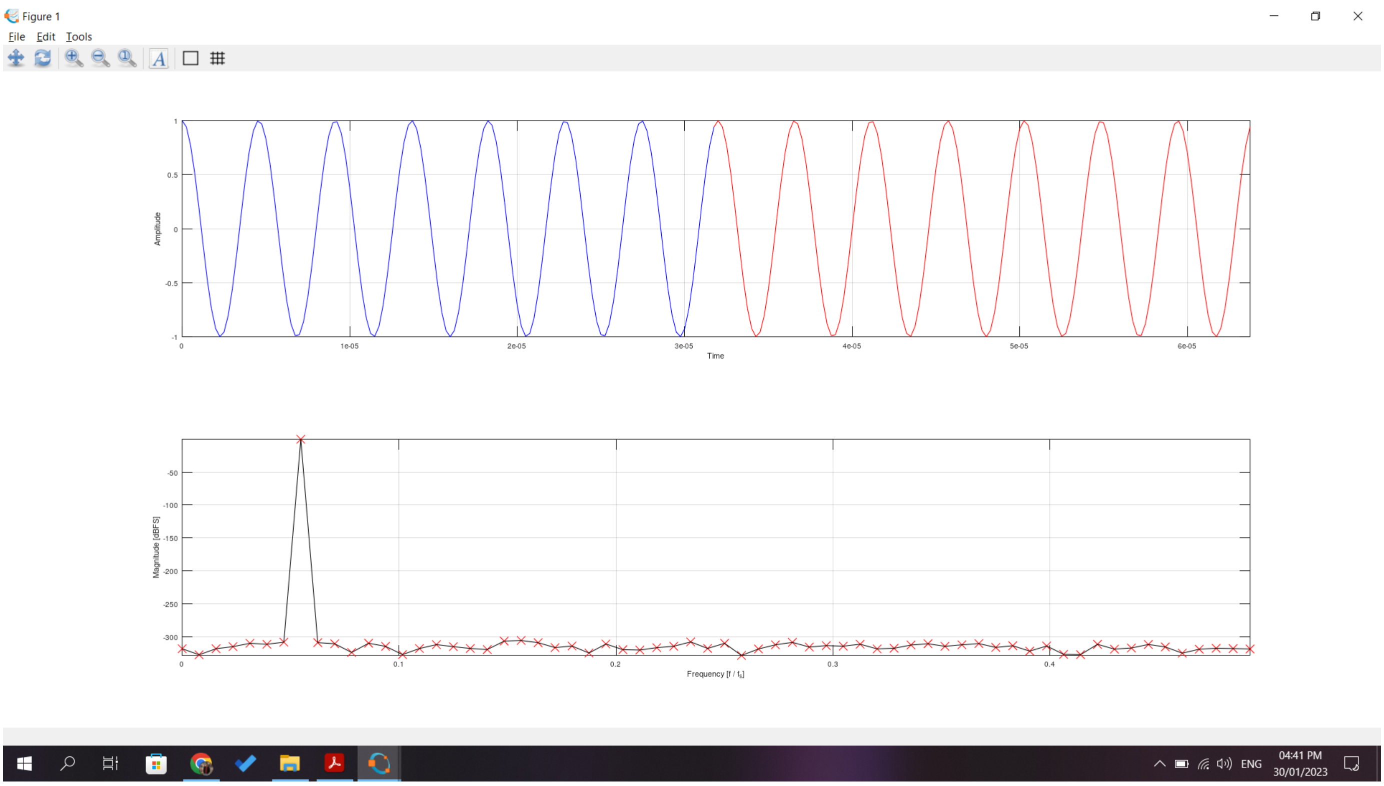
Analog Integrated System Design Lab 01

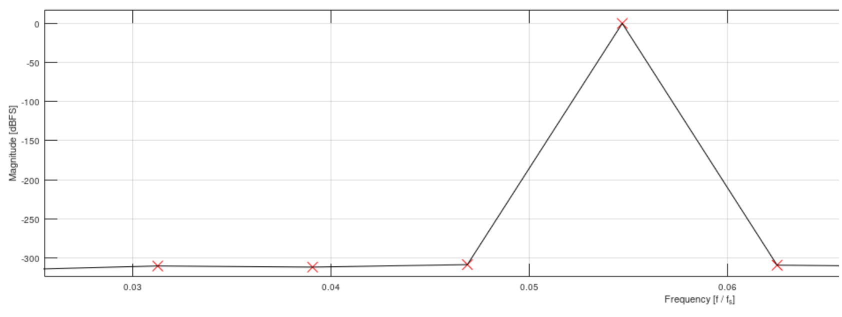
Sampling and Quantization in MATLAB

Part 1: Sampling and Windowing

1. Report the output plot of the included MALTAB code.



a. What is the power of the peak signal (in dBFS)?



>> 0 dB

b. How many bins are occupied by the test signal?

>> 1 bin

c. What is the noise floor (in dBFS)?

>> -305 dBFS

d. If the sampling is ideal, what is the source of error that causes the noise floor?

>>It's due to the quantization errors

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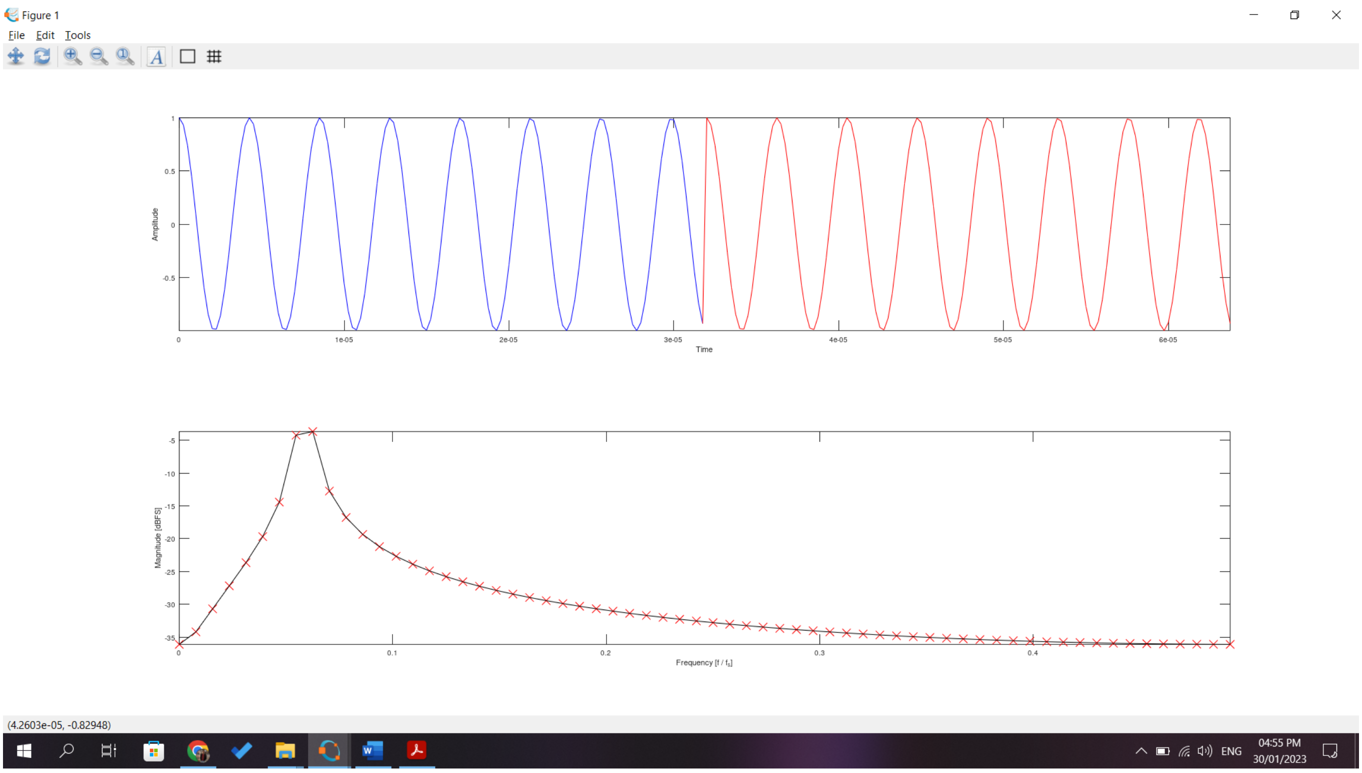
2. Change the no. of cycles to intentionally violate the coherent testing condition (Hint: Check the MATLAB code comments). Report the new output plot.



a. What is the power of the peak signal (in dBFS)?

>> -3.7 dB

b. How many bins are occupied by the test signal?

>> 2 bins

c. What is the noise floor (in dBFS)?

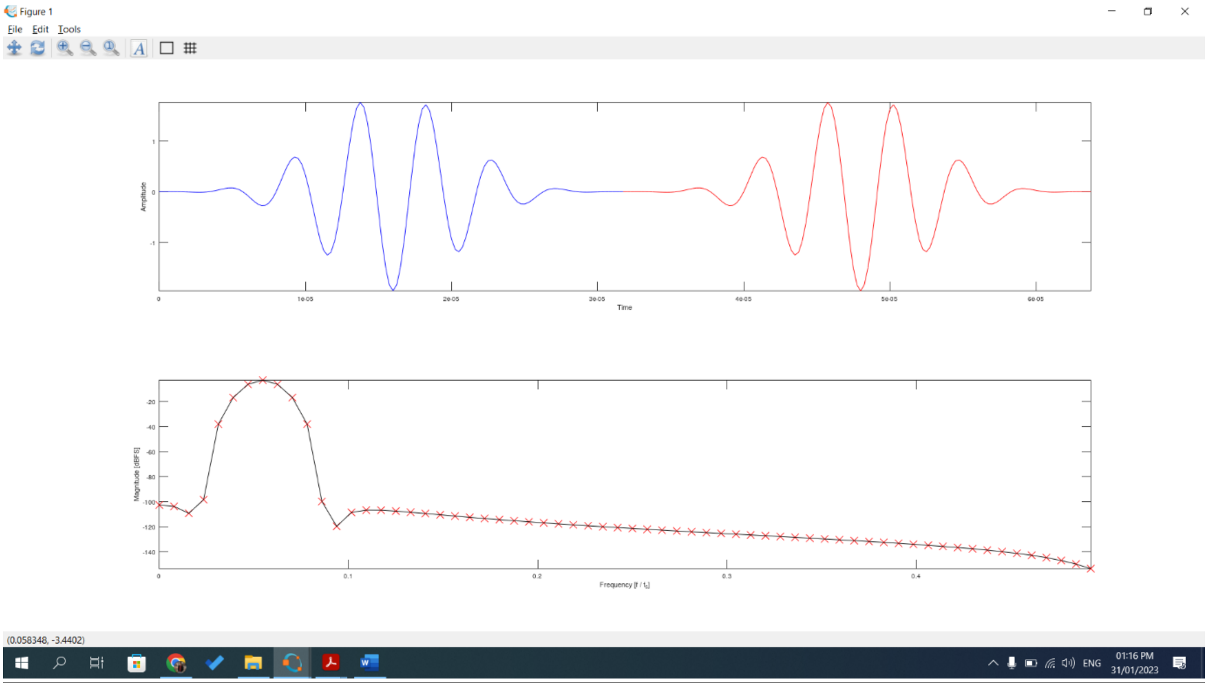
>>- 35 dBFS

d. If the sampling is ideal, what is the source of error that causes the noise floor?

>>It's due to the quantization errors

3. Repeat the previous two questions while applying a Blackman Harris window (Hint: Check the MATLAB code comments).

1. Report the output plot of the included MALTAB code.



a. What is the power of the peak signal (in dBFS)?

>> -3.44 dB

b. How many bins are occupied by the test signal?
>> 7 bin
c. What is the noise floor (in dBFS)?

>> -150 dBFS

d. If the sampling is ideal, what is the source of error that causes the noise floor?

>>It's due to the quantization errors and non-coherent errors

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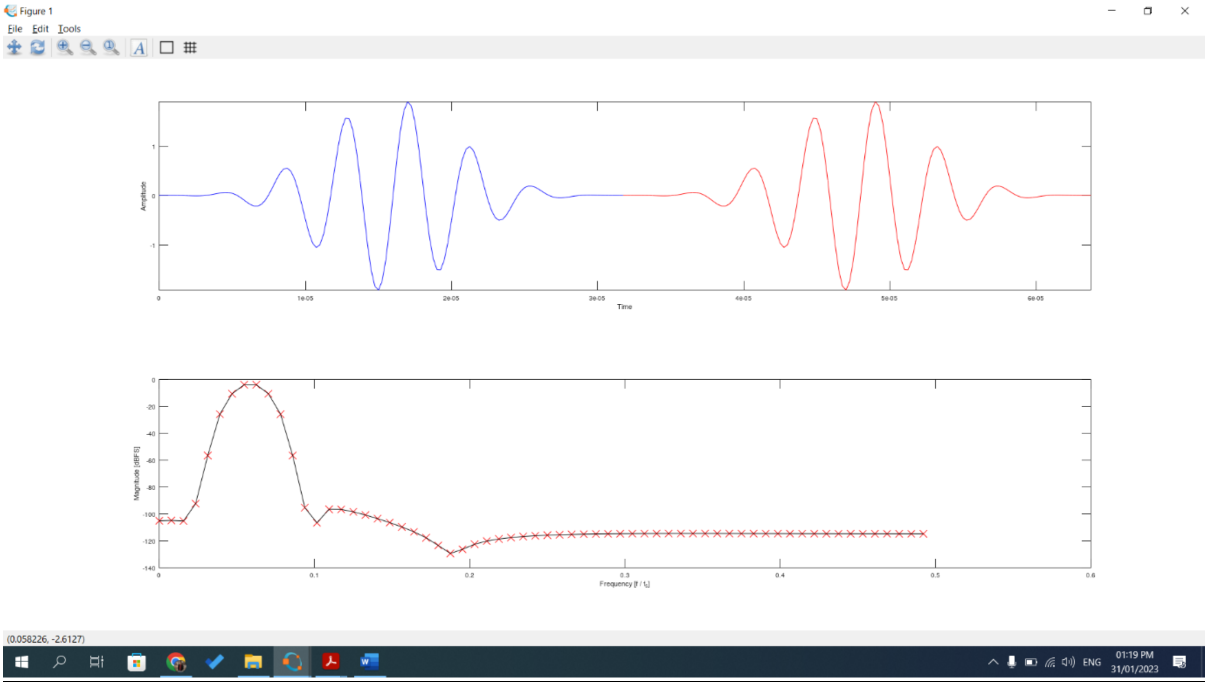
2. Change the no. of cycles to intentionally violate the coherent testing condition (Hint: Check the MATLAB code comments). Report the new output plot.



a. What is the power of the peak signal (in dBFS)?

>> -2.6 dB

b. How many bins are occupied by the test signal?

>> 8 bins

c. What is the noise floor (in dBFS)?

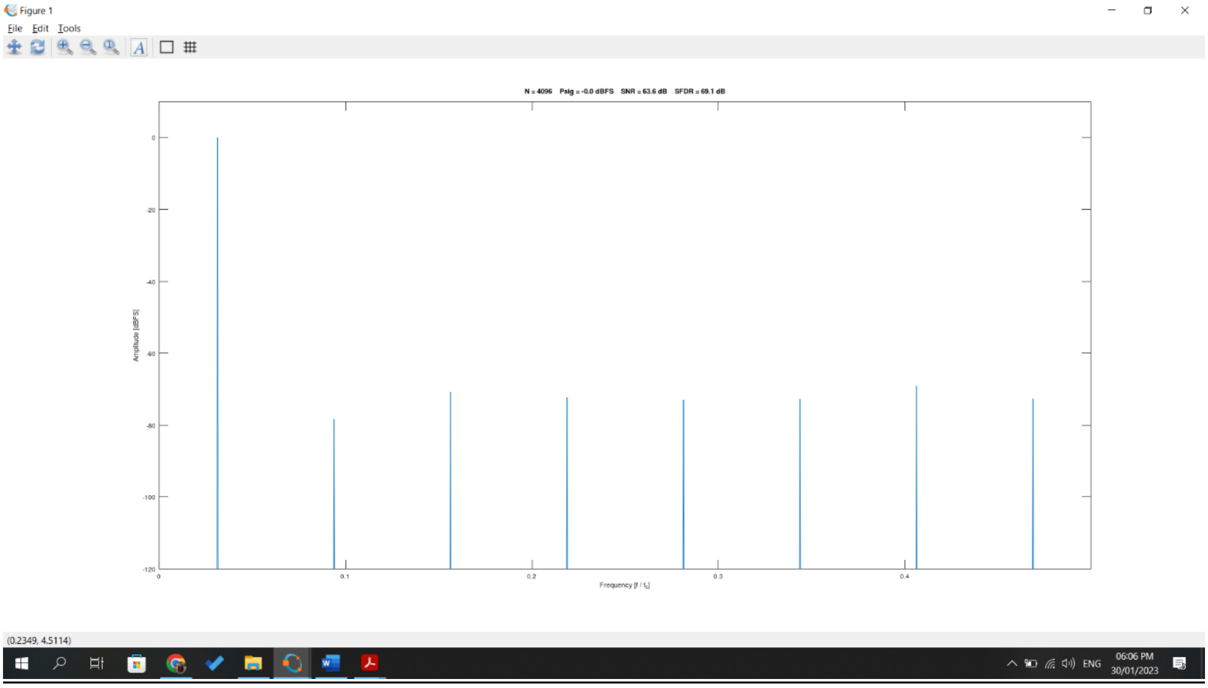
>> -120 dBFS

d. If the sampling is ideal, what is the source of error that causes the noise floor?

>>It's due to the quantization errors and non-coherent errors

Part 2: Quantization

1. Report the output plot of the included MALTAB code.



a. Do you notice distortion components? Why?

>> yes there is distortion due to that the M/Mc is an integer number so the harmonics are periodic and not random.

Notice that the noise floor level is not seen here as it's so low compared to others while in matlab it can be seen

b. Calculate the SNR analytically and compare it with the SNR computed by MATLAB.

>>SNR= 63.6 dB SFDR=69.1 dB

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>> lab_1_part_2

Psignal = -6.7009e-04
Pnoise = -63.561
SNR = 63.560
SFDR = 69.116
>> |
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$$P_{sig} = \frac{1^2}{2} = 0.5 = -3\ dB$$

$$P_{noise} = \frac{delta^2}{12} = \frac{\left(\frac{2}{1023}\right)^2}{12} = -65dB$$

$$SNR = P_{sig} - P_{noise} = 62\ dB$$

c. Calculate the noise floor analytically and compare it with noise floor in the MATLAB plot.

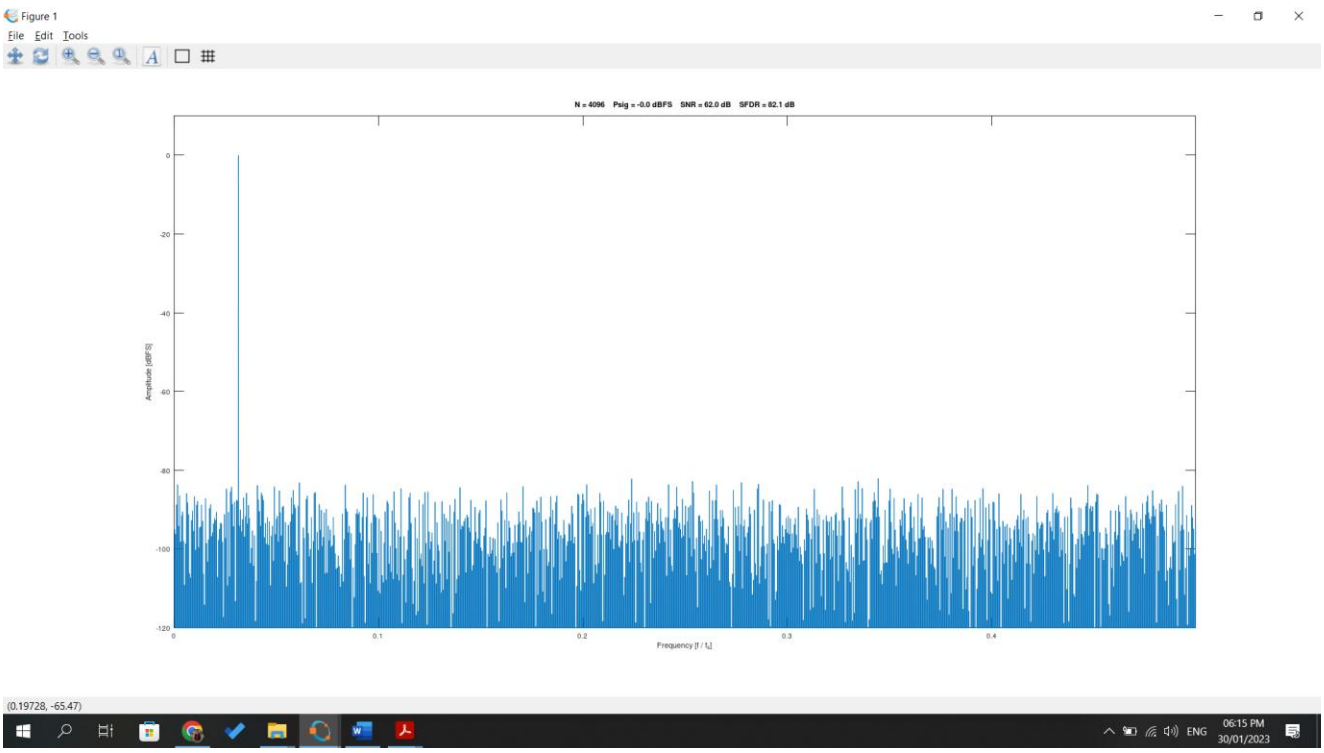
>> -75 dBFS as seen from the graph

d. How much is the SFDR? Why?

>>SFDR=69.1 dB

because M/Mc is an integer number so the harmonics are periodic and not random.

2. Change the no. of cycles to satisfy the coherent testing condition (Hint: Check the MATLAB code comments). Report the new output plot.



a. Do you notice distortion components? Why?

>> No, there is no distortion due to that the M/Mc is not an integer number so the harmonics are random.

b. Calculate the SNR analytically and compare it with the SNR computed by MATLAB.

>>SNR= 62 dB   SFDR=82.1 dB

$$P_{sig} = \frac{1^2}{2} = 0.5 = -3\ dB$$

$$P_{noise} = \frac{delta^2}{12} = \frac{\left(\frac{2}{1023}\right)^2}{12} = -65dB$$

$$SNR = P_{sig} - P_{noise} = 62\ dB$$

c. Calculate the noise floor analytically and compare it with noise floor in the MATLAB plot.

>> -85 dBFS as seen from the graph

d. How much is the SFDR? Why?

>>SFDR=82.1 dB
because M/Mc the M/Mc is not an integer number so the harmonics are random.

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3. Compare the SFDR of the two cases. Comment.

in the first case the SFDR is high as the ratio of M/Mc is an integer number so the distortion of the harmonics is periodic and not random so it has a higher value.

While in the second case SFDR is lower as the ratio of M/Mc is not an integer number so the distortion of the harmonics is NOT periodic and it’s random so it has a lower value and the noise floor decreased.