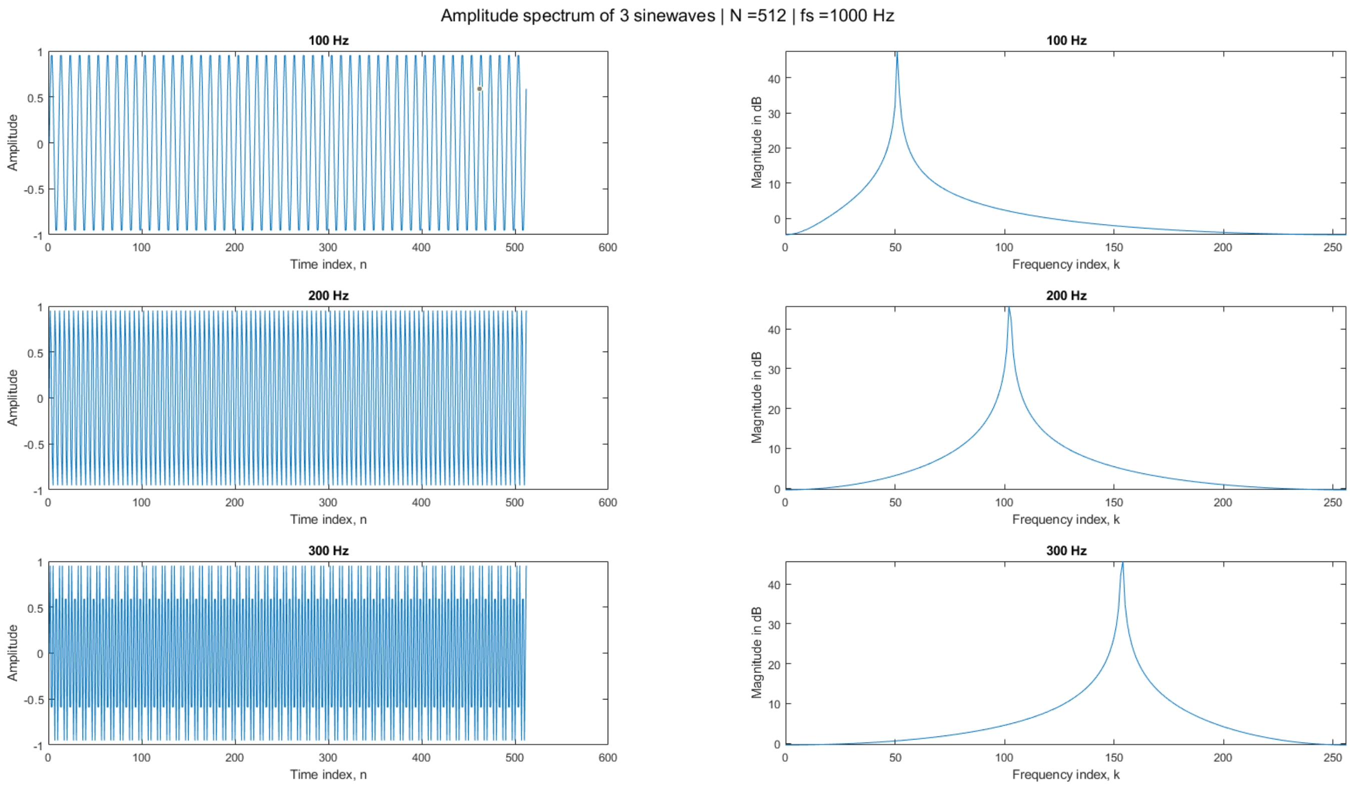
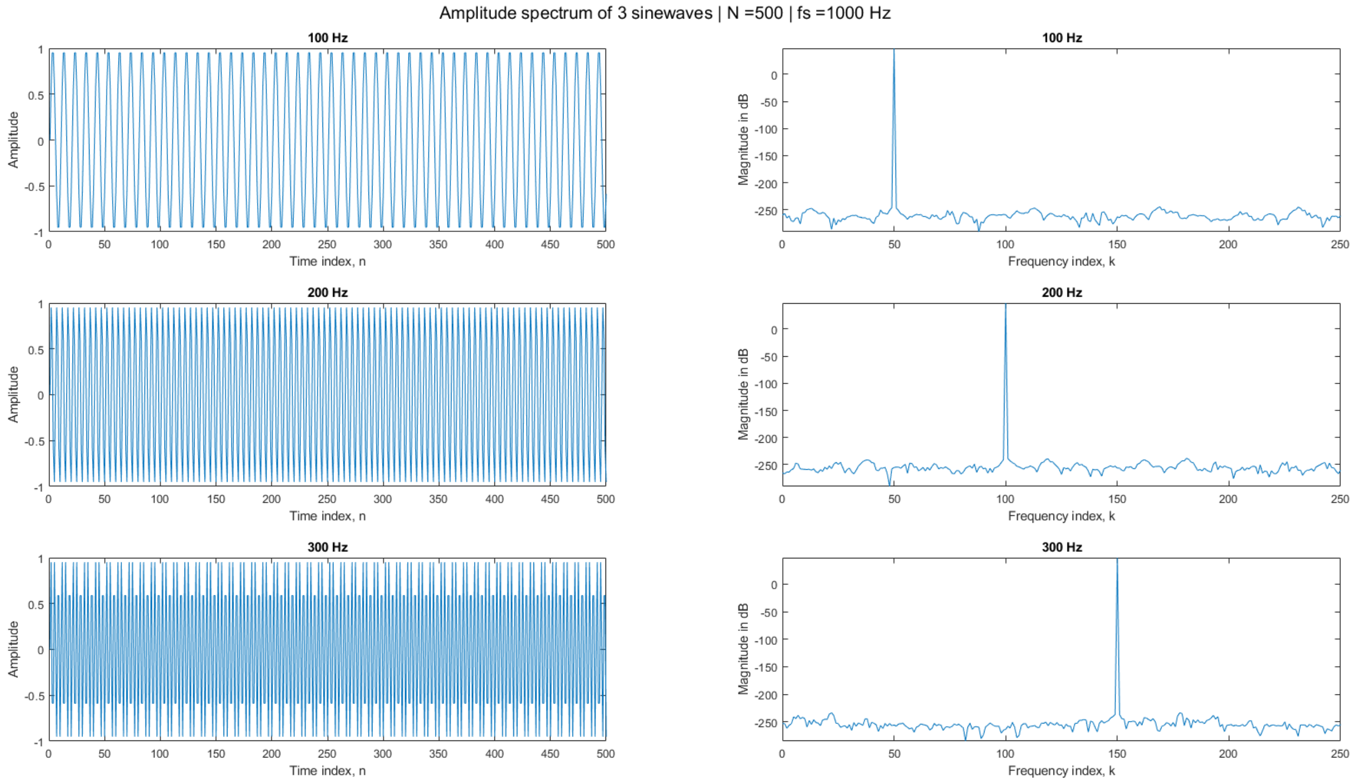
Q1

Generate 512 samples of digital sinewaves at different frequencies (100, 200, and 300 Hz) with the sampling rate of 1000 Hz). Use amplitude spectrum to verify that the frequencies of generated signals are correct.



Code in https://github.com/belongtothenight/RTDSP_Code/blob/main/src/w5_code5_1.m

Just by changing the number of samples from 512 to 500 which is $0.5 \times f_s$, we can get the clear DFT result instead of a wide range of result.



Code in https://github.com/belongtothenight/RTDSP_Code/blob/main/src/w5_code5_2.m

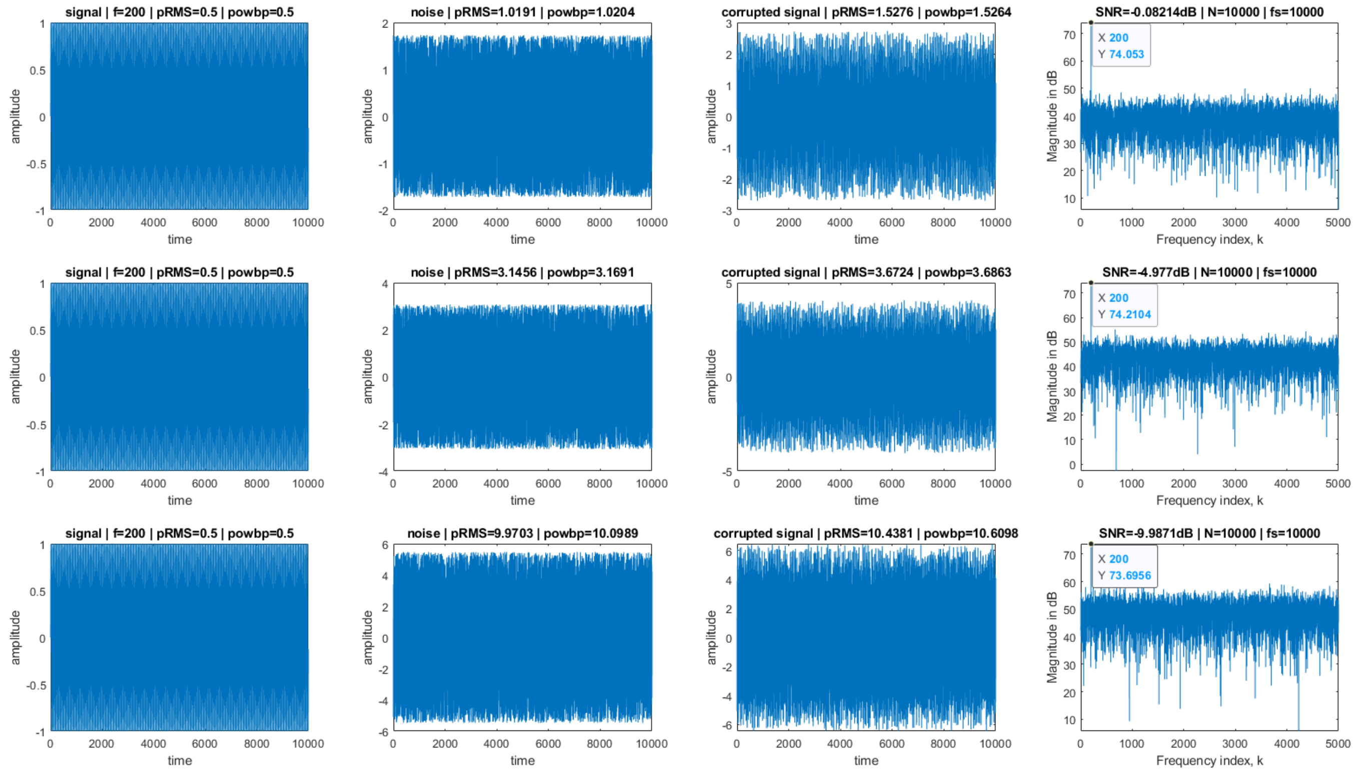
Q2

Add white noise to the 200 Hz sinewave generated in step 1 with different SNRs (0, 5, 10 dB). Use amplitude spectrum to verify that the SNR of generated signals are correct.

Since we've already achieved 0 dB SNR with noise signal, a coefficient (α) is needed to amplify generated noise signal.

For 0 dB, $\because 20log_{10}(\alpha) = 0\ dB \quad \therefore \alpha = 1$
For 5 dB, $\because 20log_{10}(\alpha) = 5\ dB \quad \therefore \alpha = \sqrt[4]{10}$
For 10 dB, $\because 20log_{10}(\alpha) = 10\ dB \quad \therefore \alpha = \sqrt{10}$

Each row of the following figure represents 0, 5, and 10 dB SNR correspondingly.

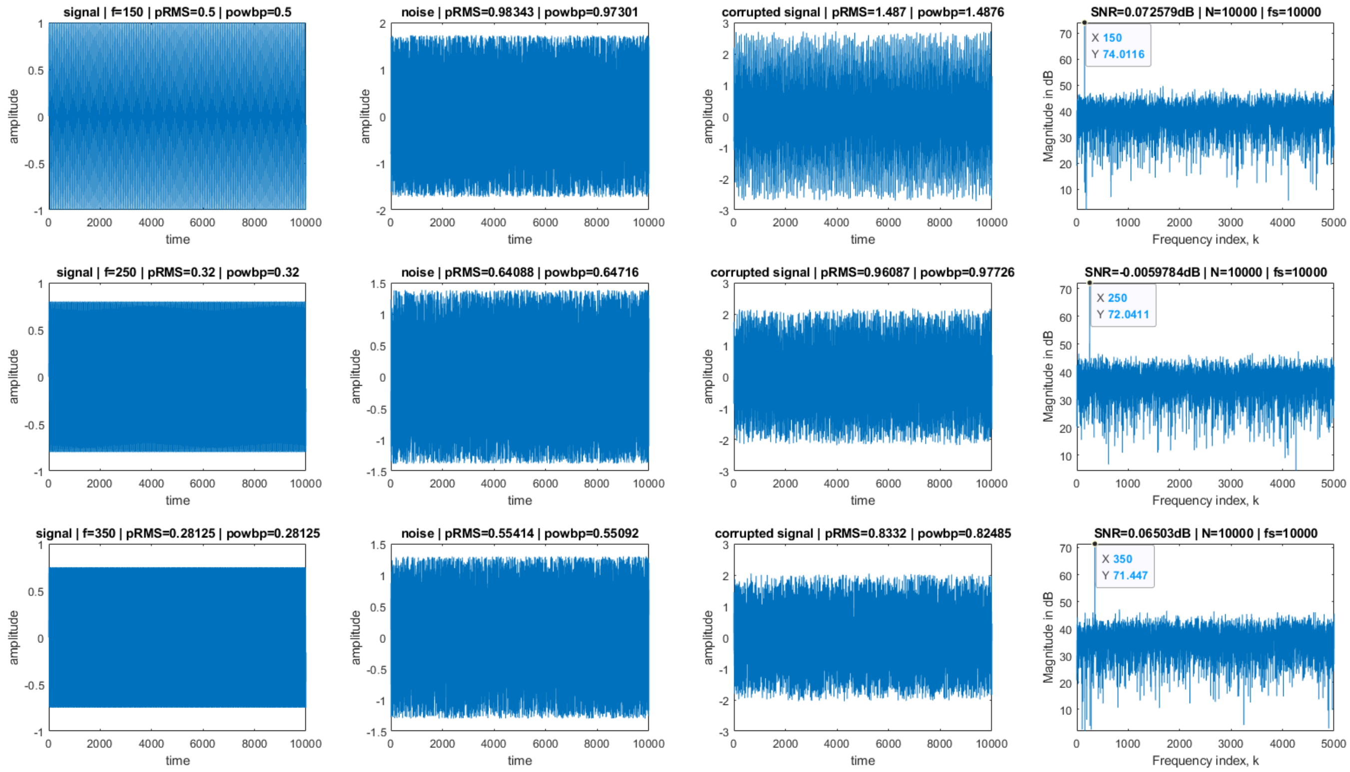


Code in https://github.com/belongtothenight/RTDSP_Code/blob/main/src/w5_code6.m

Q3

Generate 512 samples of digital signal consists of 3 sinewaves at different frequencies (150, 250, 350 Hz), with corresponding amplitude (1, 0.8, 0.75) respectively, and the sampling rate 1000 Hz, which are corrupted by white noise with SNR 0 dB.

Following the calculation above,
For 150 Hz with $A = 1$, $\alpha = 1$
For 250 Hz with $A = 0.8$, $\alpha = 0.8$
For 350 Hz with $A = 0.75$, $\alpha = 0.75$



Code in https://github.com/belongtothenight/RTDSP_Code/blob/main/src/w5_code7.m