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Lab Assignment # 5
Digital Signal Processing WiSe2020

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Task	Measurements and Comments	
2.1	Δf=156.25, f1=625	Integer number of periods (4) and actual spectrum of the original signal is observed; freq. component at 625.
2.2	Δf=156.25, f1=703.125	Due to non-integer periods (4.5) artificial high frequency components show up in FFT and noise is also observed as higher side lobe levels. Also, we can: 156.25x4.5=703.125
2.3	N=64, Δf=156.25, f1=1250, f2=1406.25	Smearing effect was observed. Side lobe of strong component masked with the main lobe of weak component.
2.4	N=1024, Δf=9.7656, f1=1201.1, f2=1298.8	By increasing the number of samples smearing error was reduced and frequency components that were smeared in 2.3 were separated and clearly observed. However, increasing N leads higher computation.
2.5	N=64, Δf=156.25,	Keeping the N small and changing the phase the smearing was reduced in this particular case.
2.6	Periods 10 (integer)	Due to small amplitude of weak components its main lobe was masked by the side lobe of strong component
2.7	Periods 9.5 (non-int)	Like 2.2, artificial components appeared, both peaks were not determined, weak components masked like 2.6
2.8	Periods 9.5 N=128, Δf=78.125,	Side lobe level was reduced by applying **Hann** window. The weak comp. become visible as interference was reduced but due to non-integer periods artificial high freq. appeared and strong comp. was not visible.
2.9	A uniformly distributed white Gaussian noise spectrum was observed.	
2.10	Distortions increase when noise was added. Again components were not identifiable due to artificial frequencies coz of non-int. periods	
2.11	Interference was reduced when **Hann** window was applied, and the weak component became visible.	
2.8 & 2.11	It was also observed that windowed FFT of a signal with DC offset will produce the shape of the FFT of the window function around DC bins, which may mask out the interested signals at those bins [2].	

2.12	Strong Comp.		Weak Comp.		DC	Observations
	F(rad/s) F(Hz)	A(dB)	F(rad/s) F(Hz)	A (dB)	A(dB)	**Abbreviations:** A= Amplitude, ML=Main Lobe, SL=Side Lobe, comp.=Component
Rect.	0.7 1114	-6.056	0.6143 977.6	-30.06	-5.805	Overall, the spectrum was distorted, and weak component was not visible, but by zoom and close observation estimation was taken at point of interference.
Bartlet	0.7 1114	-6.023	0.5918 941.9	-43.09	-5.892	weak component was not differentiable because of interference between strong component's SL and weak comp's ML, but estimation at merging point was taken.
Hann	0.7 1114	-6.024	0.6021 959.4	-45.97	-5.893	By applying Hanning window, the weak component's ML became separated and visible however side lobes of both components were observed merging.
Hamm.	0.7 1114	-6.029	0.5989 953.1	-42.56	-5.88	The peak become more prominent at the cost of poor drop off rate of side lobes, so if the amplitude weak comp. is much smaller it can be masked by SL of strong one
Black-man	0.7 1114	-6.022	0.6016 956.3	-45.63	-5.894	The SL level in Blackman window is much lower than hamming window and the width of its main lobe is also less than Kaiser window.
Kaiser (α=10)	0.7 1114	-6.021	0.6009 956.6	-45.46	-5.895	Both components are visible. The Kaiser window has lowest side lobes level but due to the wider main lobe width, there are chances of smearing.

It is observed that the **amplitude of the DC components** is almost constant for all the windows mainly because of increased zero padding.

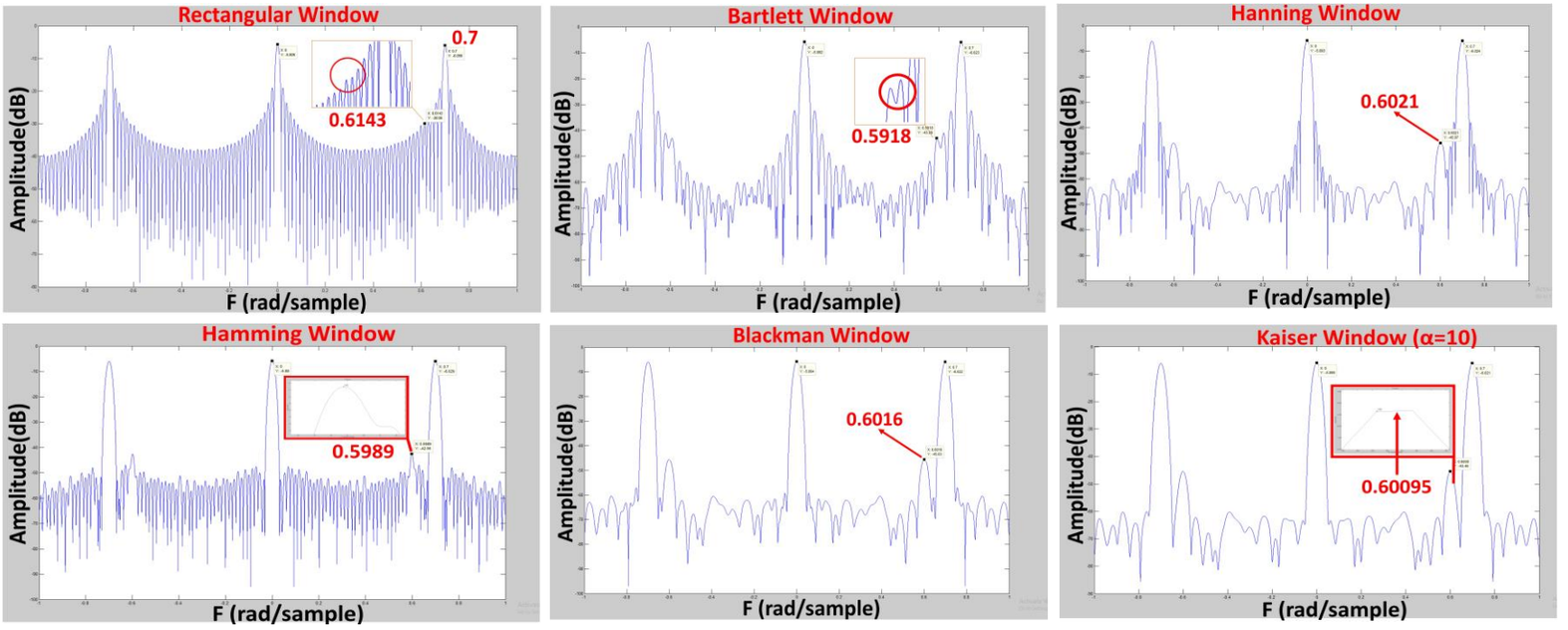

Figure: Task 2.12 FFT spectrums after different windows (detailed frequency and amplitudes are mentioned in Table)

References

[1] Brückl, S., 2020. DSP Lecture Notes and Lab Manuals, MS-EE UAS Kempten.
[2] Mathworks.com. Matlab and Simulink. [online] [Accessed 6 January 2021].

I affirm that I have performed all the tasks myself and cited all the sources.

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