In The Name of God

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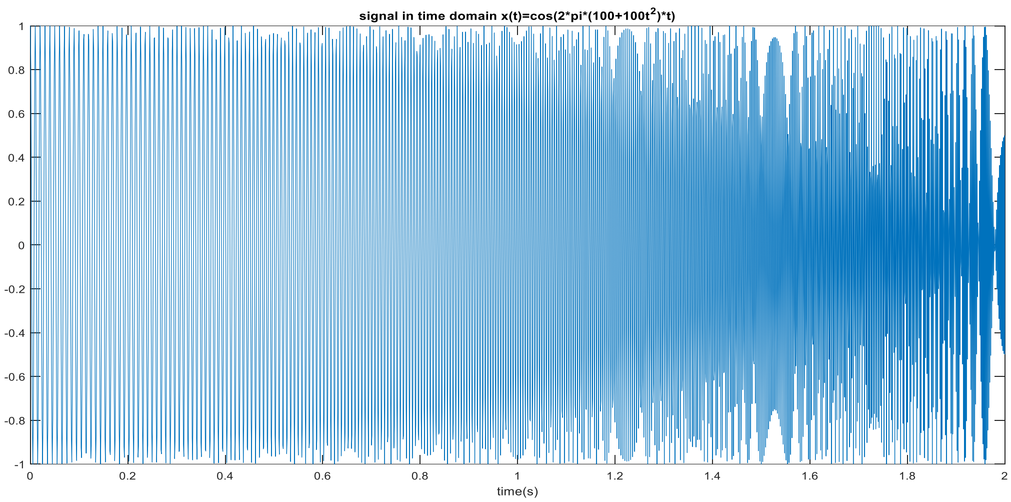
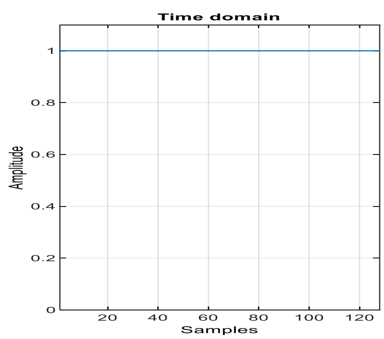
Question1:

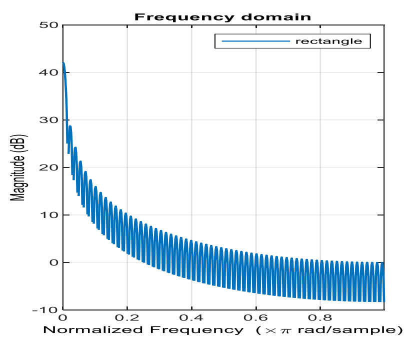
a) We can see signal in time domain in below figure:



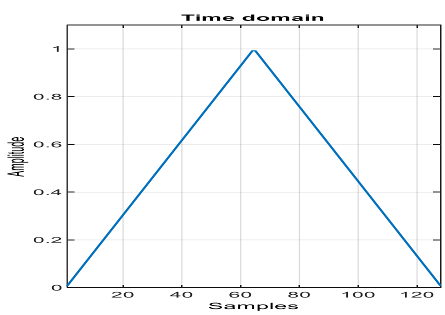
b) Now, assume different window to signal.

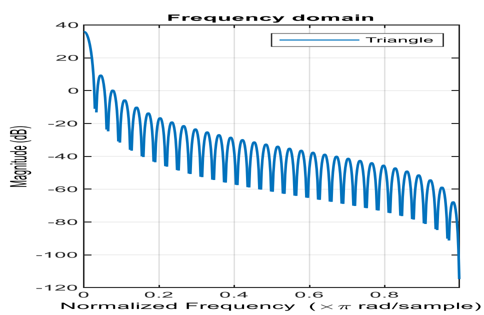
First consider rectangle window. We can see the result on the below figure:



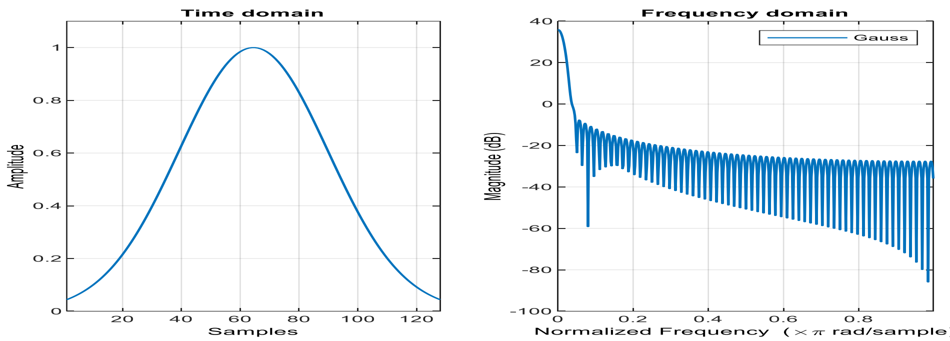


Then, consider Triangle window:

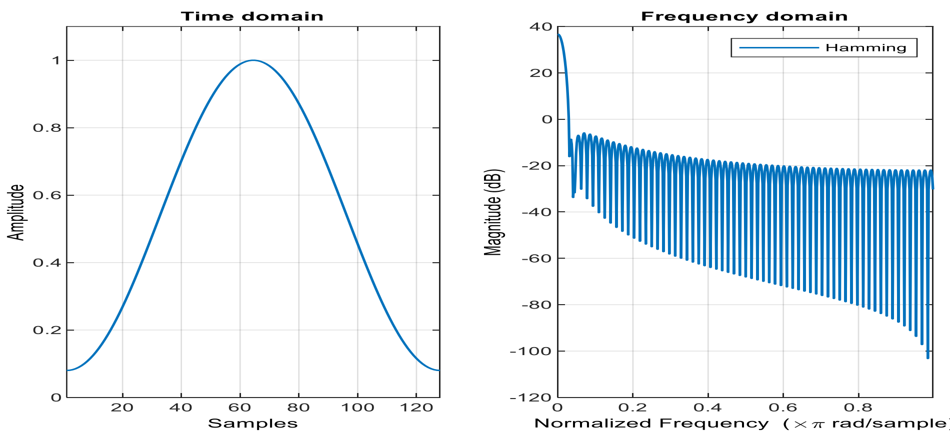




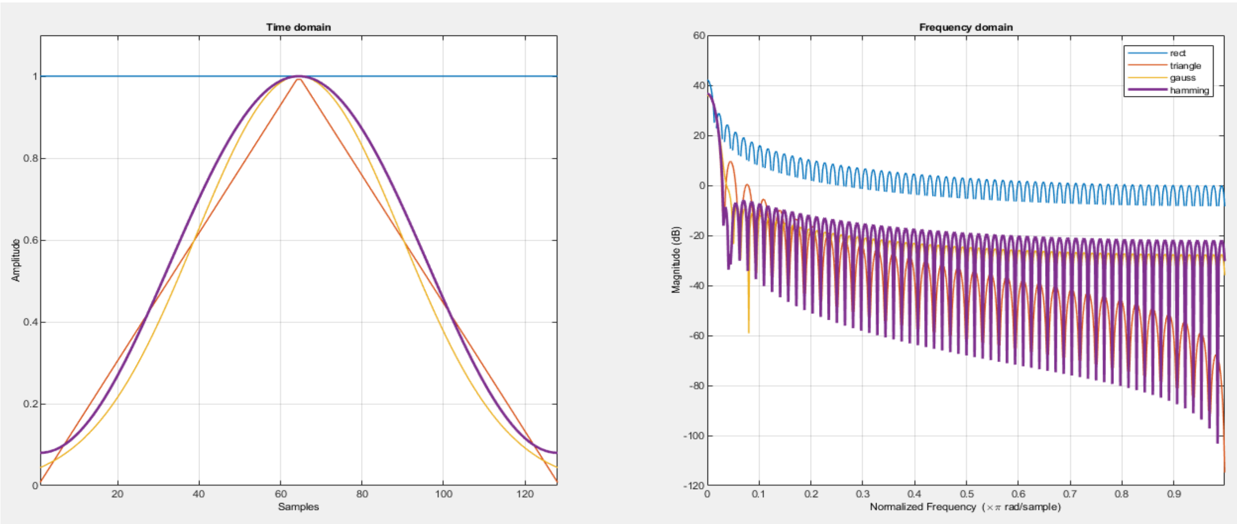
And after that, consider Gauss window:



At last, consider Hamming window:

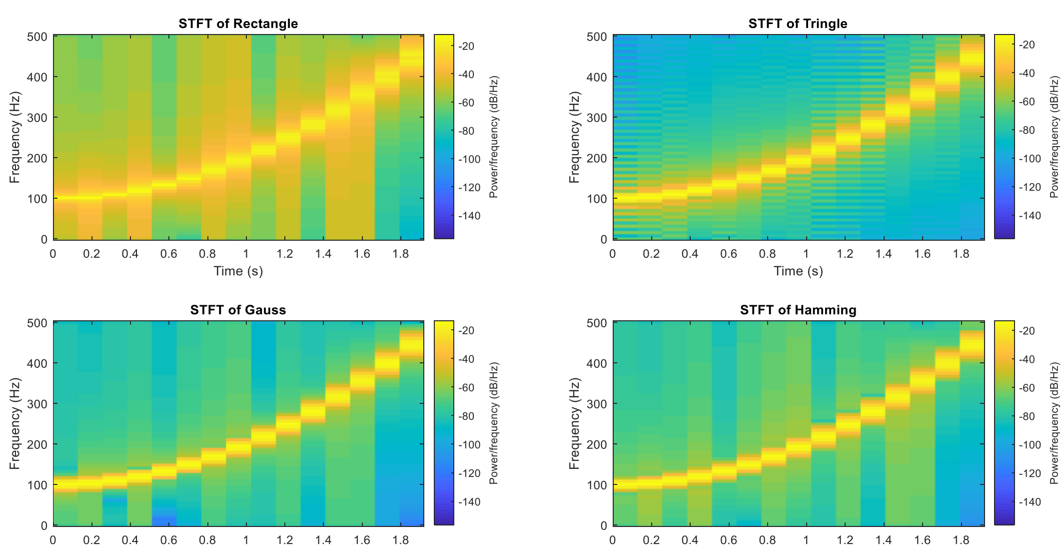


on below figure, we can see four figures together:



As we see on above figure, we figure out each window is smoother, the frequency response decrease fast. So, hamming and Gaussian window have smaller side loop than others. On the other hand, the width of main lop for hamming and Gaussian is bigger than others.

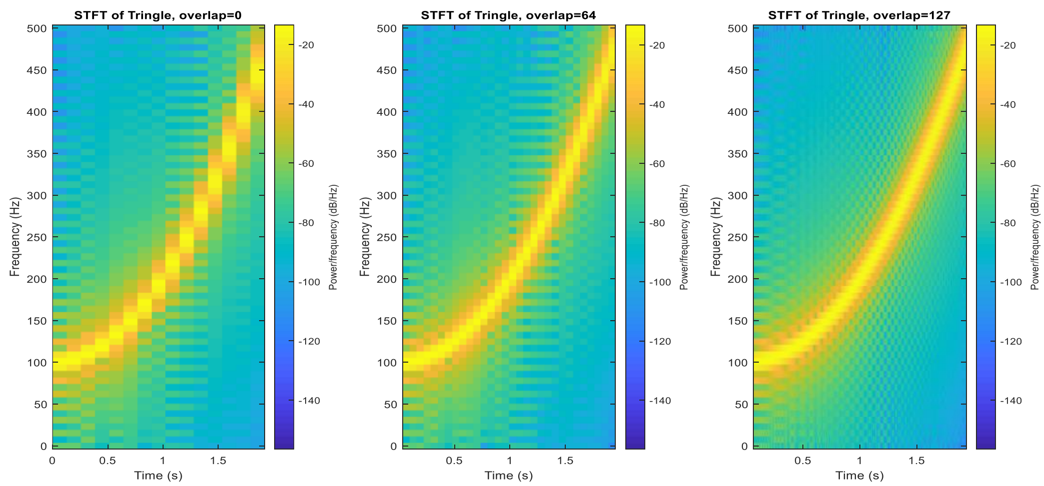
c) In this section we can see the results of STFT of four windows with overlap=0:



Base on the above figure, we know at any time, the yellow section has bigger power than other frequencies.

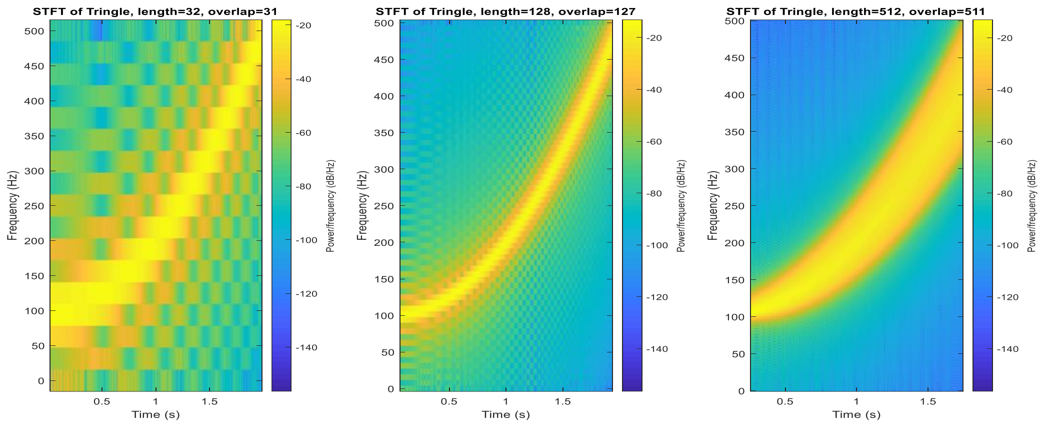
In the rectangle window, we can see the yellow part is thinner than other windows. The reason is that the main lop in the rectangle window is thinner than other windows. Base on the same reason, the Gaussian and hamming window, is fatter than others.

d)



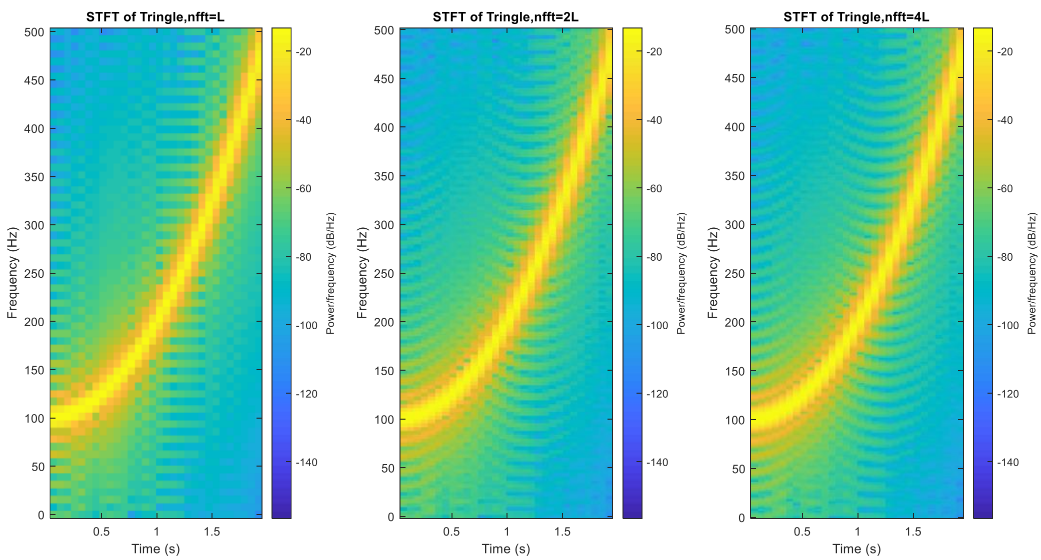
Base on the above figure, if the overlap is zero, the figure isn't smooth and we can see a jump in the yellow parts. If we increase the overlap, the yellow part on the figure is smoother, and don't see a jump in it, and the frequency increase slowly but calculation time is increasing in this case.

e)



As we can see, whatever length of the window is increasing, the curve is smoother. In length 512, we can see in each period, see a wide range of different frequencies because the length of the window is too big.

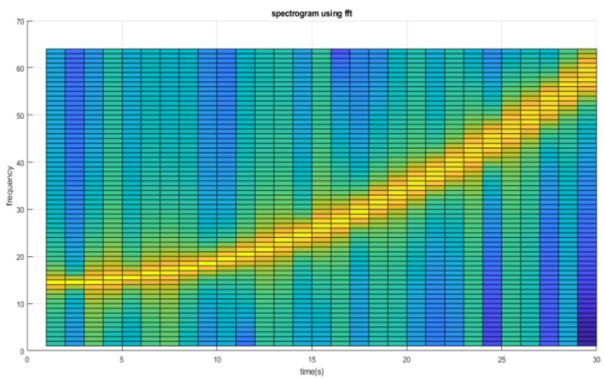
f)

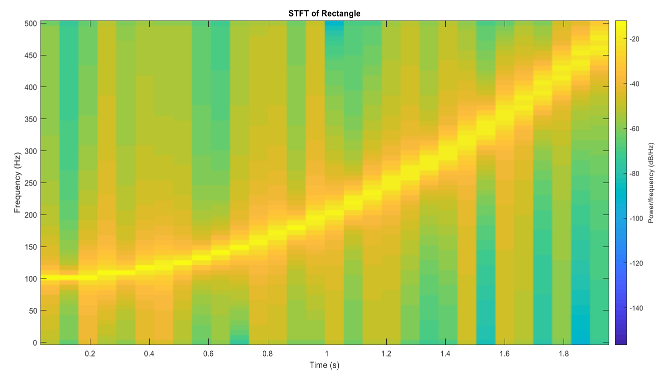


As we know, if we have an N-point signal, we need at least n-point FFT to calculate it completely. Increasing the number of FFT, increase both accuracies of calculation and time of calculation.

g)

if we choose rectangle window with length=128 and nfft=128 and overlap=64 we have:





the first figure is the result of STFT using FFT and the second one is STFT using Matlab function.

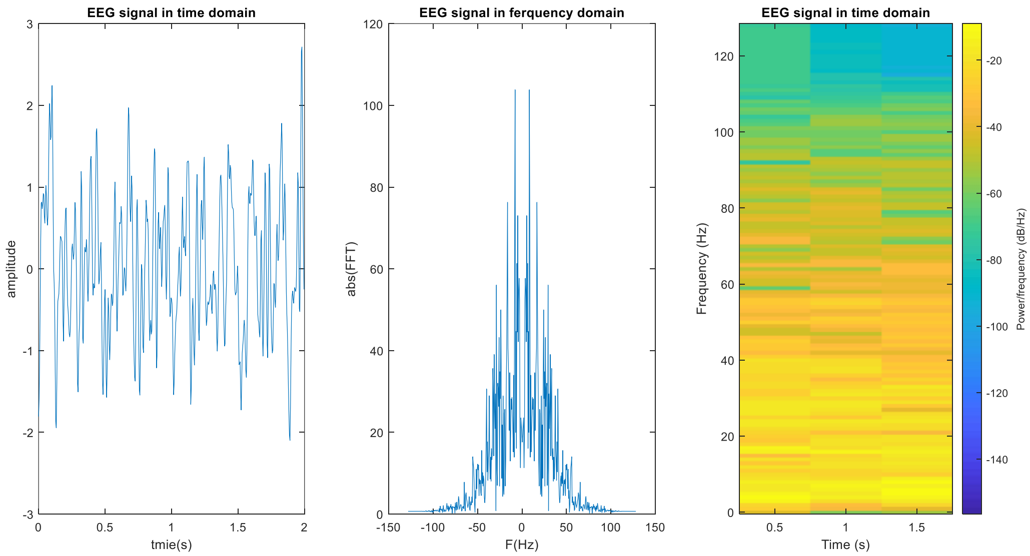
as we can see both figures are approximately is same and the differences are in details.

h) in any case, if we consider a good choice for window length (suppose N) and then select these parameters: overlap=N/2, nfft=N we can see a good result.

Question 2:

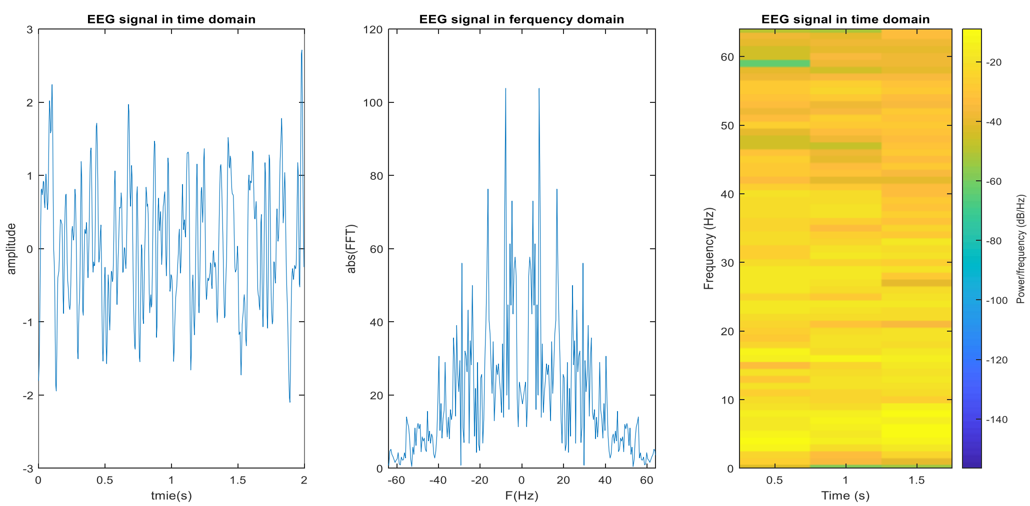
a)

plot EEG signal before any edition:



Base on the above figure, we can consider only frequencies that are smaller than 64 HZ and can ignore other frequencies.

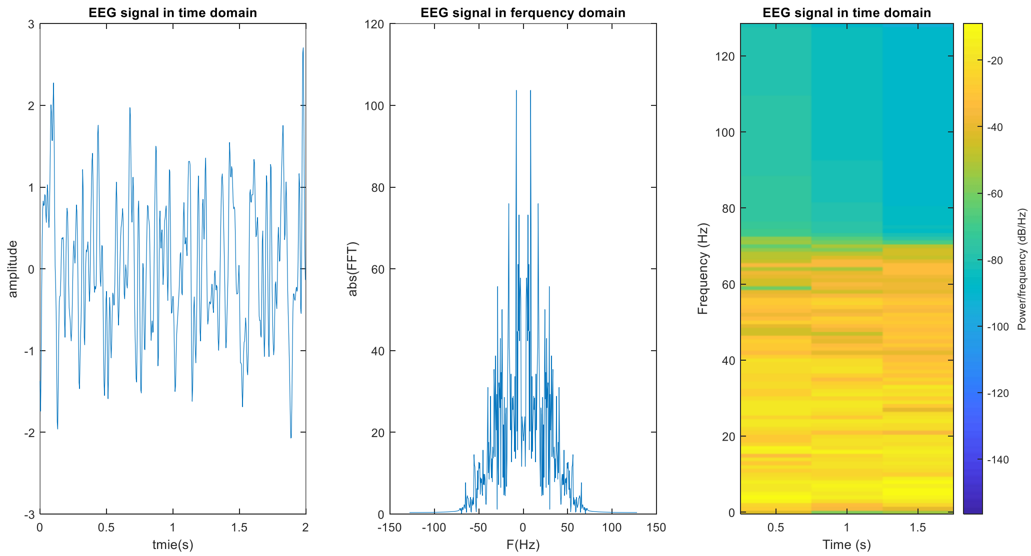
After edition plot we have the below figure:



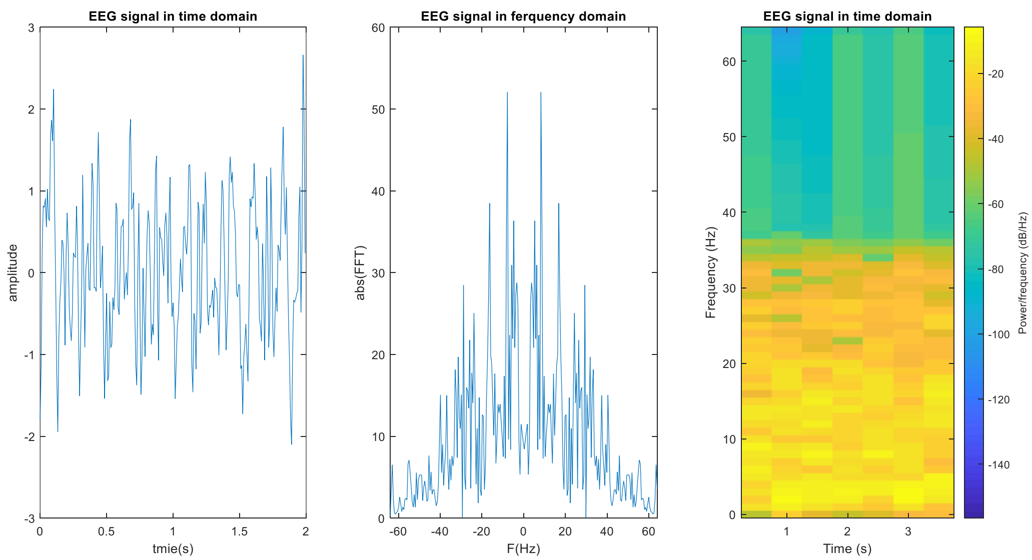
b)

as we see in previous section, we can

after applying Low pass filter with cut-off frequency 64:

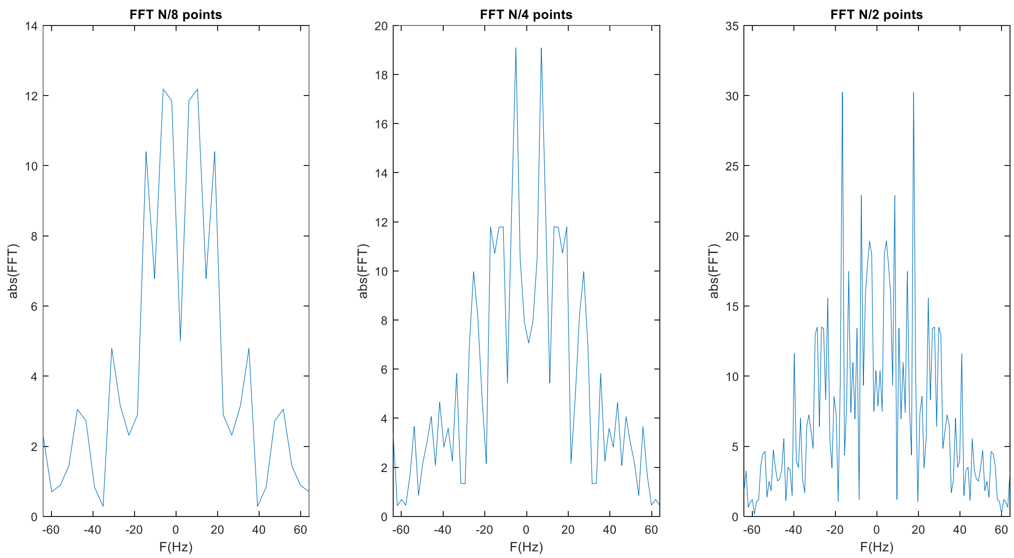


And then down sample it:



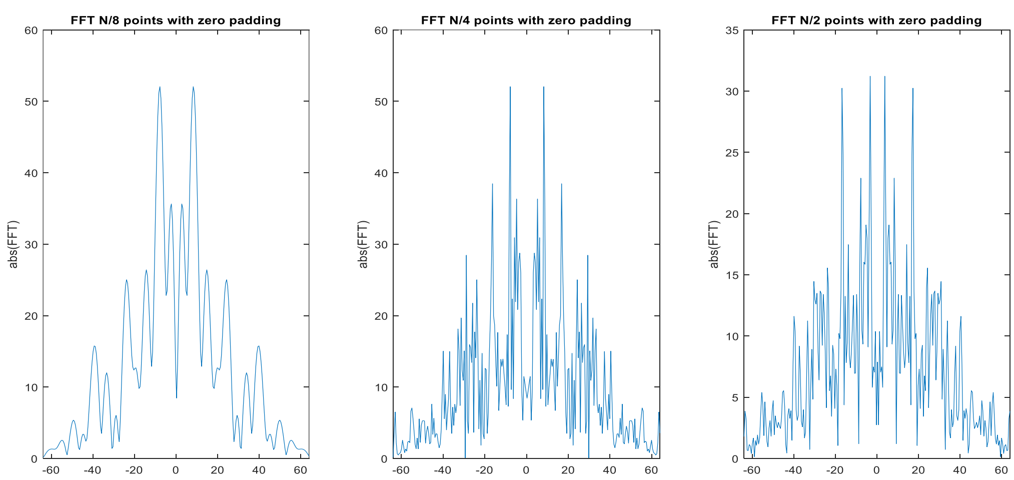
We know from the Nyquist theorem, if we want to keep frequency till 64 Hz, we must be assumed at least Fs=2*64=128 Hz. So, in this case, we can downsample the EEG signal two times without losing data.

c)



As we see the general shape of the figures is the same. But as the increasing number of DFT, the result is better and the accuracy increases.

d)



We can see after zero padding, each of the figures is close to the original one. The reason for this is, when adding zeros to the array, the resolution in the frequency domain is increased.

e)

Based on all the previous sections, we figure out adding a zero pad can increase the resolution in the frequency domain and we have the smoother figure. In other word, zero padding increase frequency resolution.

Zero padding can compensate to some extent the effect of decreasing the number of points in DFT but can't reach the original one.

Windowing is good when the signal is periodic because windowing causes the loss of some data.