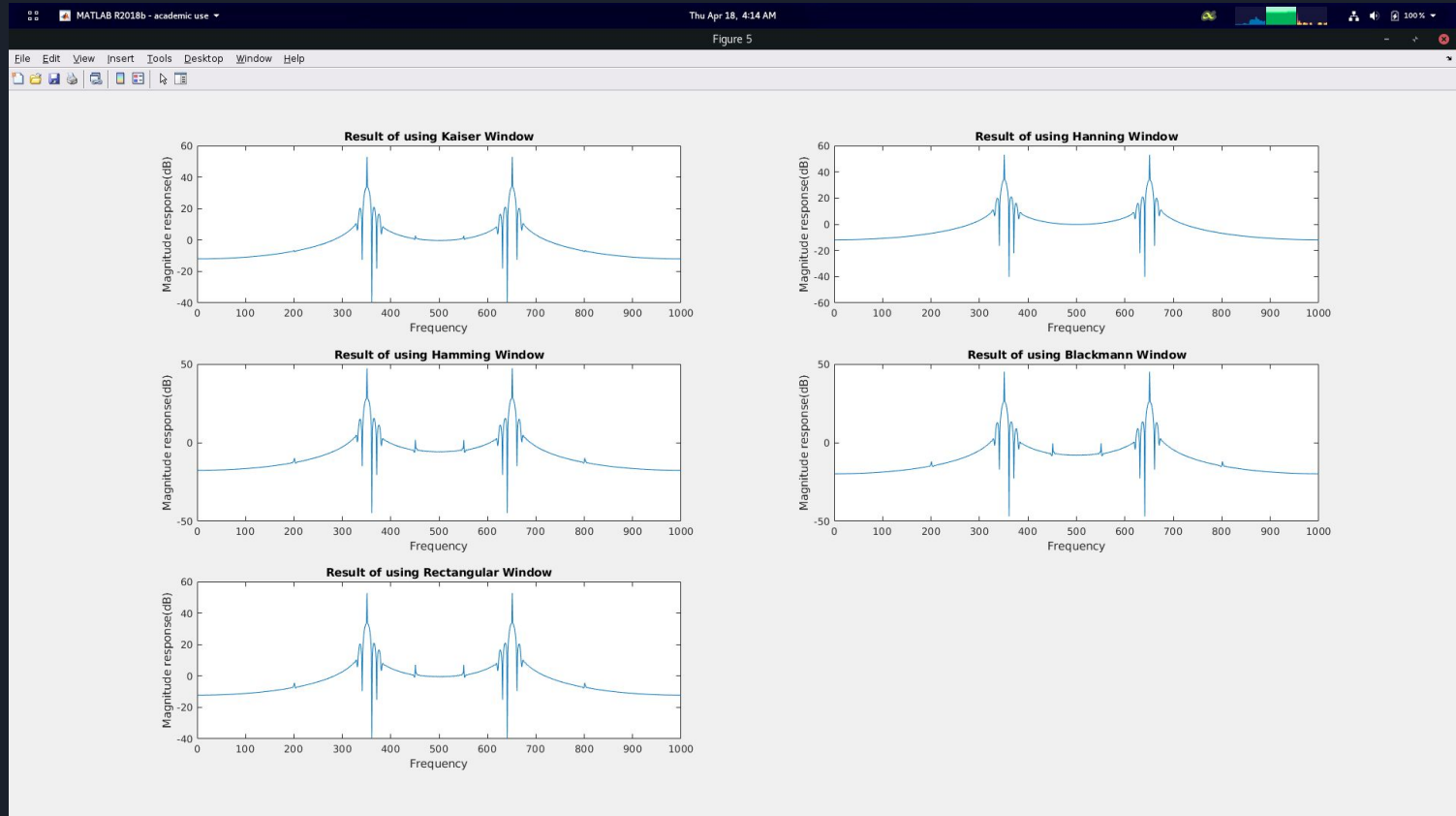
Band pass FIR filter frequency response



Frequency responses of band pass FIR filter with windows



Angle responses of band pass FIR filter with windows



FFT of filtered signals