Signal Processing

Lab 7

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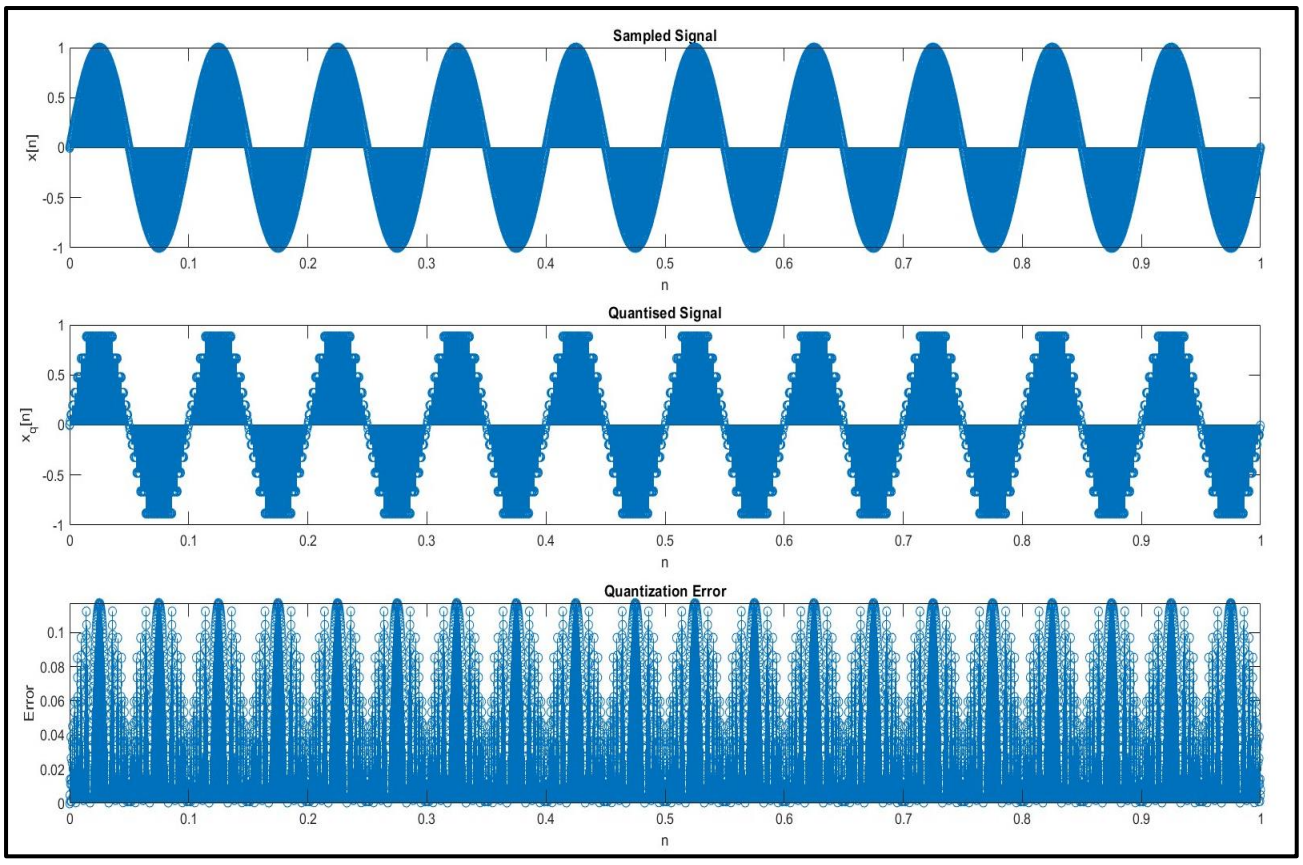
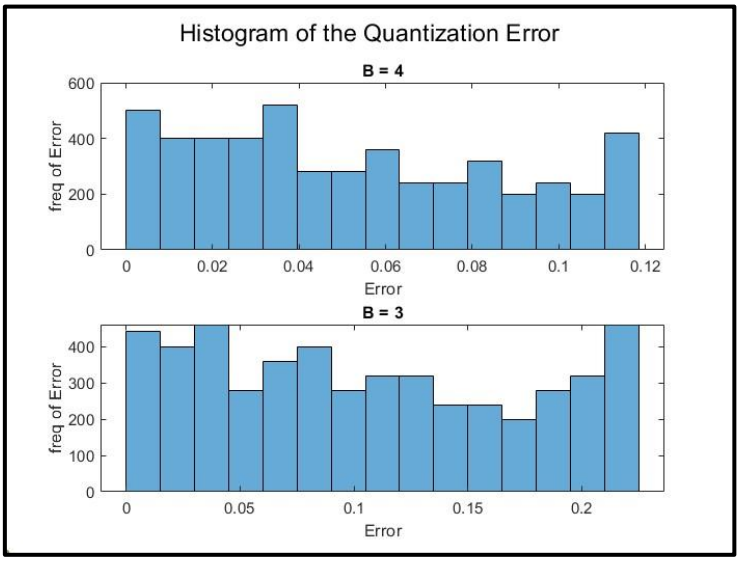
Q1.

(b, c)

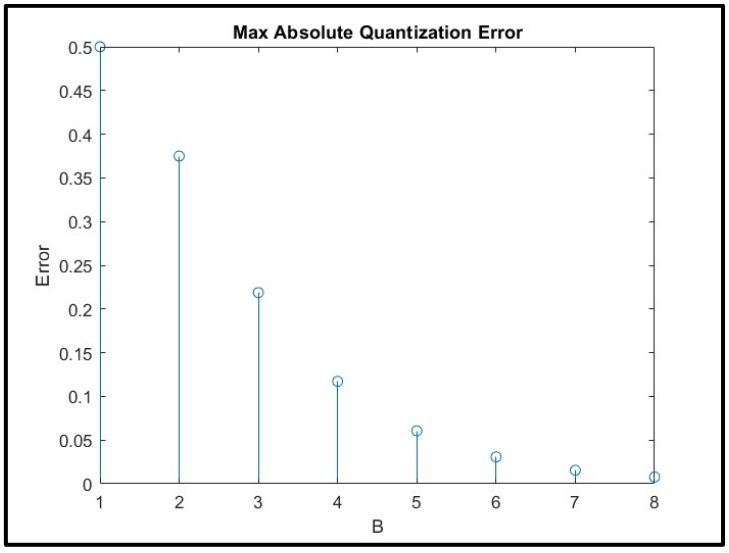


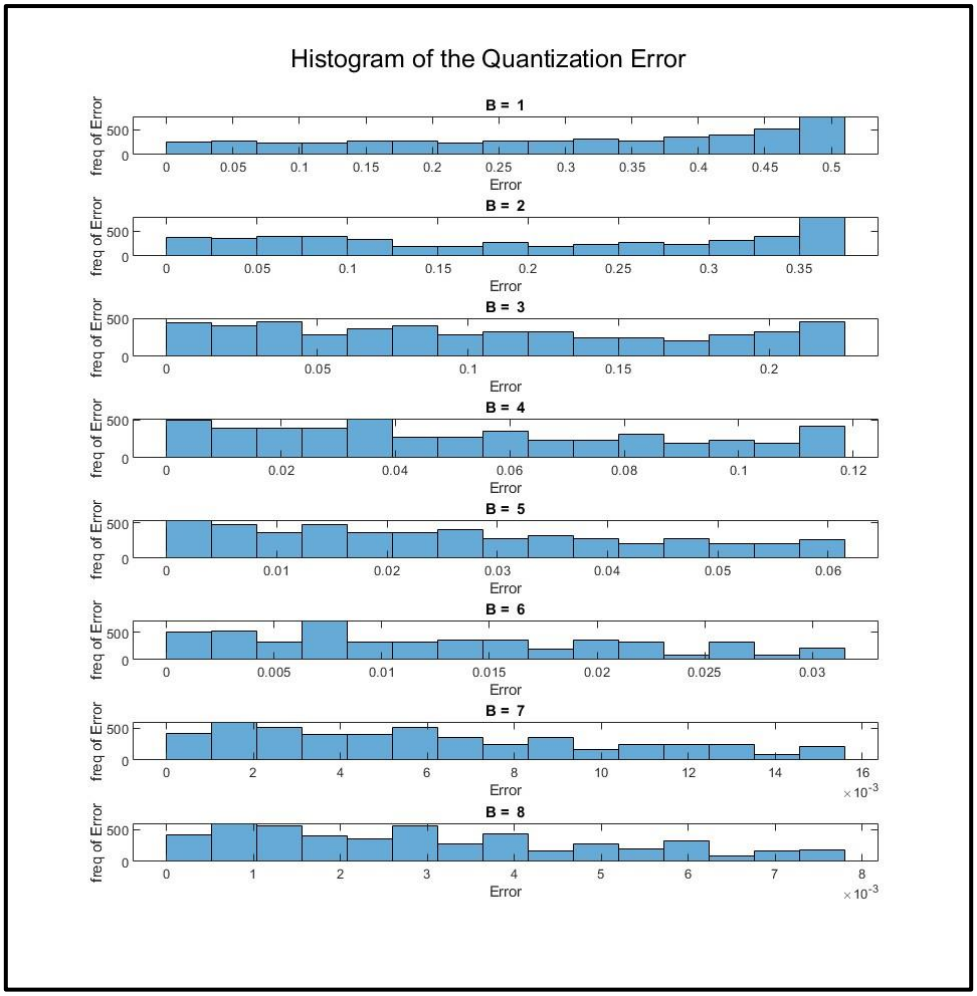
(d)



- The x axis of the histogram depicts the quantization error value while the y axis of the histogram depicts the number of times a certain value of error has occurred.
- The max error value when B = 3 is more that 0.2 while the max error value when B = 4 is less than 0.12.
- The number of times a small error occurs is greater when B = 4 that when B = 3
- As B increases, the number of levels of quantization increases and therefore the precision of rounding off the sampled signal to the quantized level increases and so error decreases.

(e)





The greater number of bits used to decide the levels of quantization, the higher the resolution, or detail captured from the original signal.

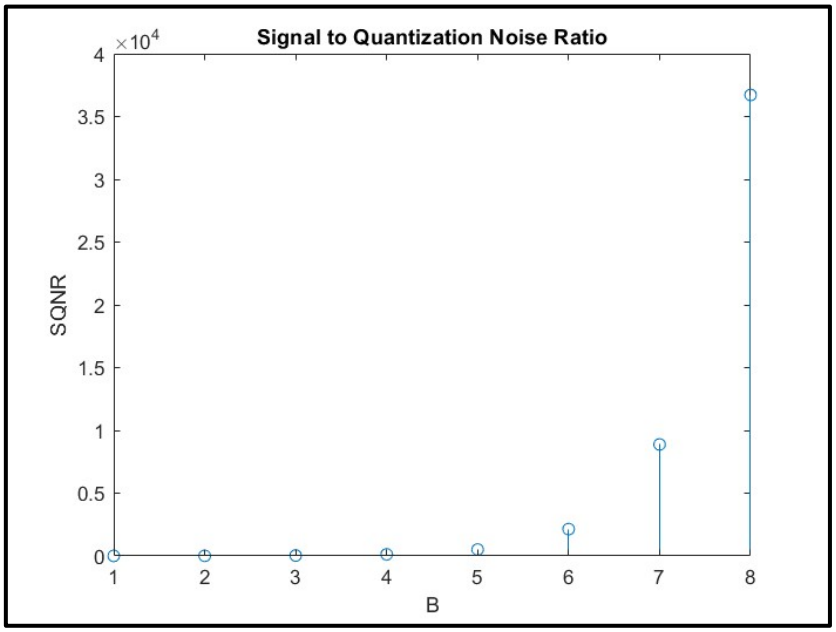
For example, if we try to capture a sine wave with only one bit. We would get a square wave, which is not a very accurate representation of the sine wave. We would have captured only the fundamental frequency.

Every time a bit is add, the resolution is doubled.

The difference between sampled signal to quantized signal is called quantization error. It can reduce by increasing quantisation level or number of bits.

- We observe that as the number of bits that decide the quantization levels is increased, the quantization error decreases. This is because the closeness of the approximation between a sample value and its nearest quantisation level depends on the number of quantisation levels available.

(f)



- We observe that that as the number of bits that decide the quantization levels is increased, the Signal to Quantization noise ratio increases.

SQNR is a measure of the quality of the quantization, or digital conversion of an analog signal. Defined as normalized signal power divided by normalized quantization noise power.

$$SQNR = \frac{\sum_n |x[n]|^2}{\sum_n |e_q[n]|^2}$$

A higher SQNR value indicates a lower value of quantization noise.

Increasing the number of bits per sample will decrease the quantization noise and, therefore, increase SQNR.

(g)

The key difference between uniform and nonuniform quantization is that uniform quantization has equal step sizes while, in nonuniform quantization, the step sizes are not equal. As a result, in the uniform quantization, some part of the signal might not be covered and therefore, increasing quantization error, while nonuniform quantization reduces the quantization error as the step size changes.

Decrease in the quantization error implies the increases in resolution of the quantised signal.

Q2.

- We observe some distortion of the quantized signals. Due to quantization the signal quality reduces.
- The greater number of bits used to decide the levels of quantization, the higher the resolution, or detail captured from the original signal. As the number of quantization bits increases, the quantized signal gets clearer, and the noise floor/hearable distortions decreases.
- Increases in the quantization bits decreases the quantization error, that is, the closeness of the approximation between a sample value and its nearest quantisation level increases, thereby increasing the resolution.
- With more quantization bits B, the quantization noise becomes more and more monotonous.
- Quantization affects the frequency content of the quantised signal compared to that of the input signal. Quantization captures only certain frequencies. For example, if we try to capture a sine wave with only one bit. We would get a square wave, which is not a very accurate representation of the sine wave. This captures only the fundamental frequency. Increasing the quantization bits B, increases the resolution of the quantised signal (the quantised signal resembles the original signal more and more) thereby increases the number different frequencies that are captured in the frequency domain.