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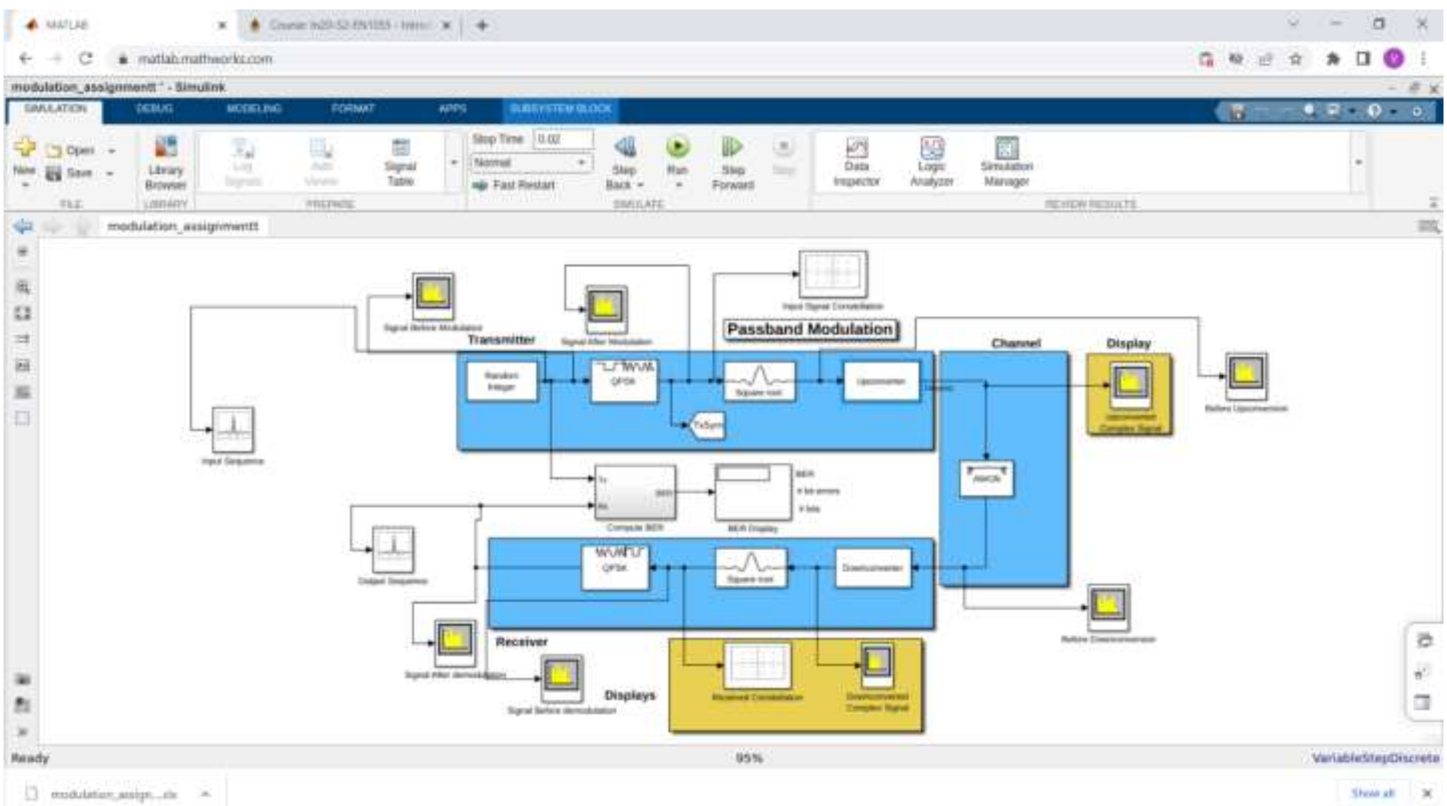
PASSBAND MODULATION

ASSIGNMENT REPORT

1. Simulate the communication link given in modulation assignment.slx and explain the functionality of it in detail.
To demonstrate the correctness of your implementation, you should provide at least the following plots as
evidence. You are encouraged to include any other plots that are inline with your arguments.

- **Input and output sequences**
- **Signals before and after modulation / demodulation**
- **Input and output constellation diagrams**
- **Signals before and after up/down converters**



The random integer generator block is used to get a sequence of randomly generated integers. In this model, since the modulation type we use is QPSK, a chunk is consist of 4 integers.

The sequence will then get moved to the QPSK block & together with the pulse shaping filter the sequence will get QPSK modulated and a pulse in the shape of root raised cosine will get output.

Since the modulated signal lies upon the baseband, it is required to be upconverted to a passband to avoid clashes. The upconverter block multiplies the modulated analog waveform with a carrier frequency of 1000000Hz to send it to the relevant passband.

In the phase of the channel, the AWGN channel block's main parameters Eb/No (the signal-to-noise ratio which sets the level of recoverability of transmitted signal) and the number of bits per symbol (since we are using QPSK modulation it is set to 2 bits are symbol) are set to preferred values.

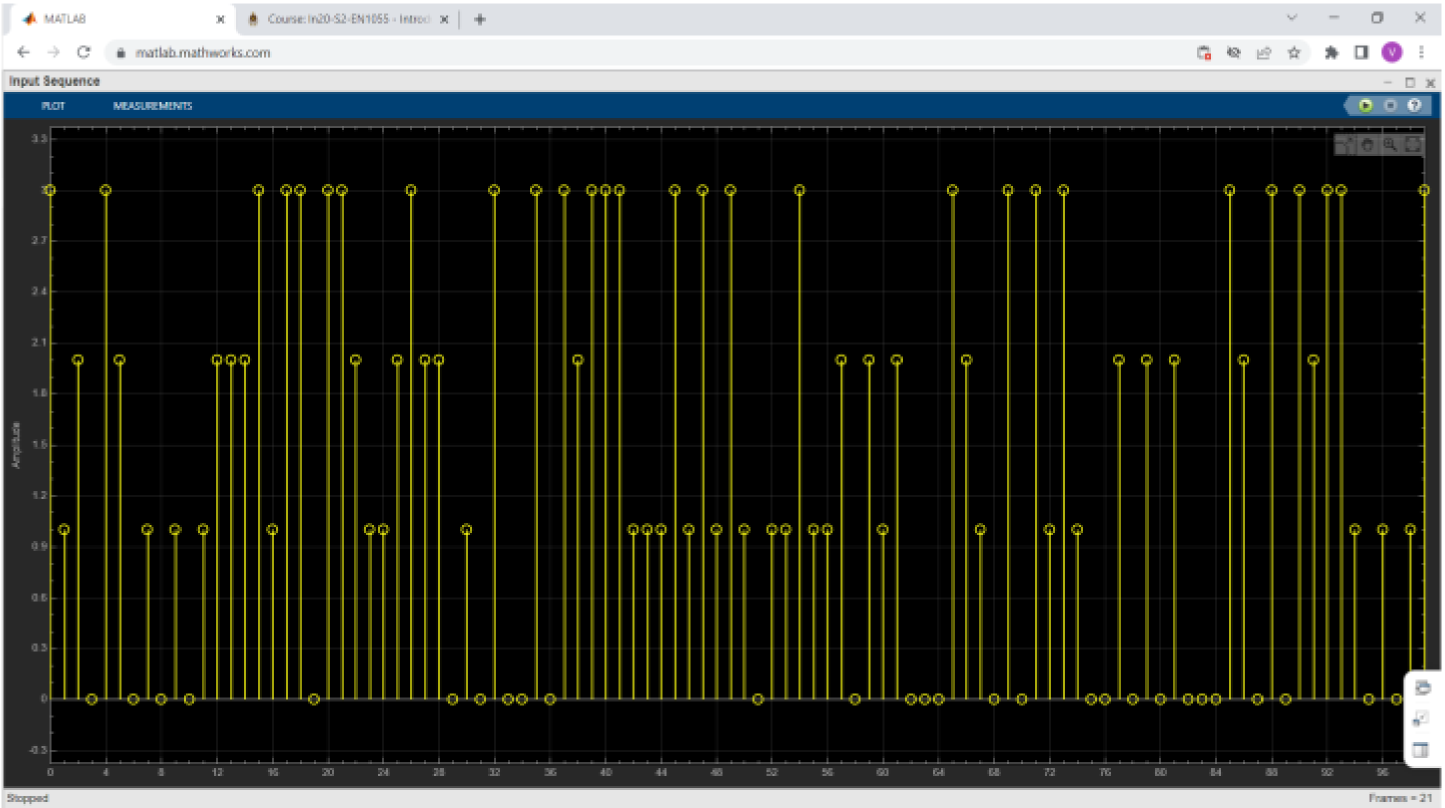
After the signal is transmitted over the channel, it will come to the downconverter block in the receiver's phase and the signal will get down-converted to the complex baseband from the real passband that the signal has shifted to, by the upconverter before the transmission.

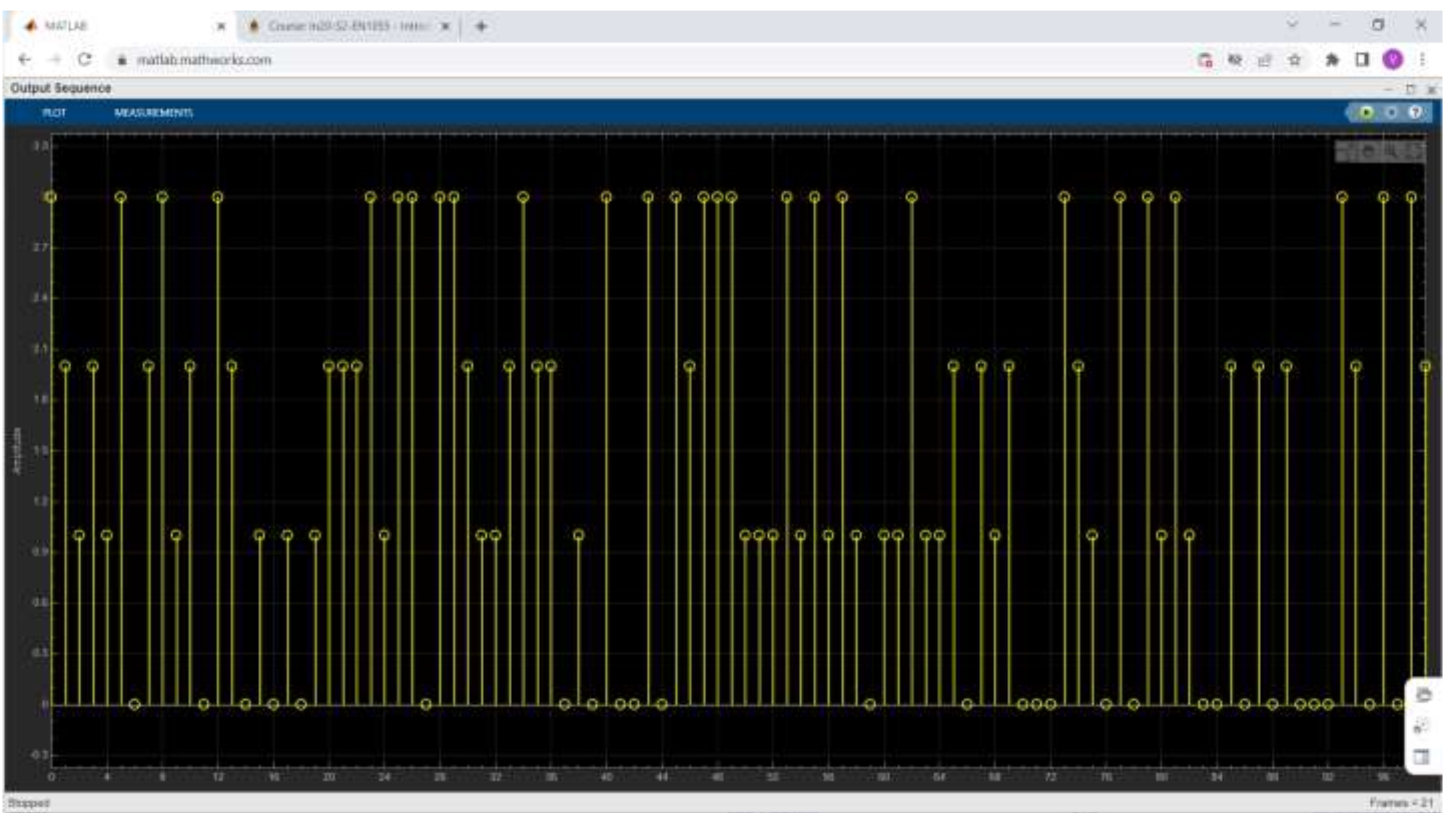
Next, the root raised cosine pulse shaping filter will decimate back to one sample per symbol and the QPSK baseband demodulator will demodulate this analog signal to digital space.

The error rate calculation block compares input data from the transmitter and input data from the receiver and then calculates the error rate as a running statistic by dividing the total number of unequal pairs of data elements by the total number of input data elements from the source.

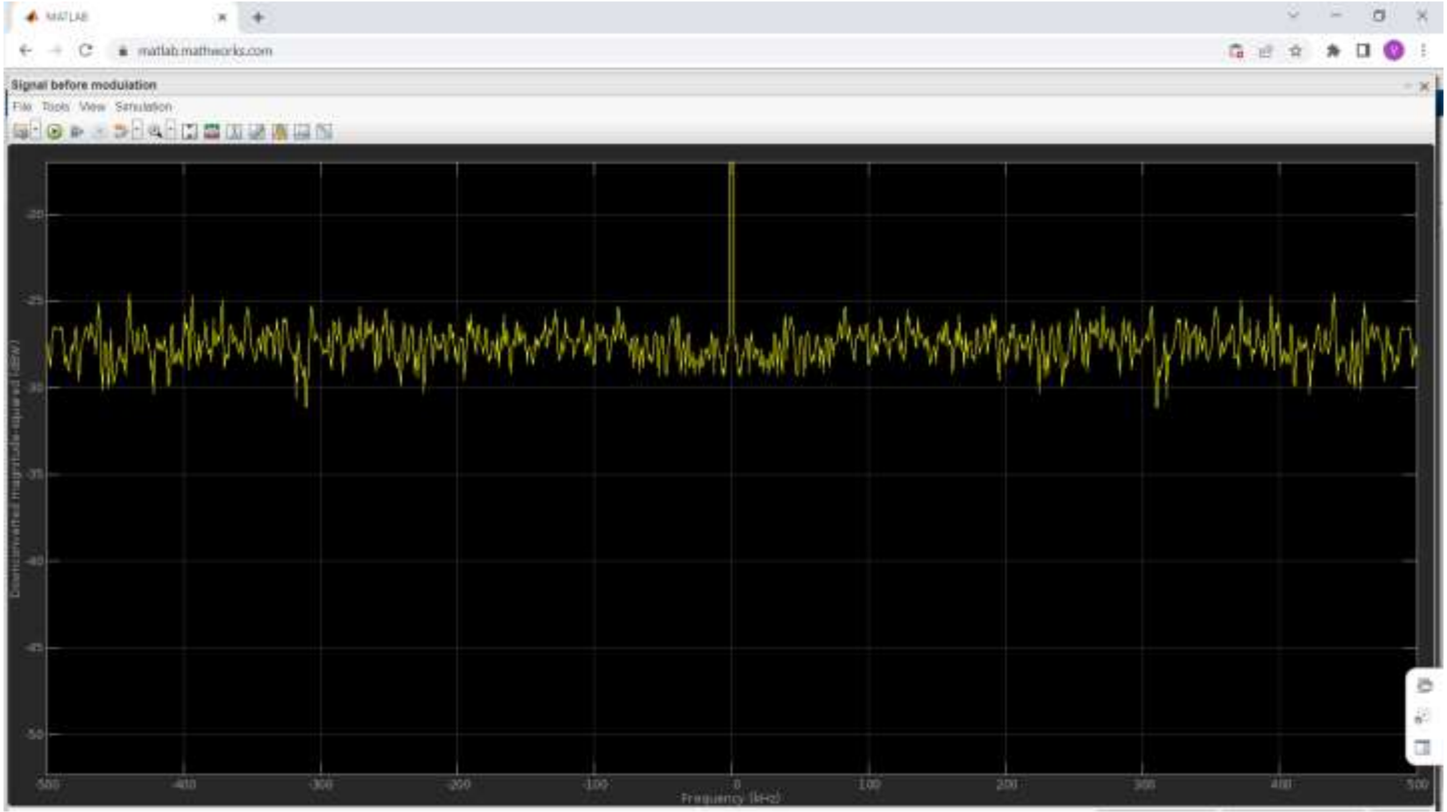
The BER display block will print out the BER value together with the number of bit errors that occurred and the total number of bits.

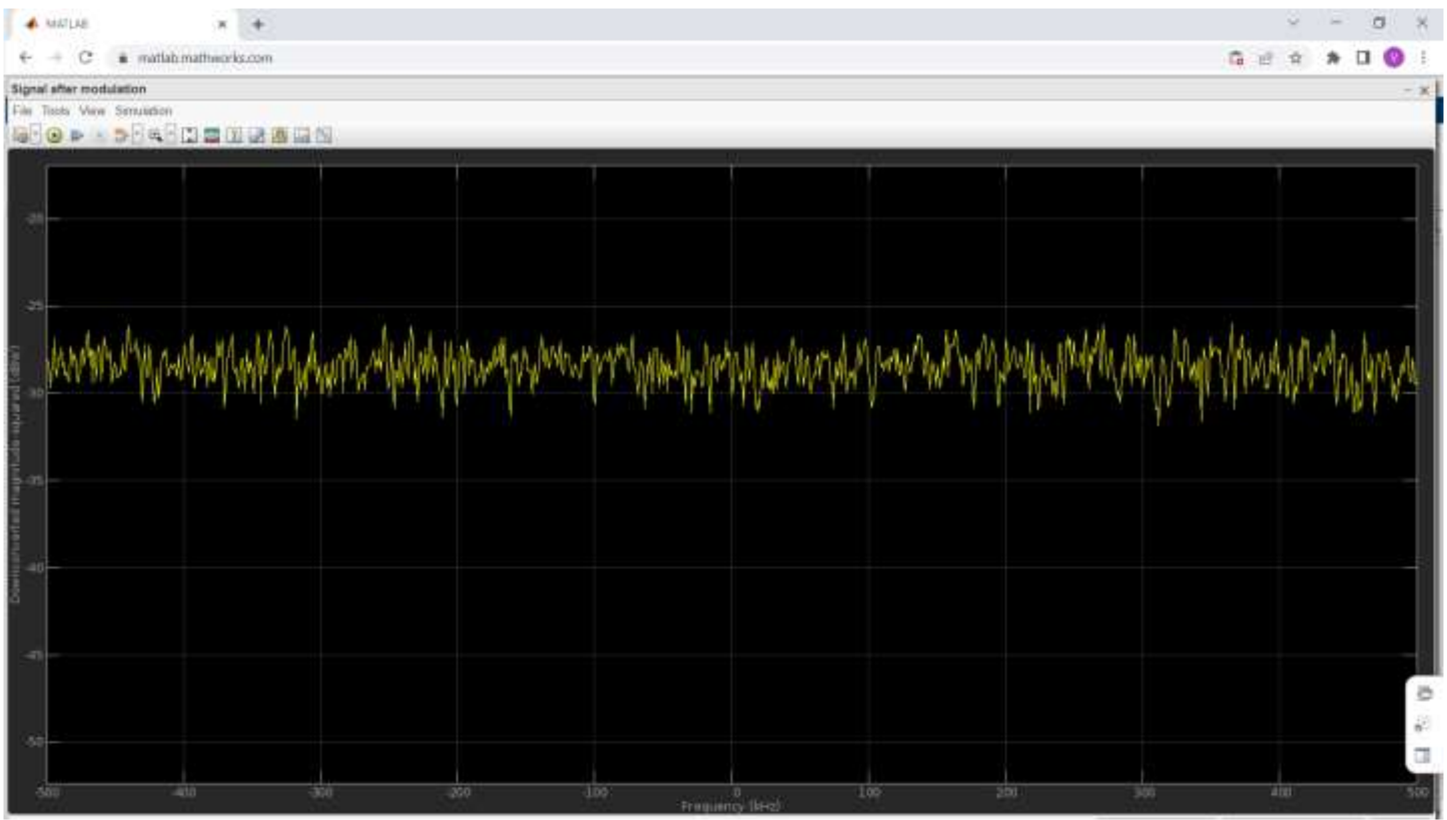
Input and output sequences



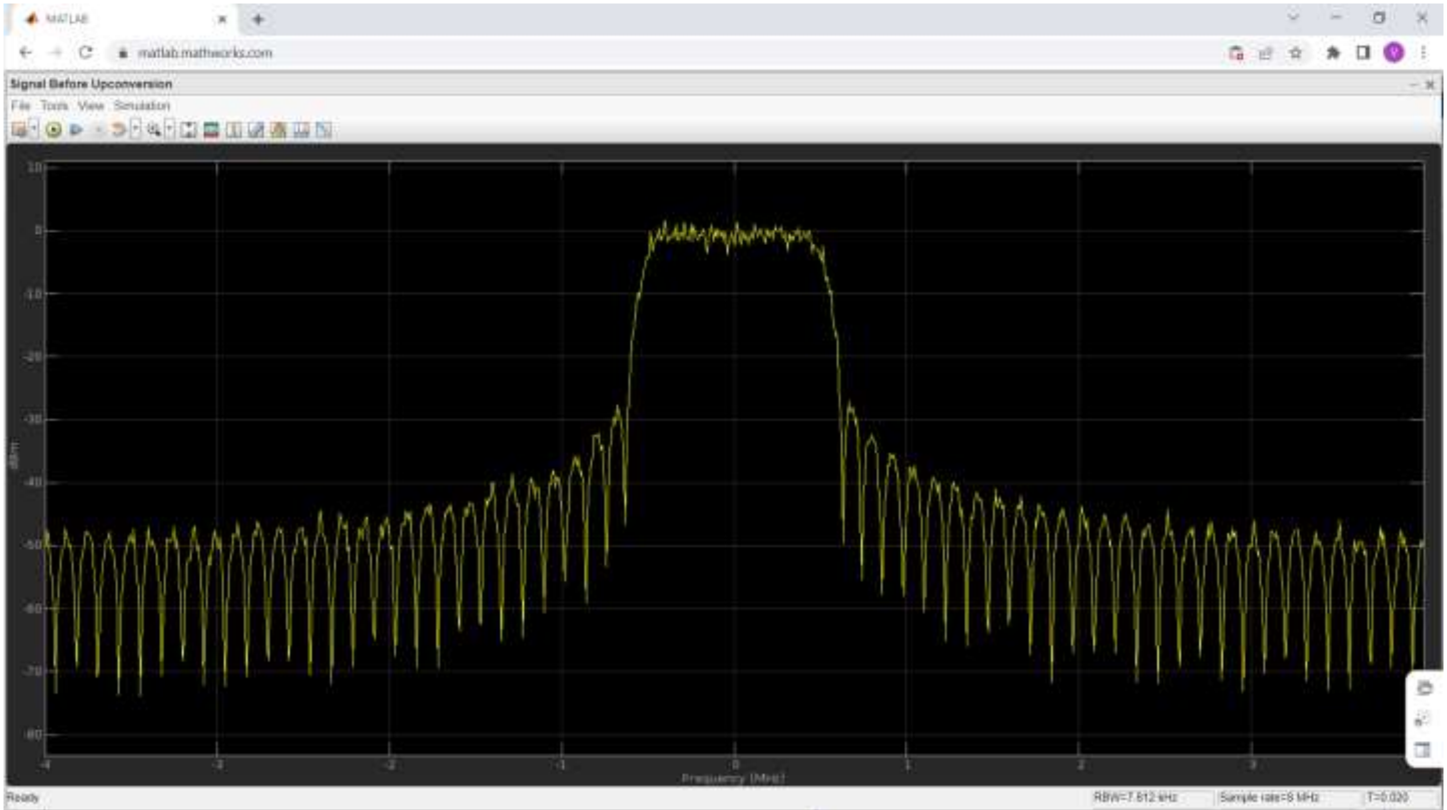


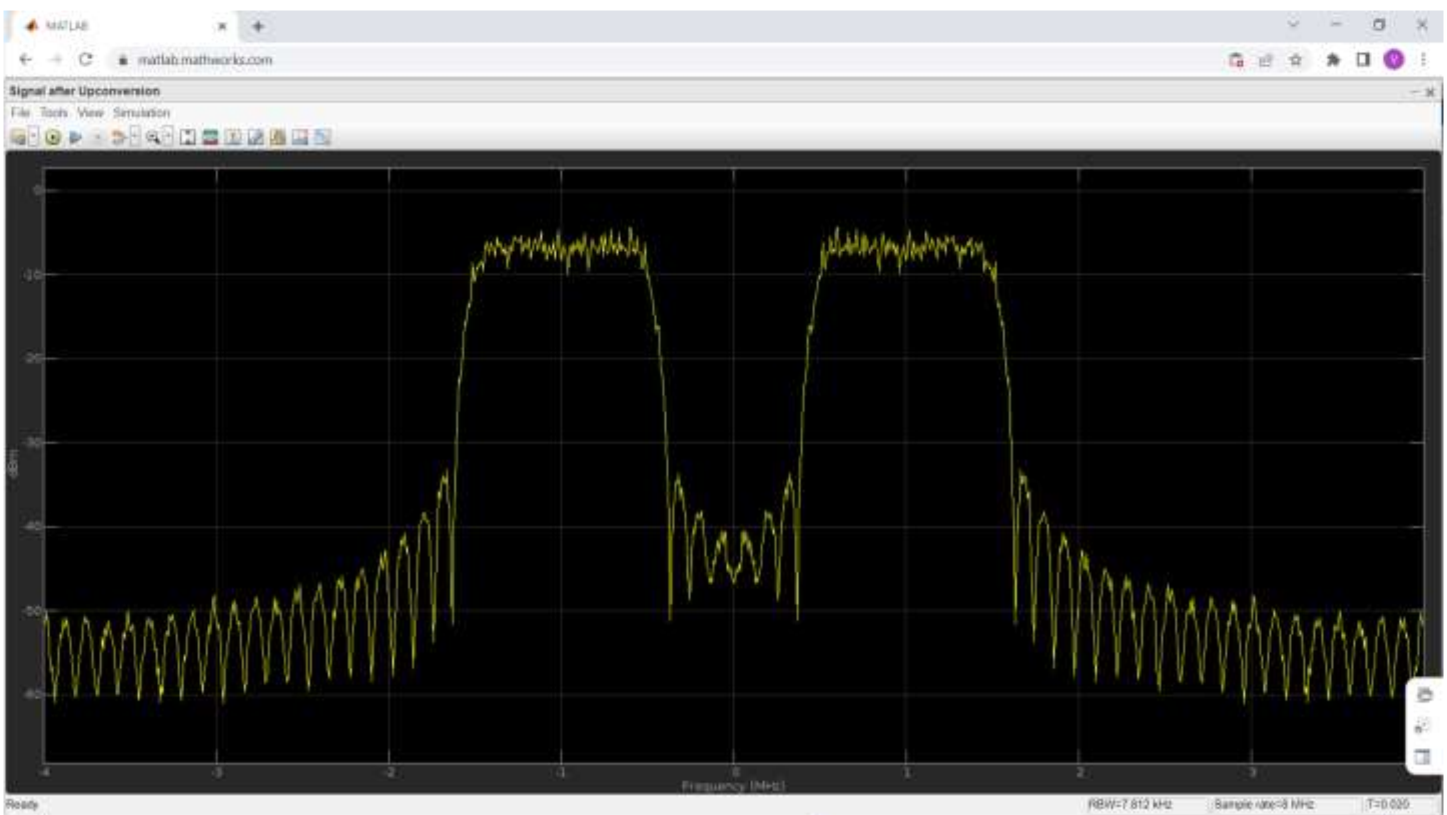
Signal before and after modulation



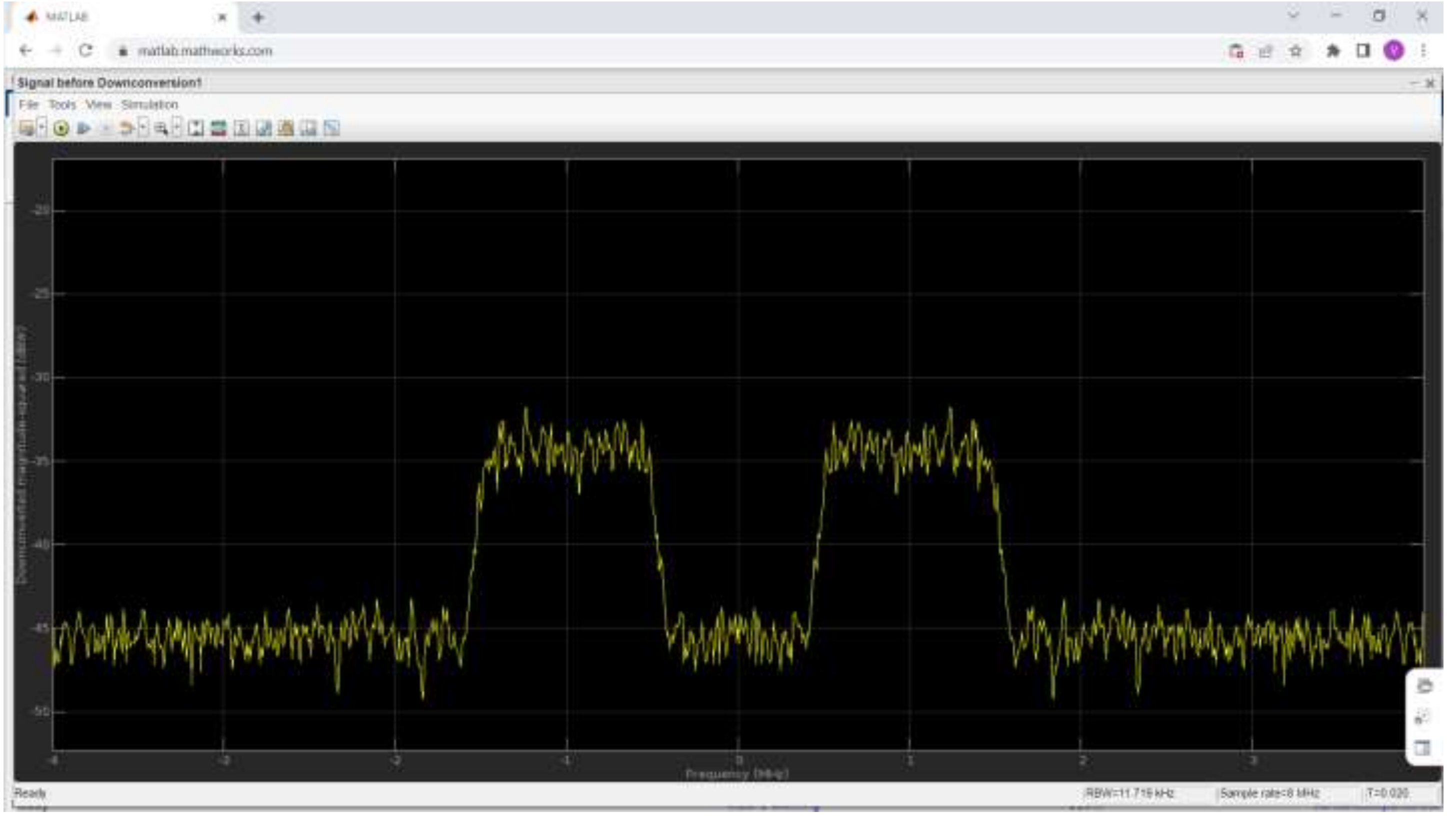


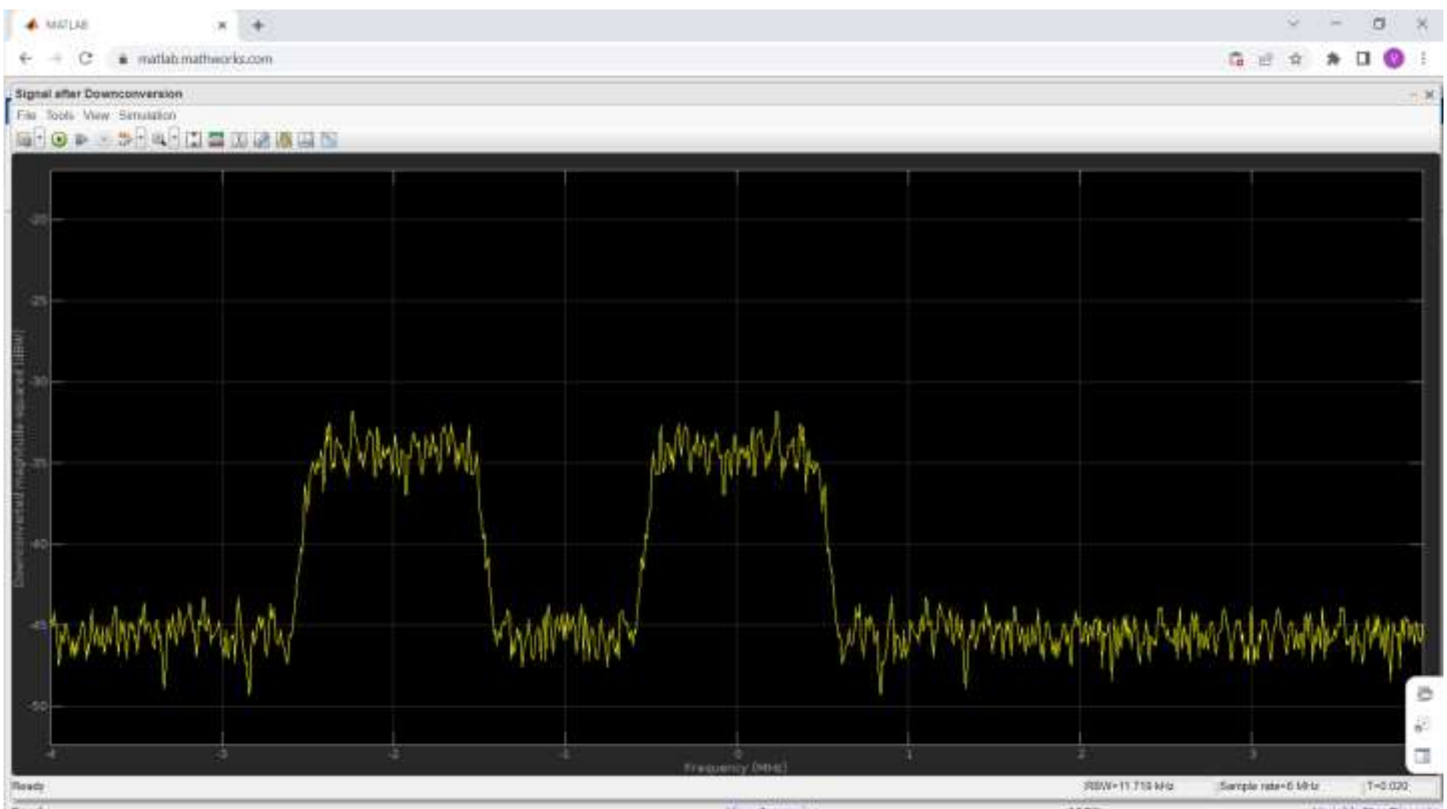
Signal before and after upconversion



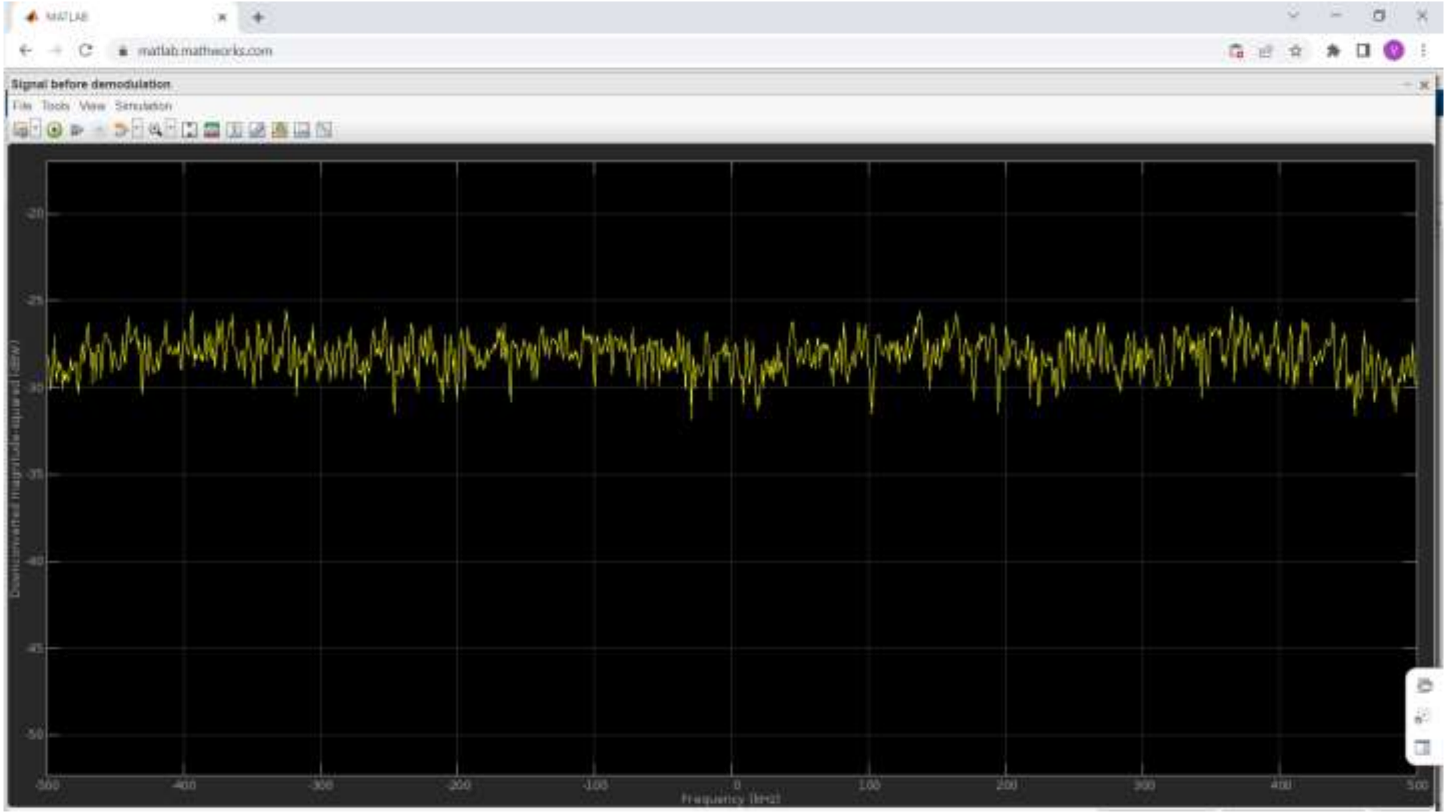


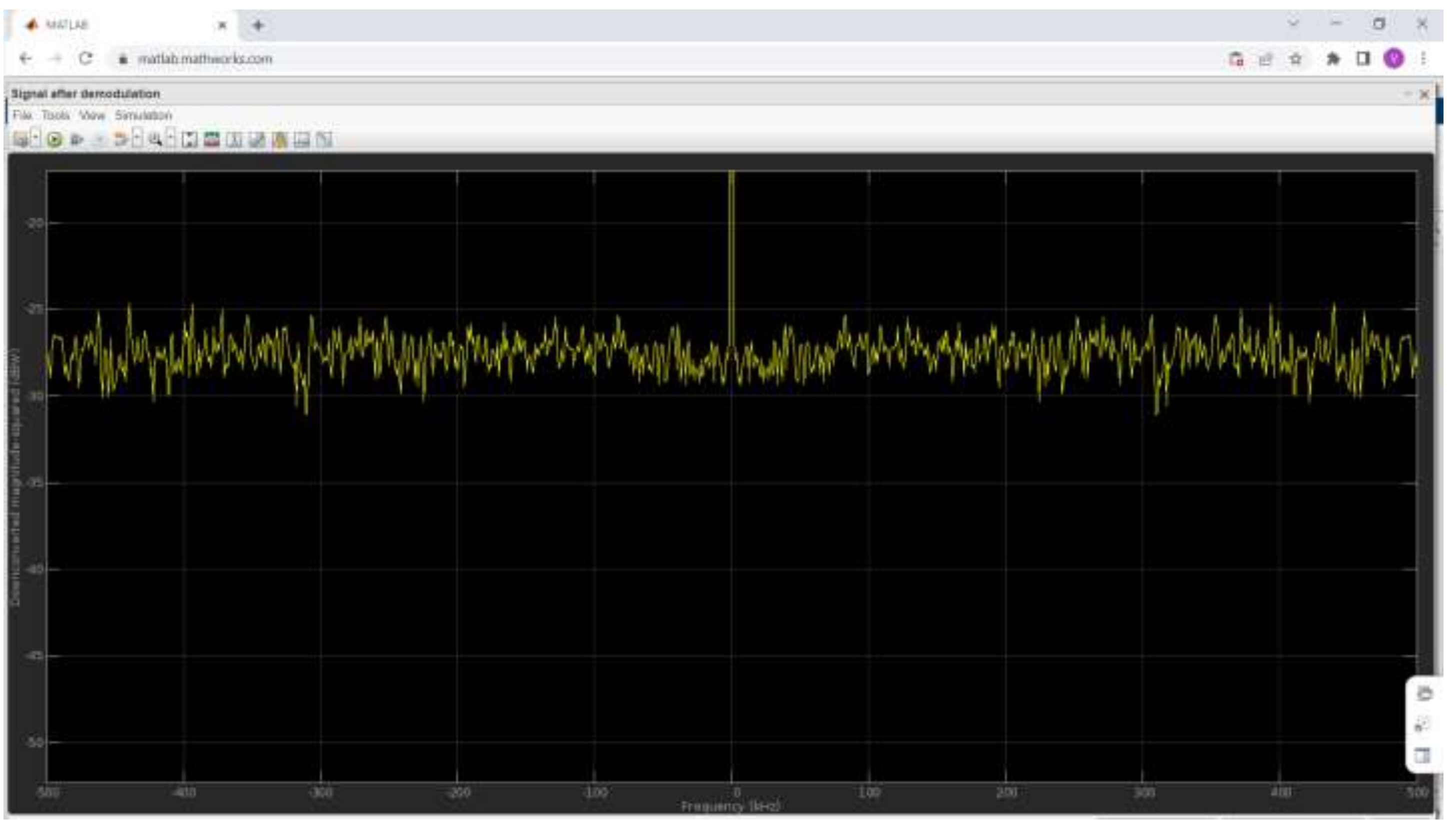
Signal before and after downconversion



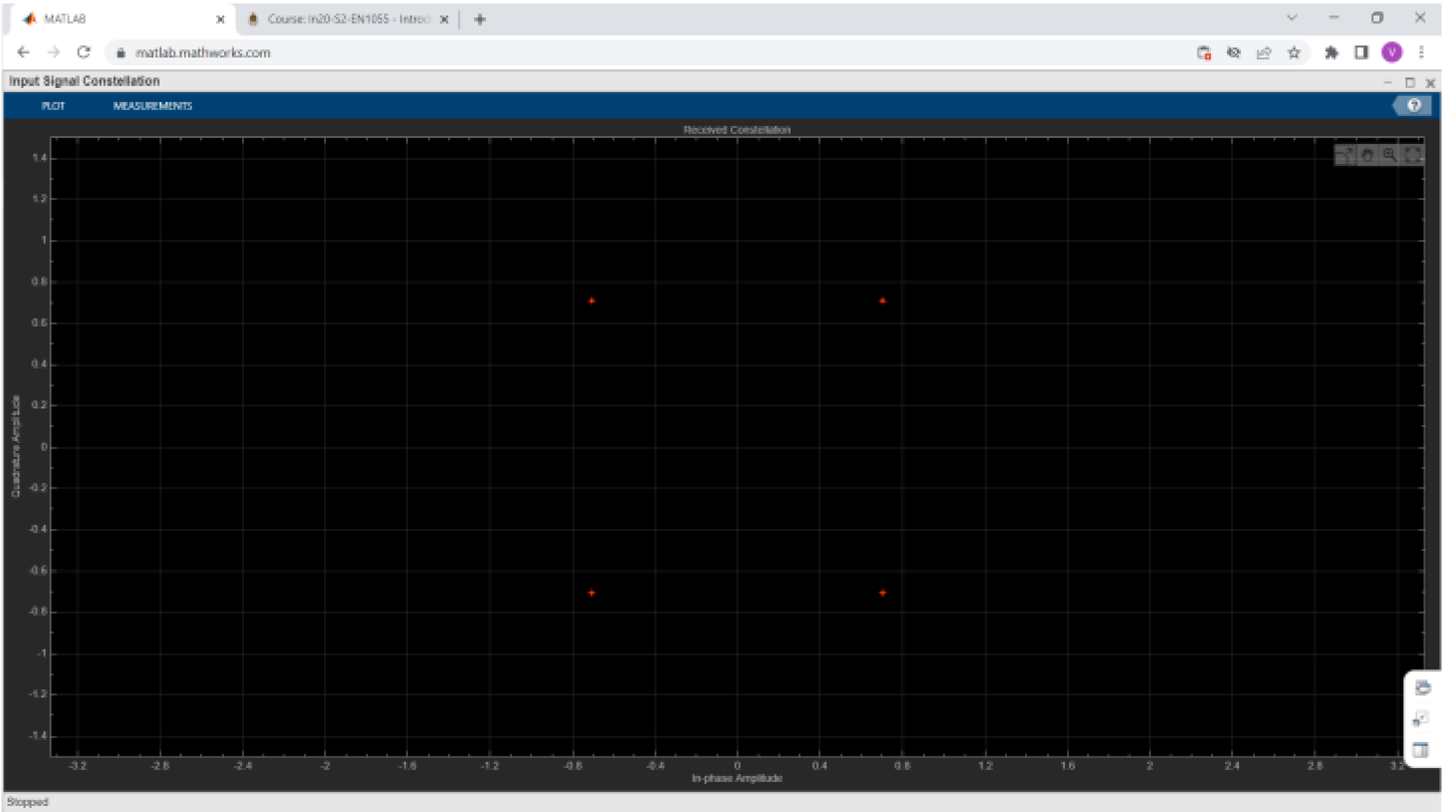


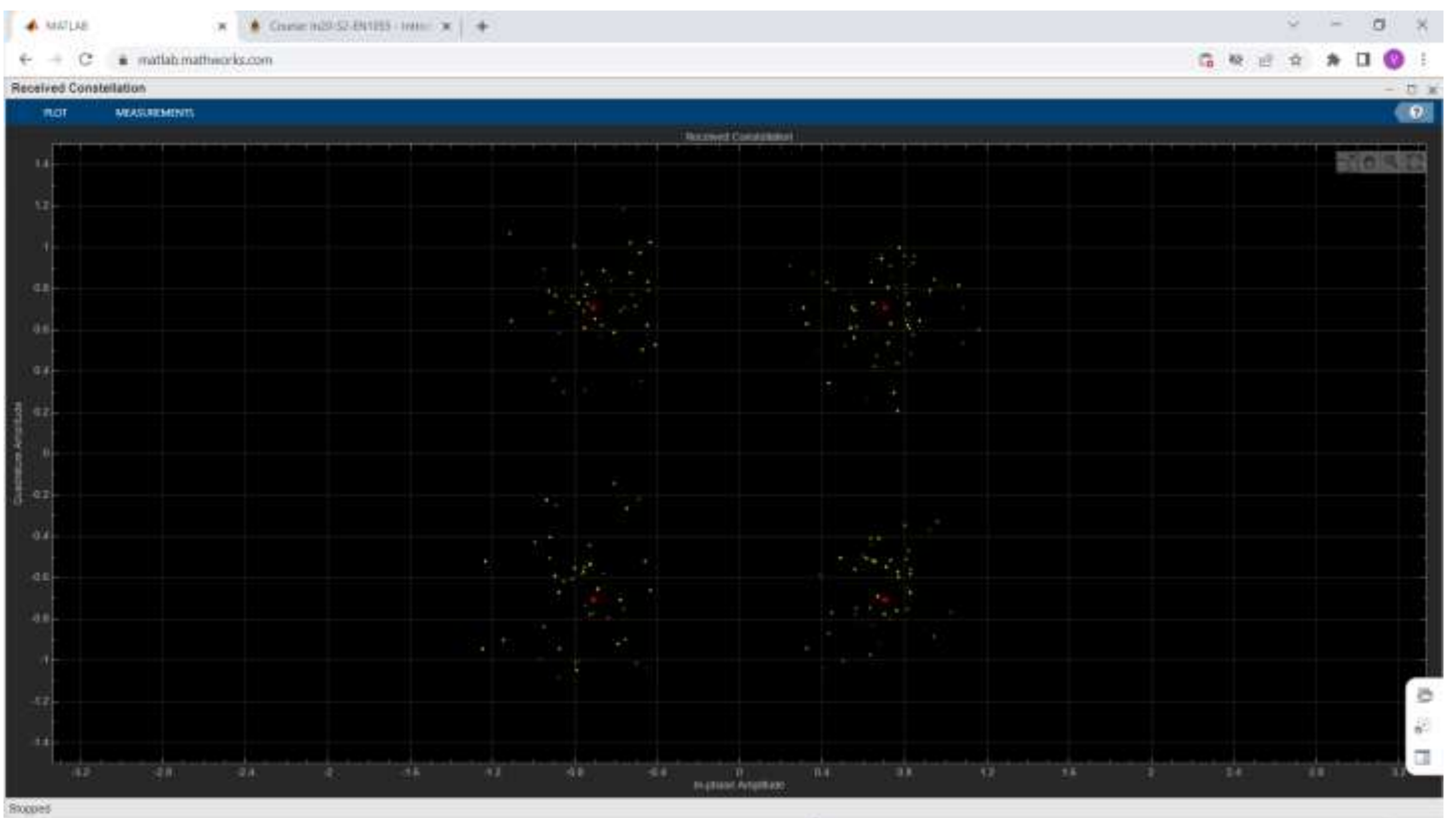
Signal before and after demodulation



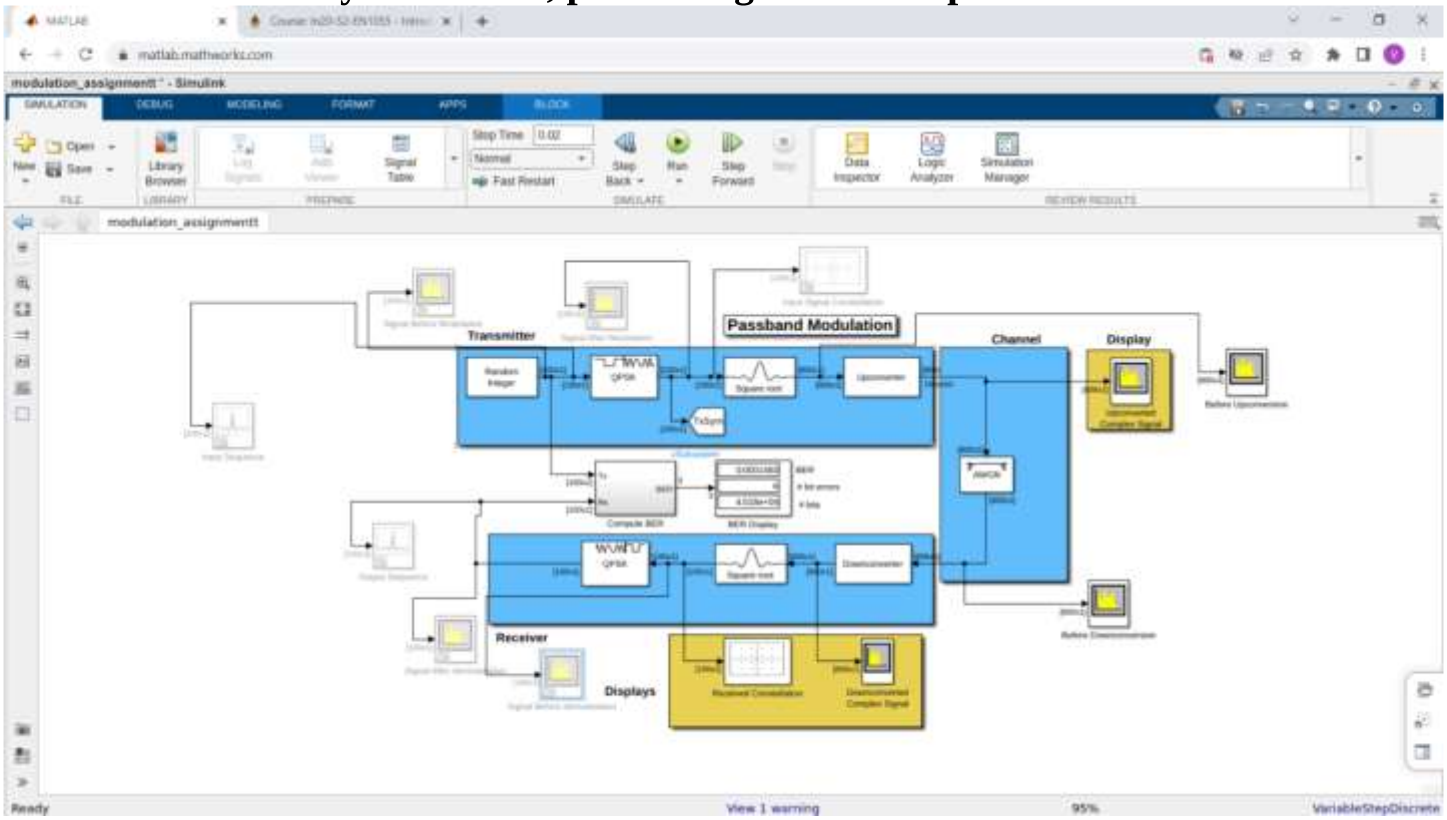


Input and output signal constellation

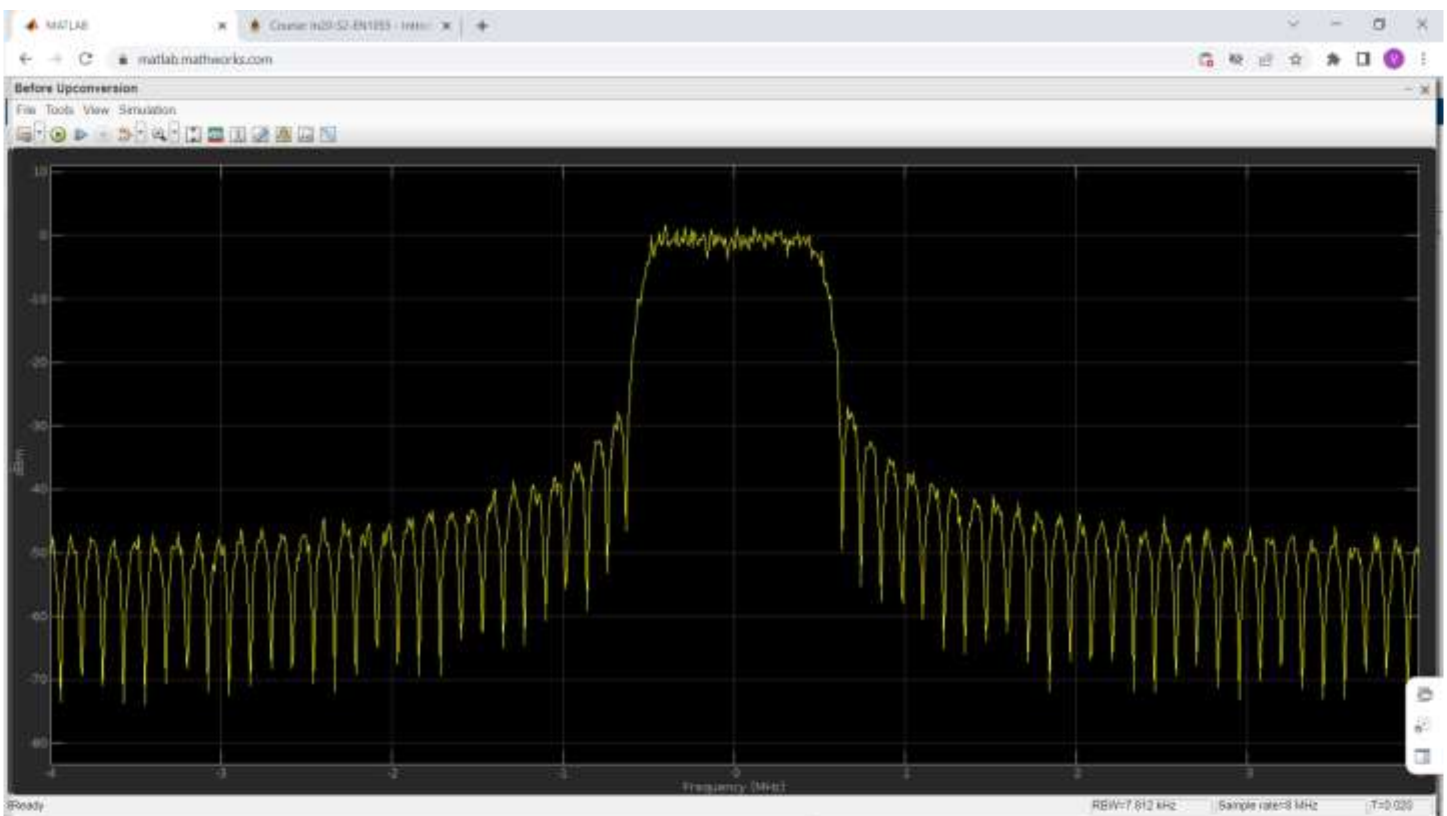


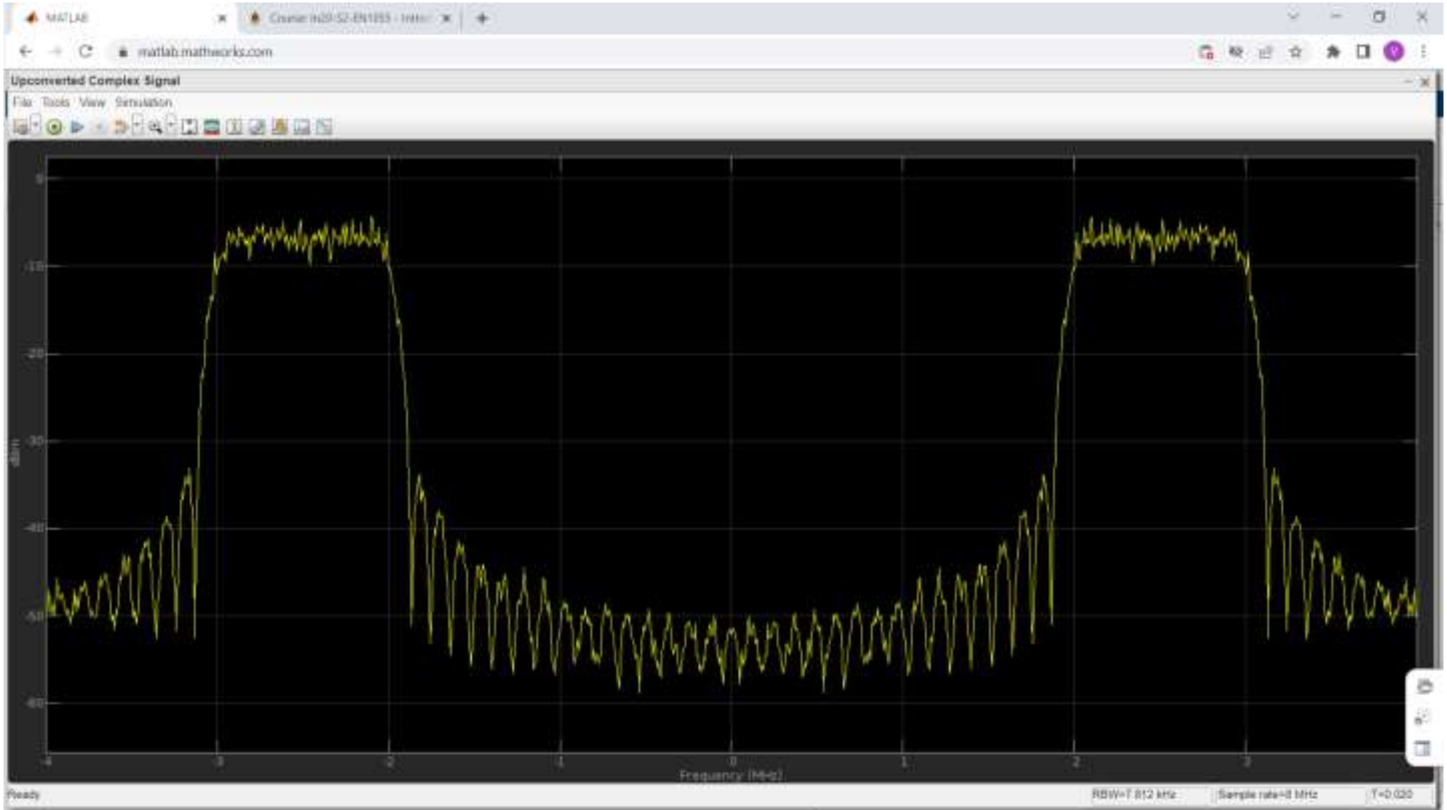


2. Now change the carrier frequency of modulation to 2.5 MHz and re-do the simulation. To verify the results, plot the signals after up/down converters.

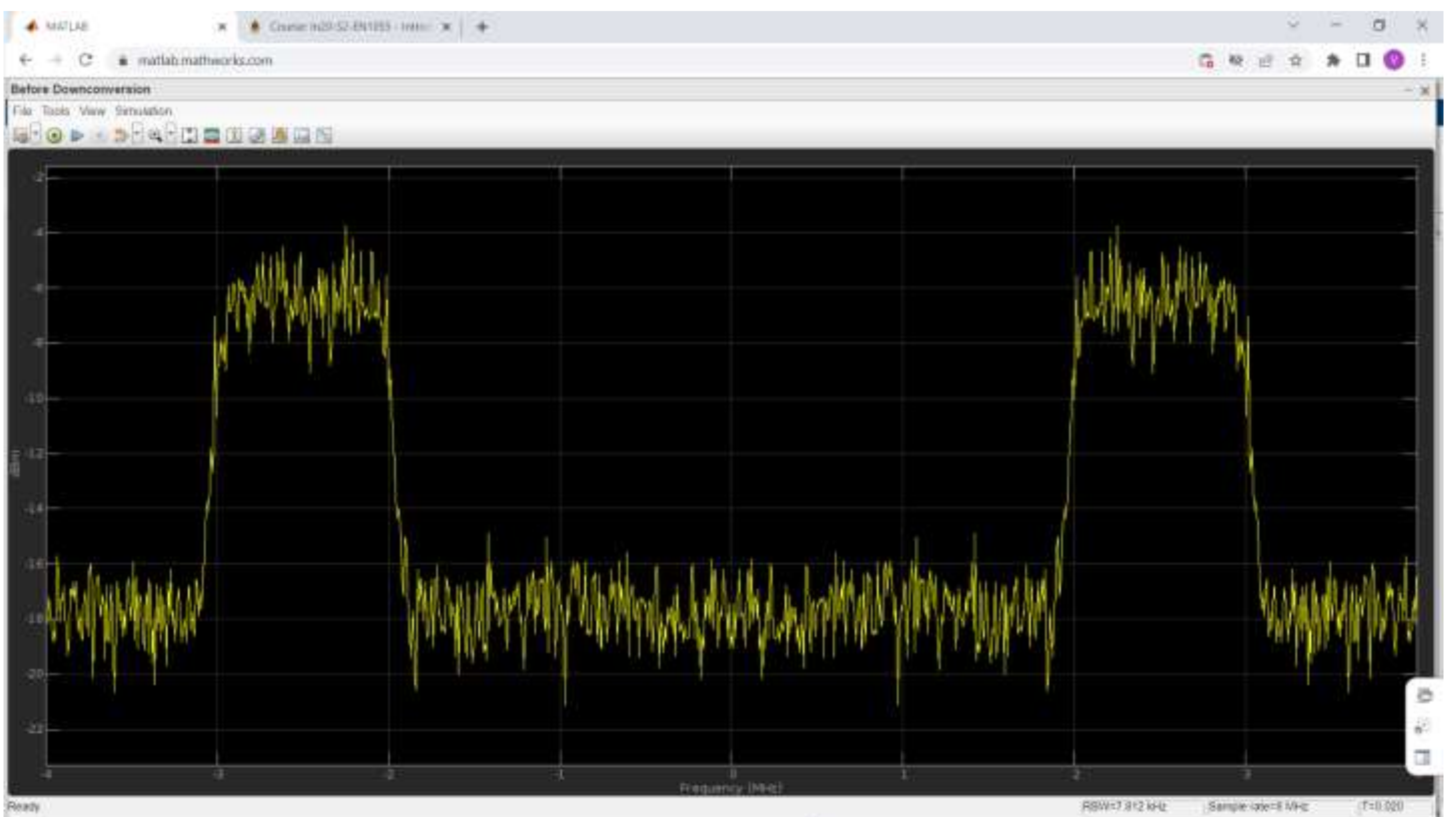


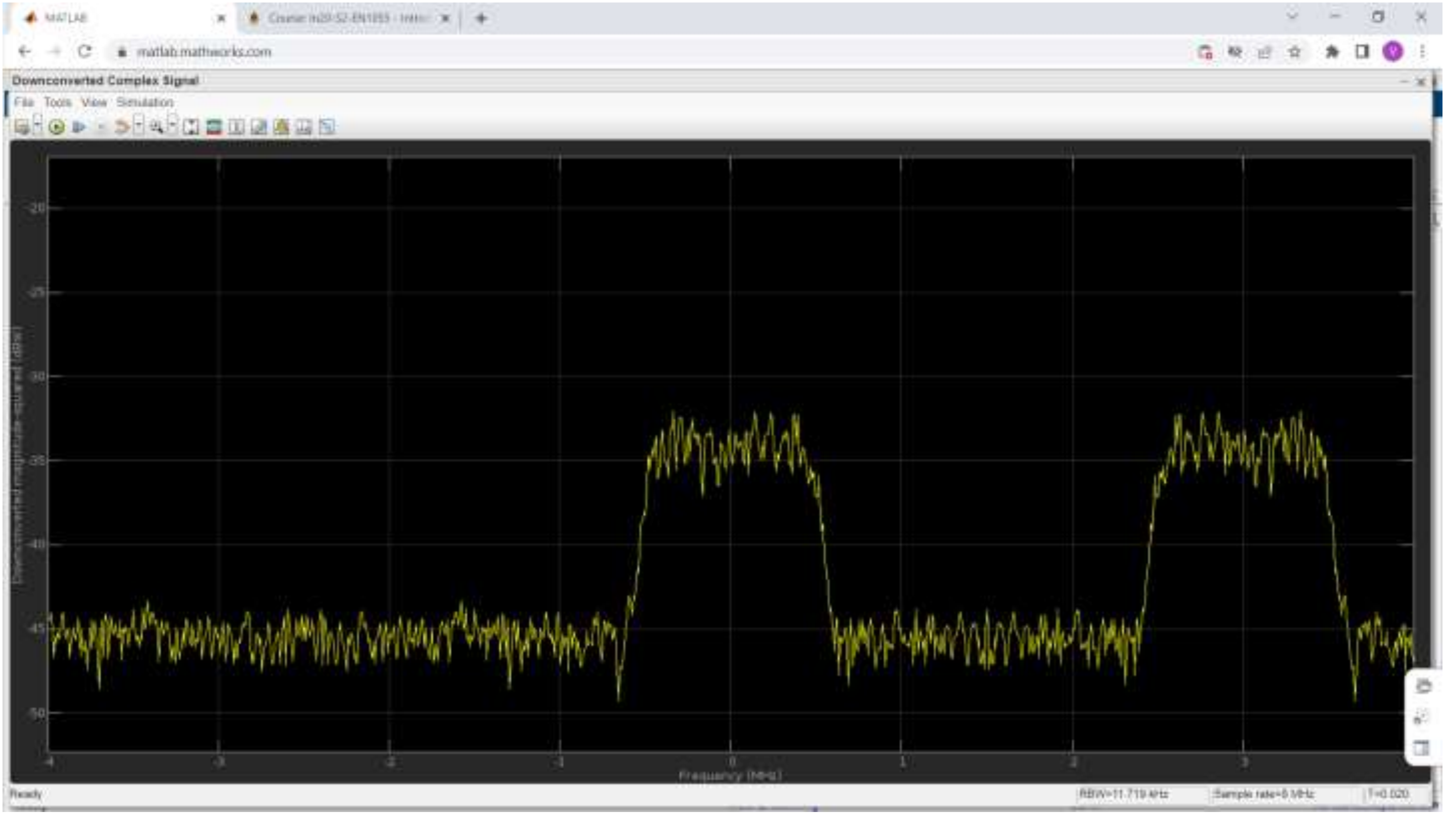
Signal before and after up conversion with the carrier frequency of 2.5MHz



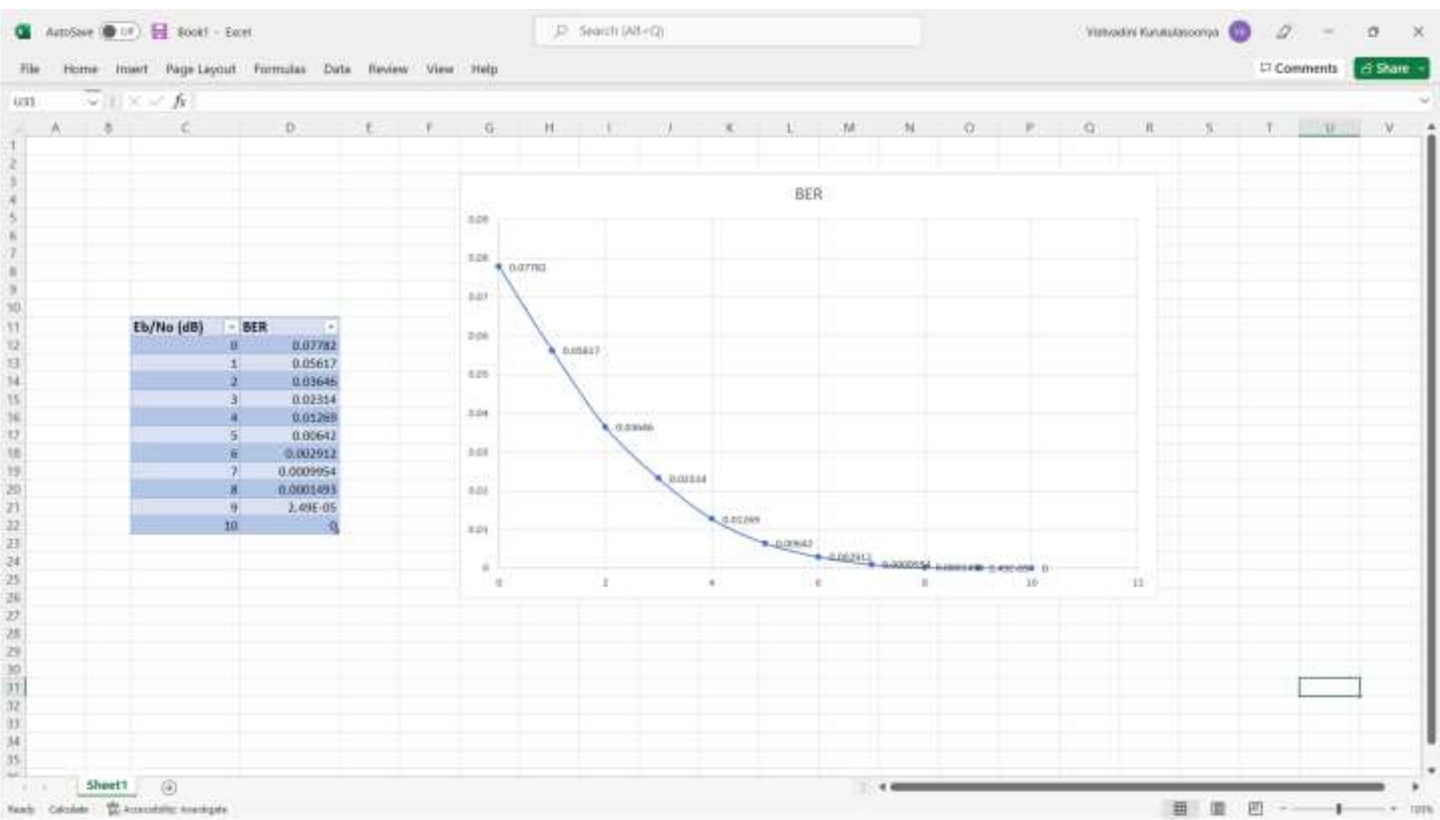


Signal before and after down conversion with the carrier frequency of 2.5MHz





3. Plot the BER while changing the Eb/No from 0 to 10 dB in the AWGN block. Briefly discuss your results.



In the above graph, the x-axis depicts the level of signal-to-noise ratio(Eb/No) from 0 to 10. This is a measure of the recoverability of the transmitted signal. It is calculated as the

Power of signal divided by the Power of noise. The y axis depicts the level of BER (Bit Error rate) which is a running statistic of the total number of unequal pairs divided by the total number of input data elements by the source.

$$\text{Signal To Noise Ratio (Eb/No)} = \frac{Power\ of\ the\ Signal}{Power\ of\ the\ Noise}$$

$$\text{Bits Error Rate} = \frac{Total\ Number\ of\ Unequal\ pairs}{Total\ number\ of\ Input\ pairs}$$

For a given Power of signal, if the Power of noise is low, the Eb/No value is high. This implies that when the Eb/No value is high the interference by the noise to the original signal is low. Therefore, it can be concluded that the rate of error measured at the receiver is very much low when the Eb/No value (or Signal to Noise Ratio) is high.

Generally, the BER performance increases with the SNR.

4. While keeping the other setting as in part (2), change the modulation to 8-PSK and re-do the simulation. To demonstrate the correctness of your implementation, you should provide at least the following plots as evidence.
You are encouraged to include any other plots that are in line with your arguments.
- **Input and output sequences**
- **Signals before and after modulation / demodulation**
- **Input and output constellation diagrams**
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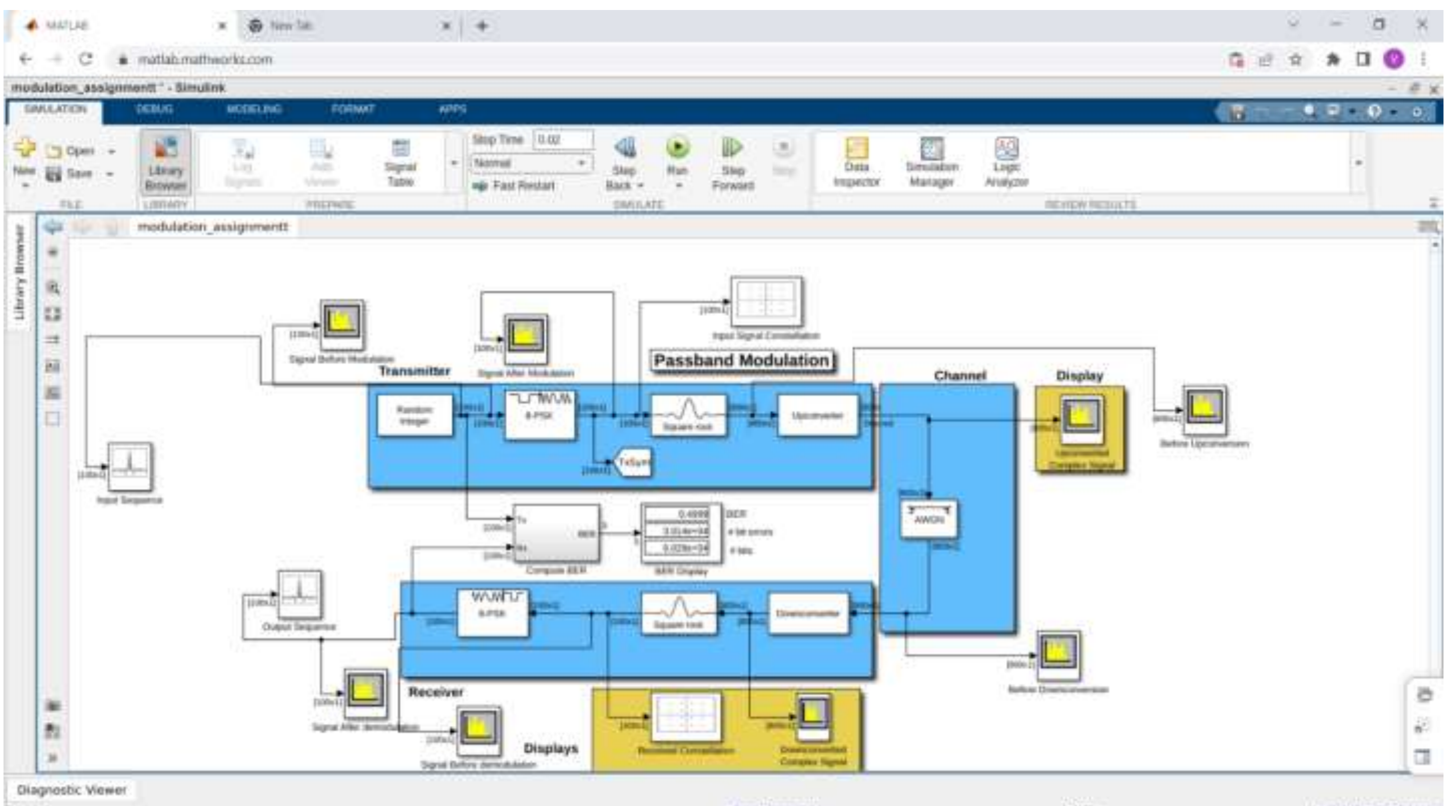
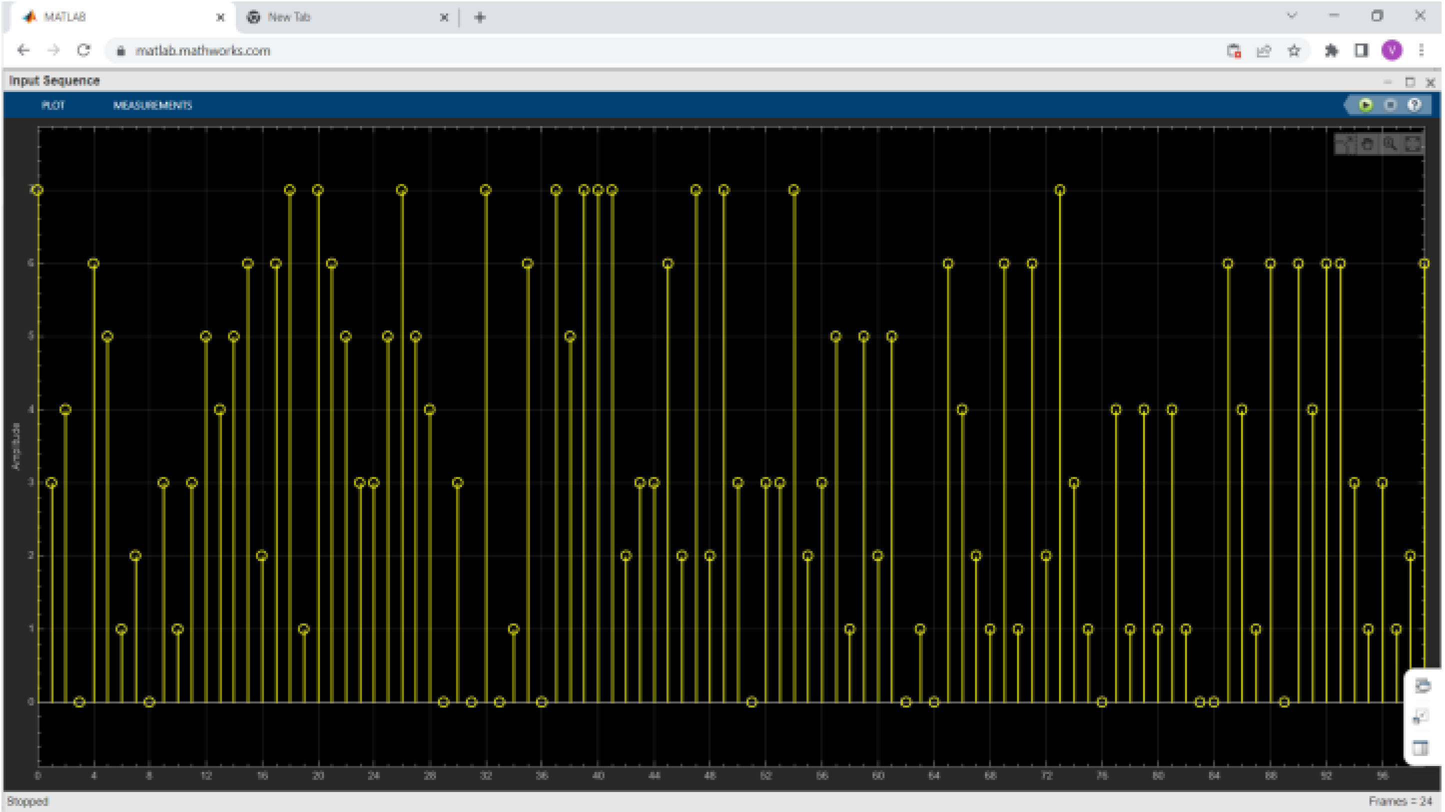
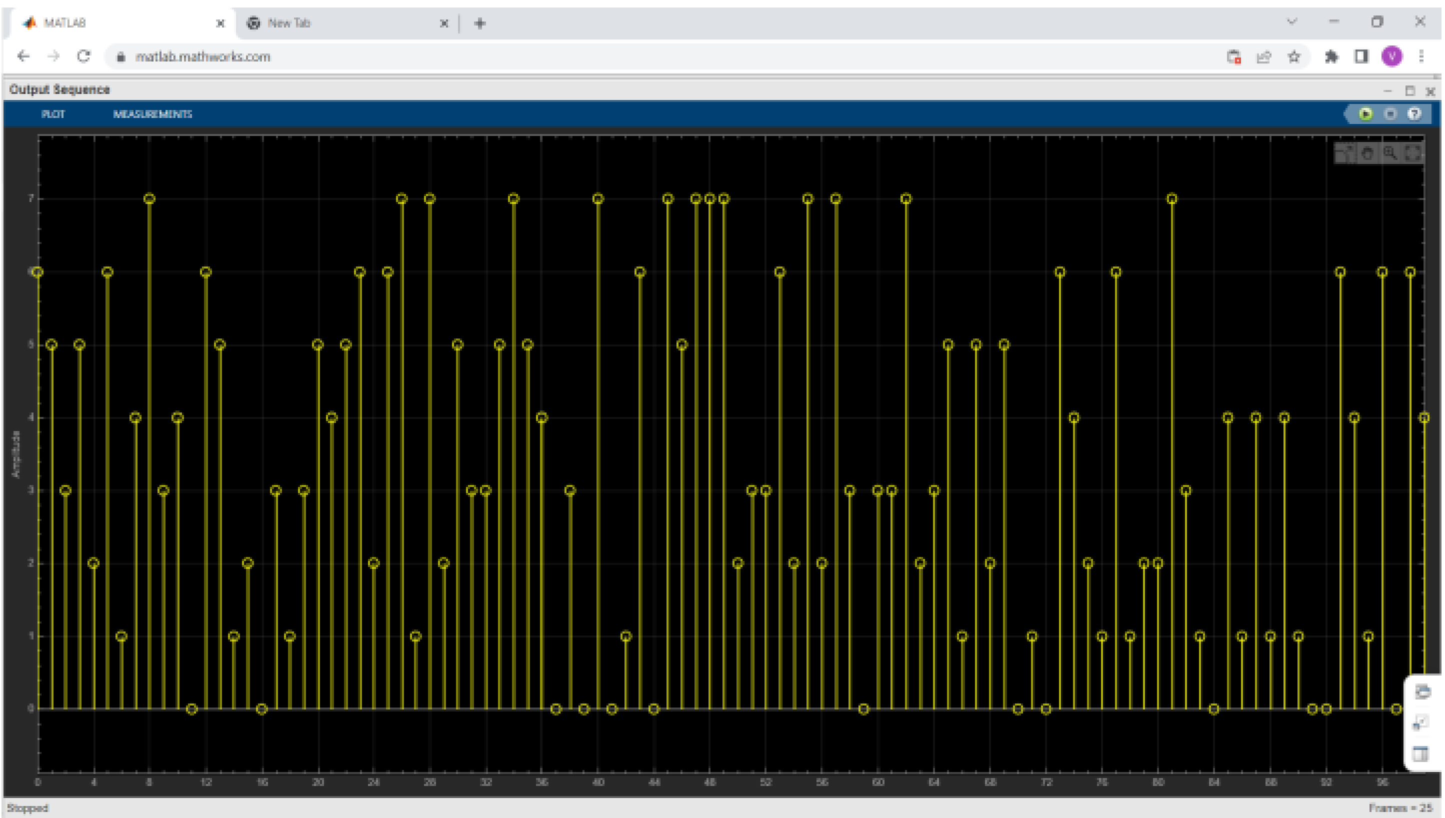
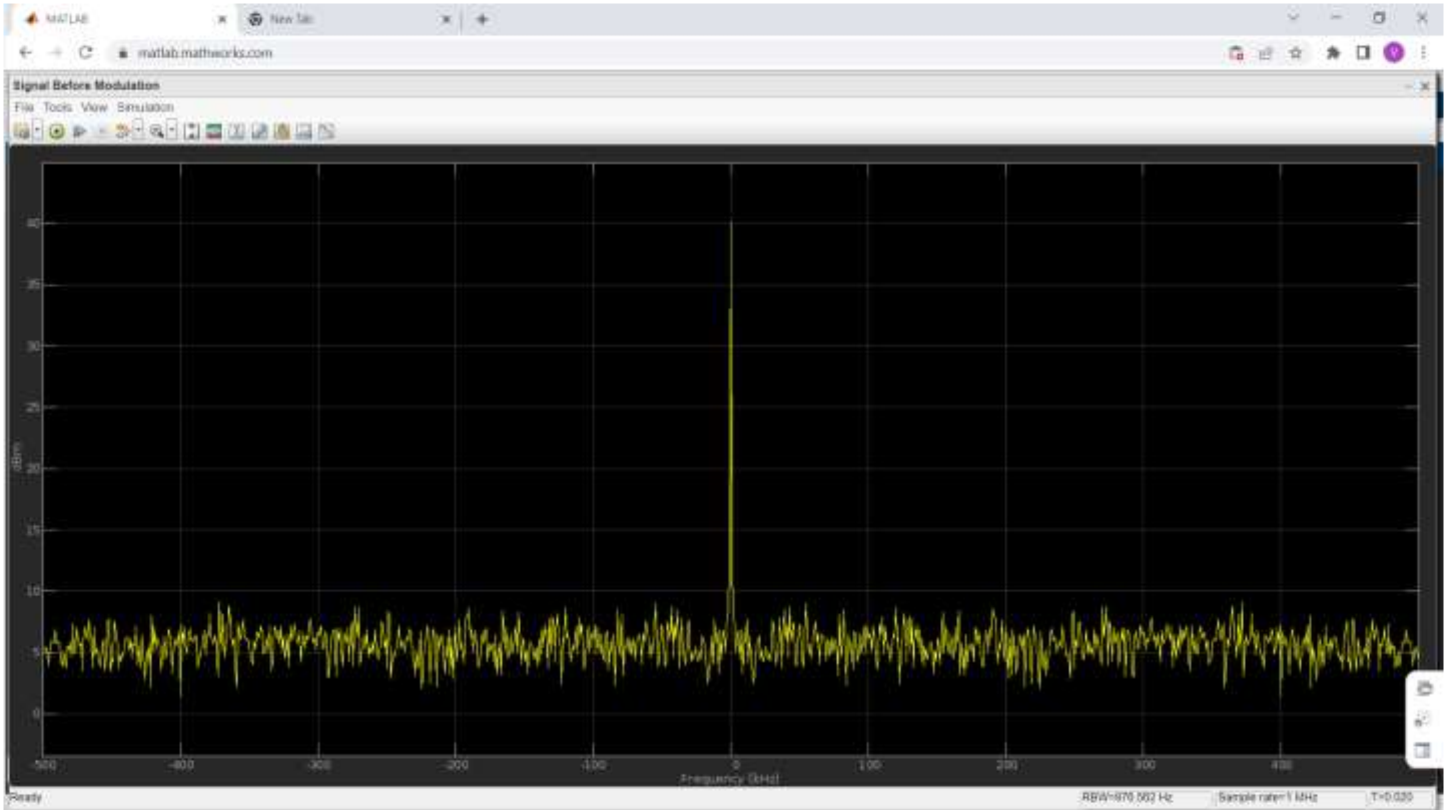


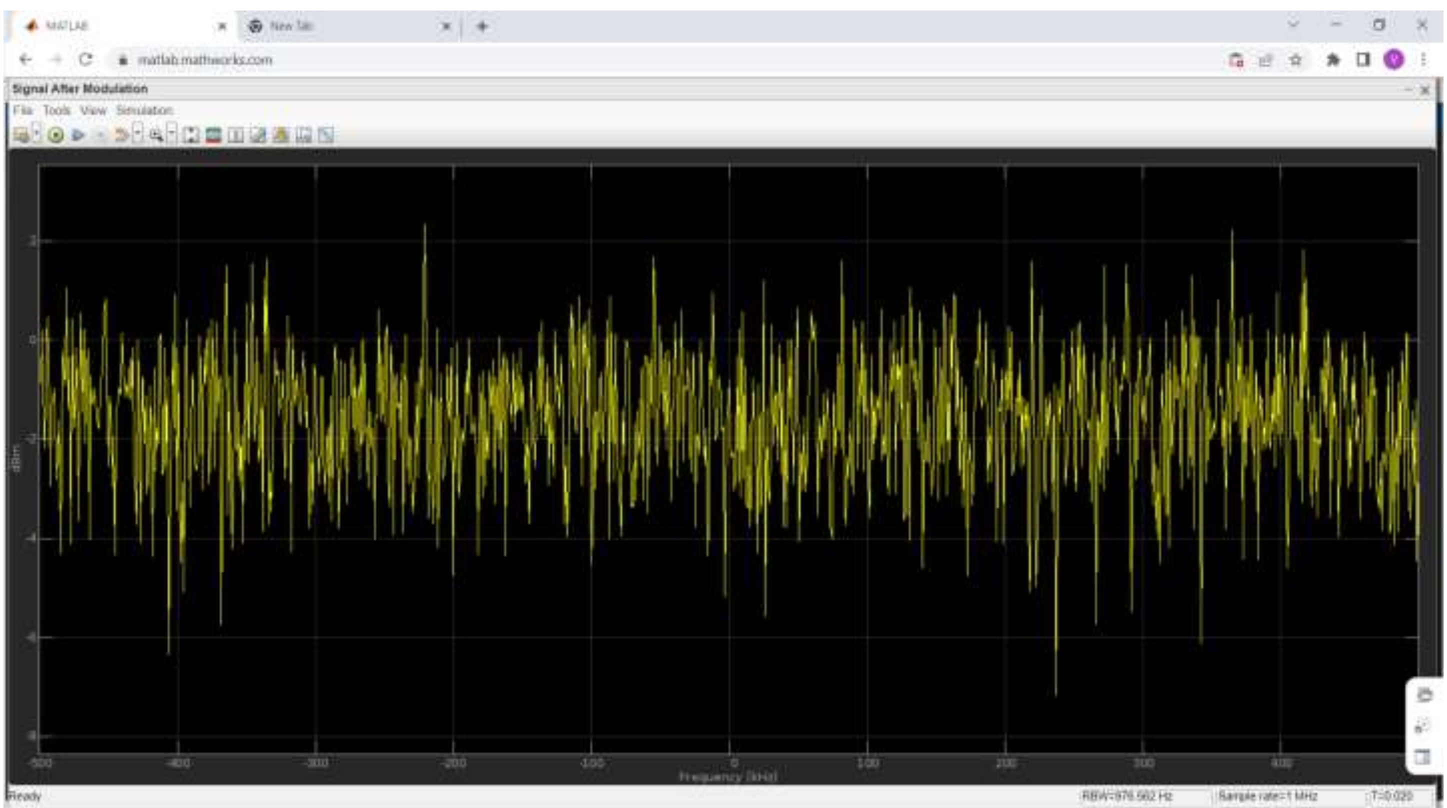
Input and output sequences



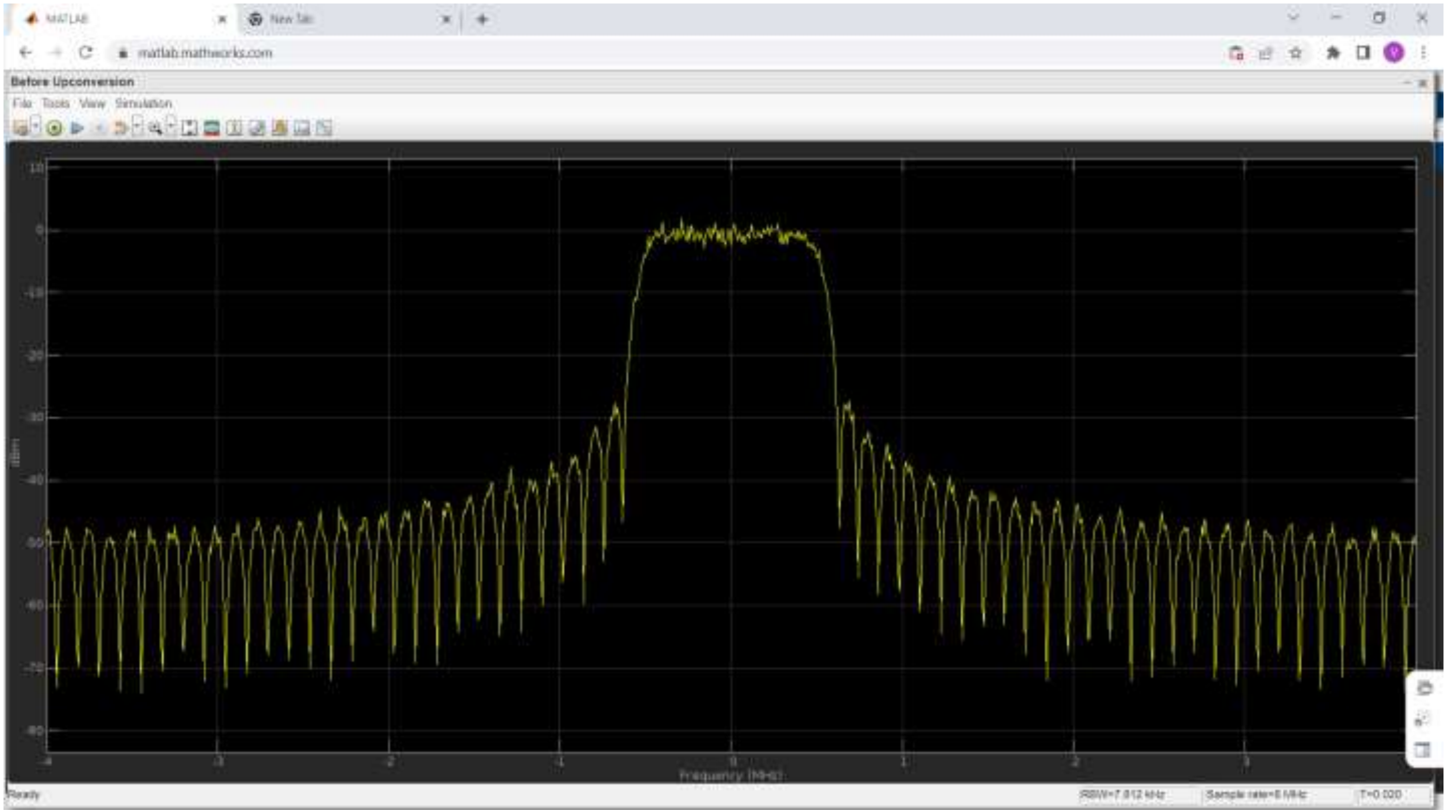


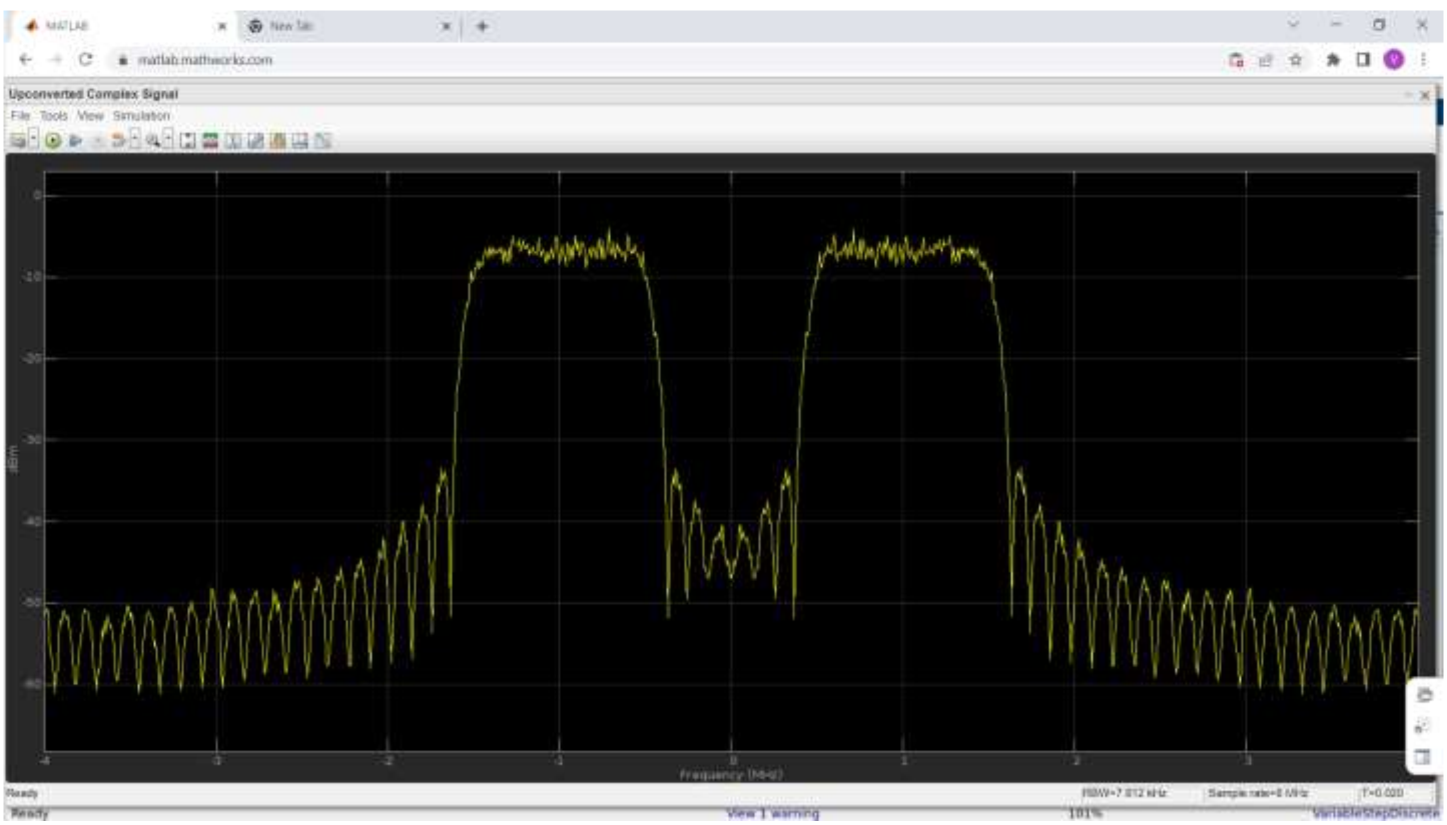
Signal before and after modulation



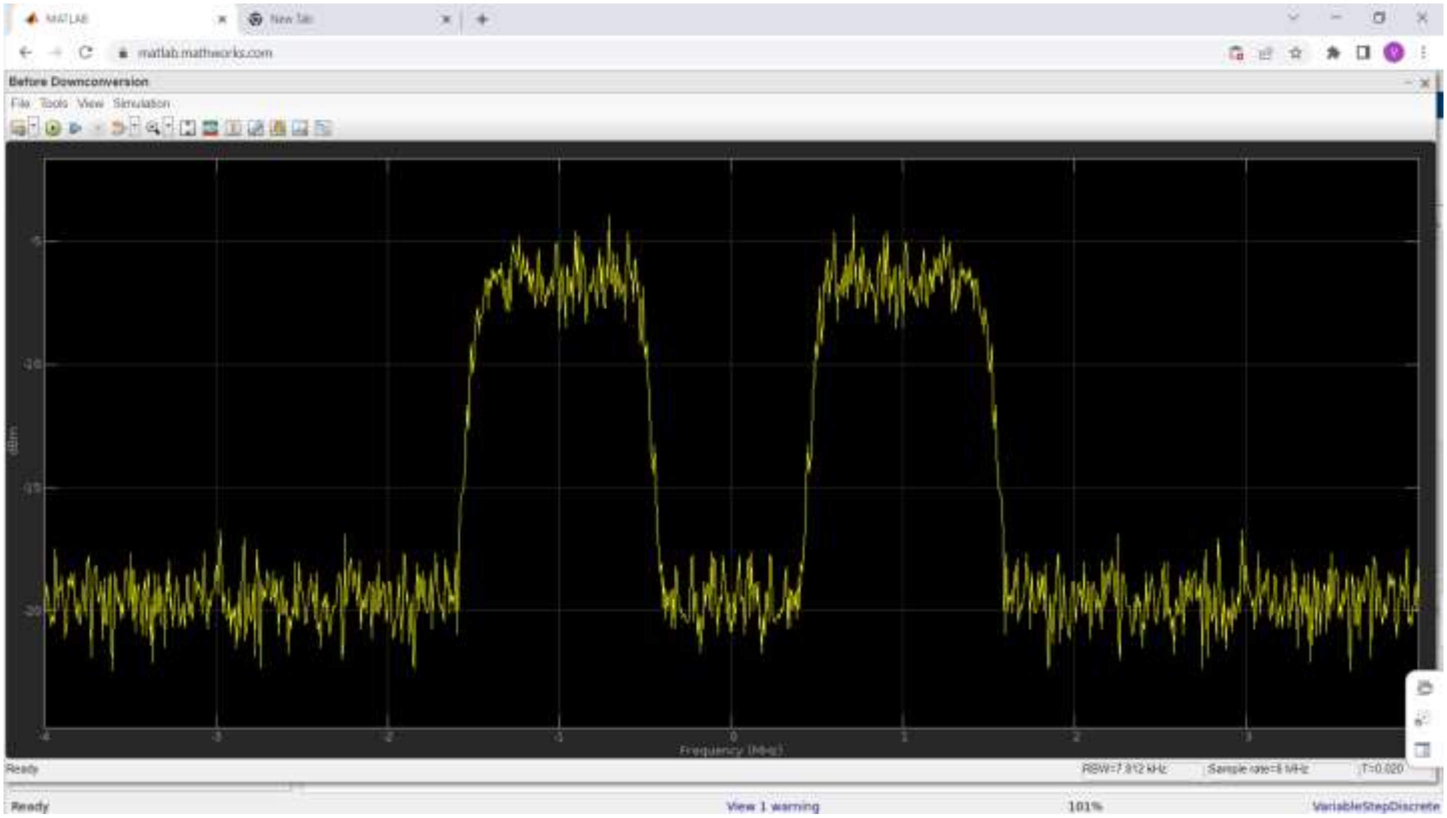


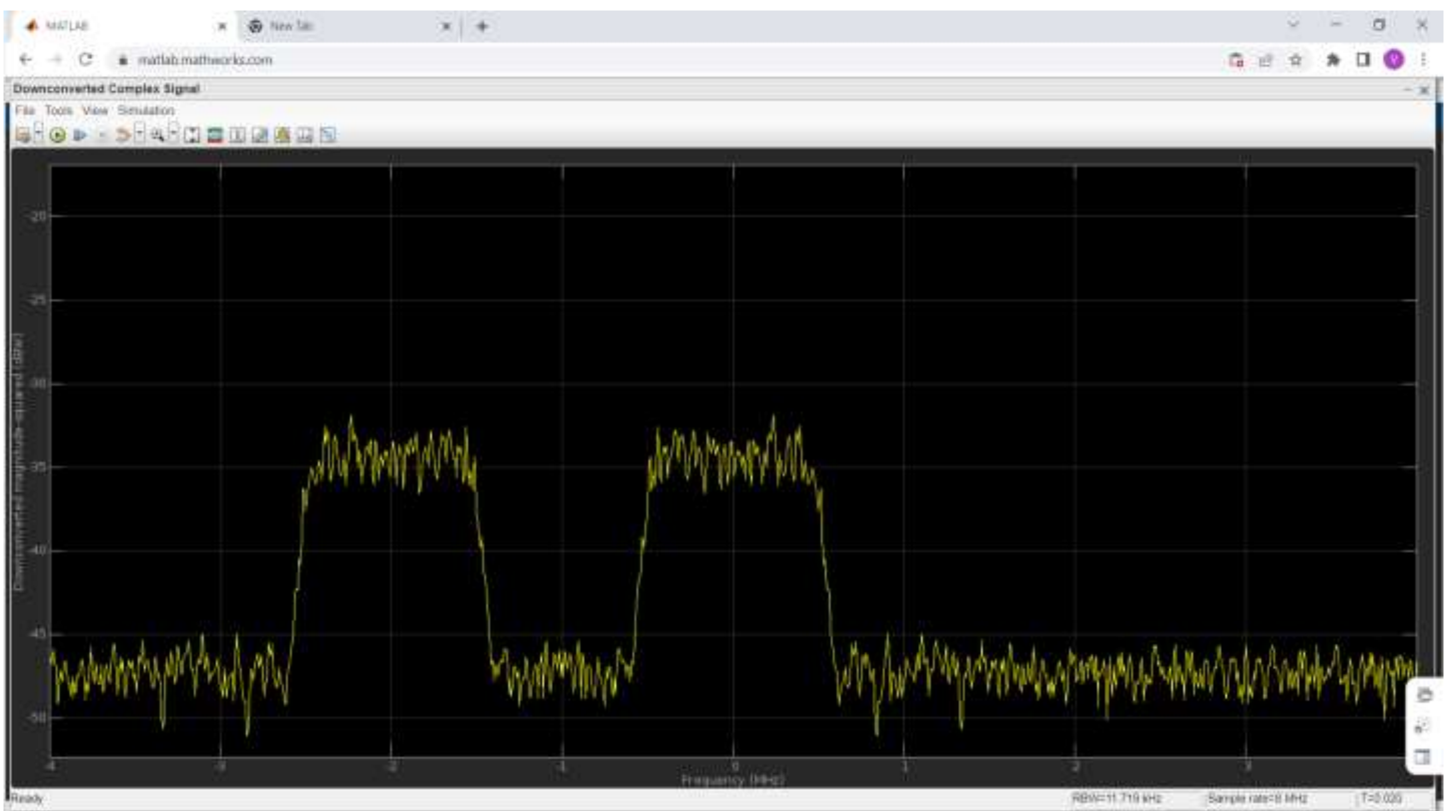
Signal before and after upconversion



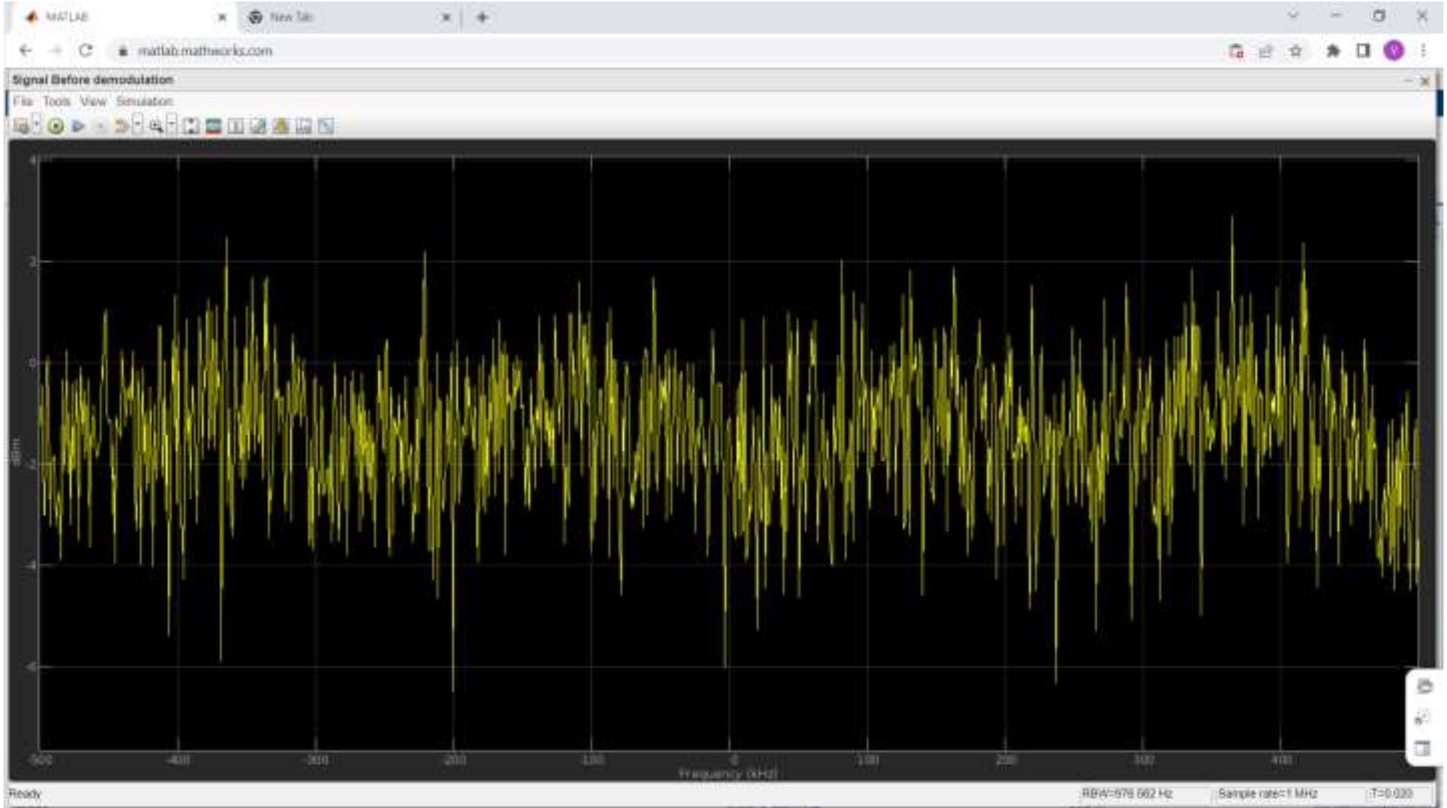


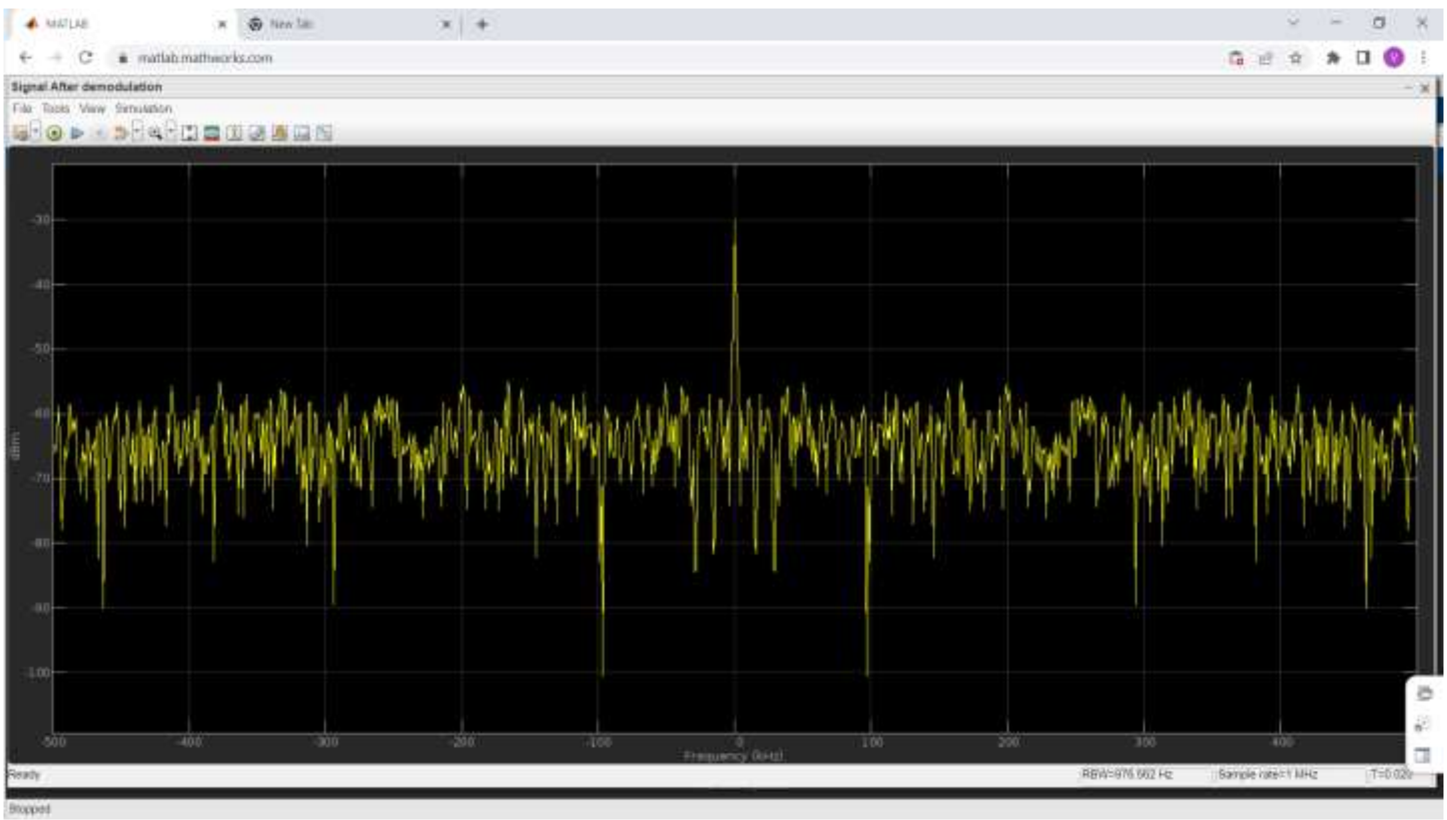
Signal before and after downconversion



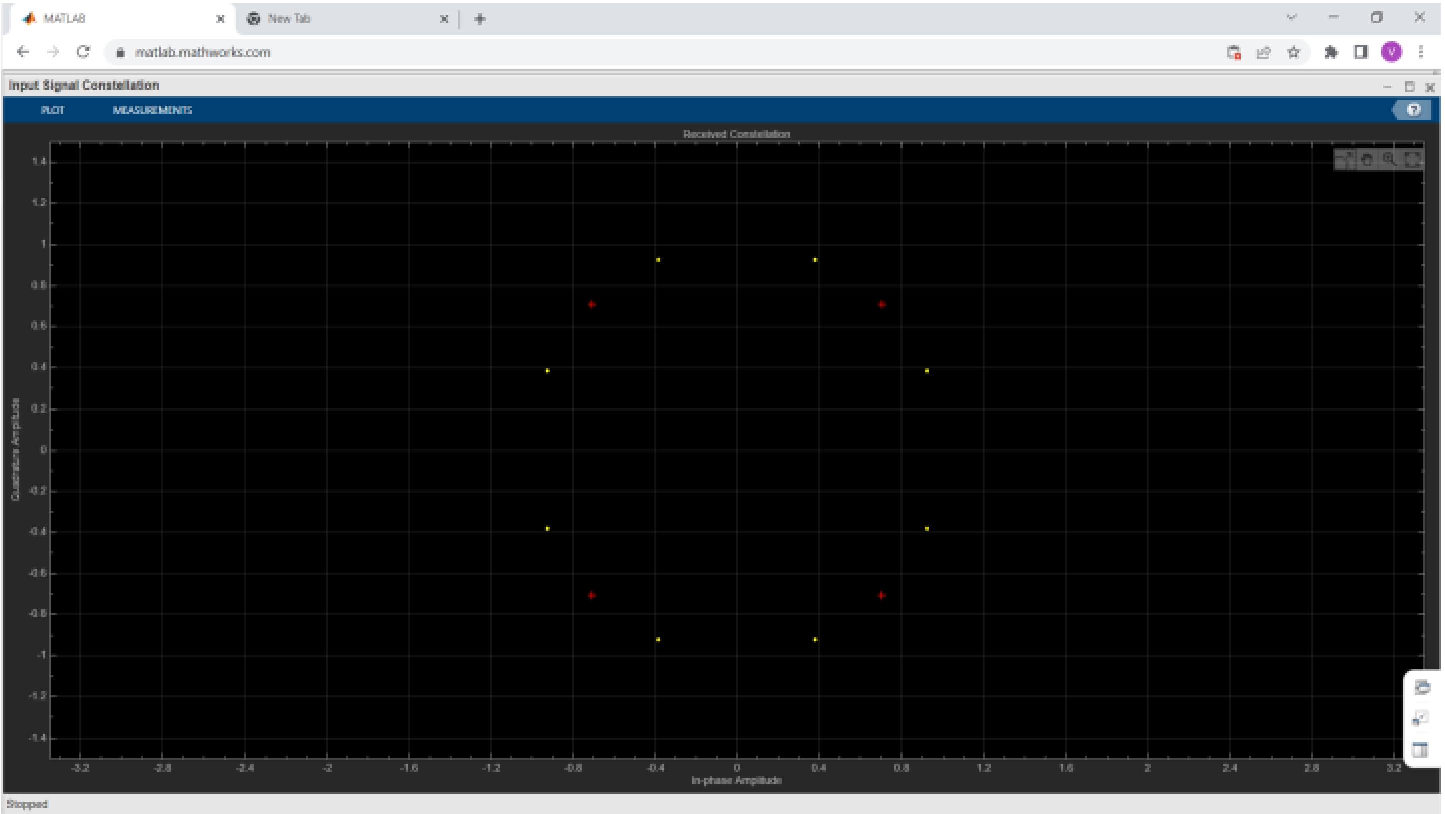


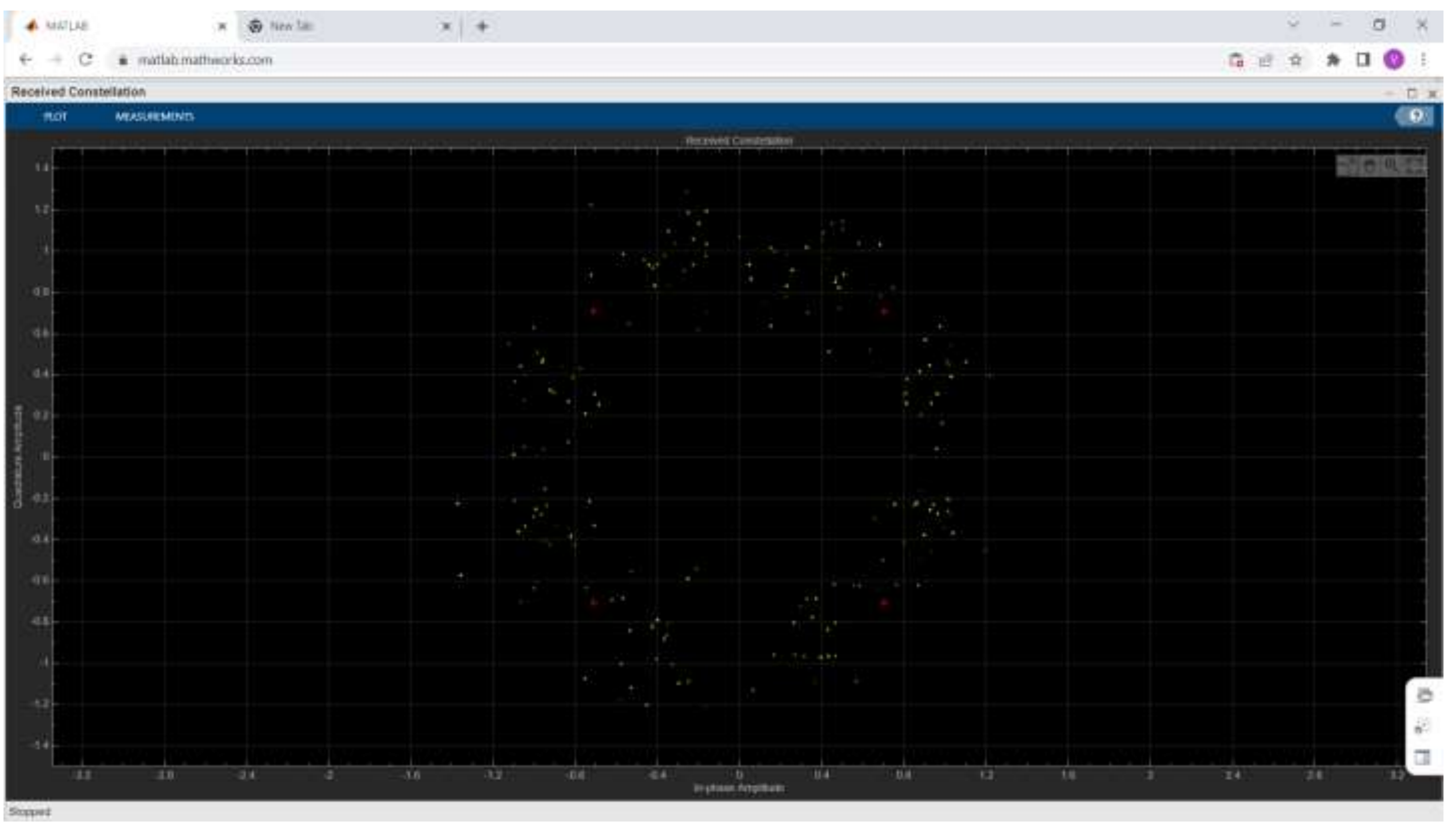
Signal before and after demodulation



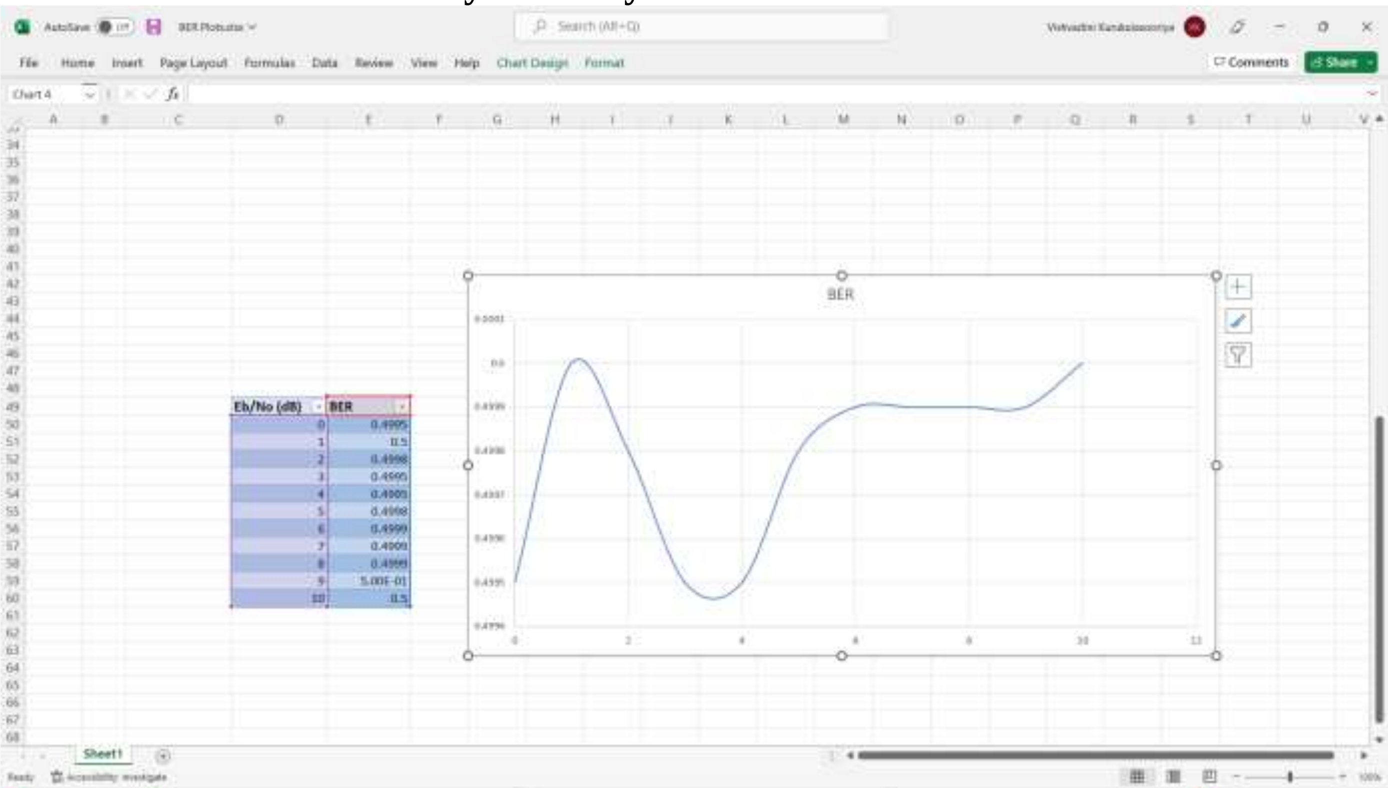


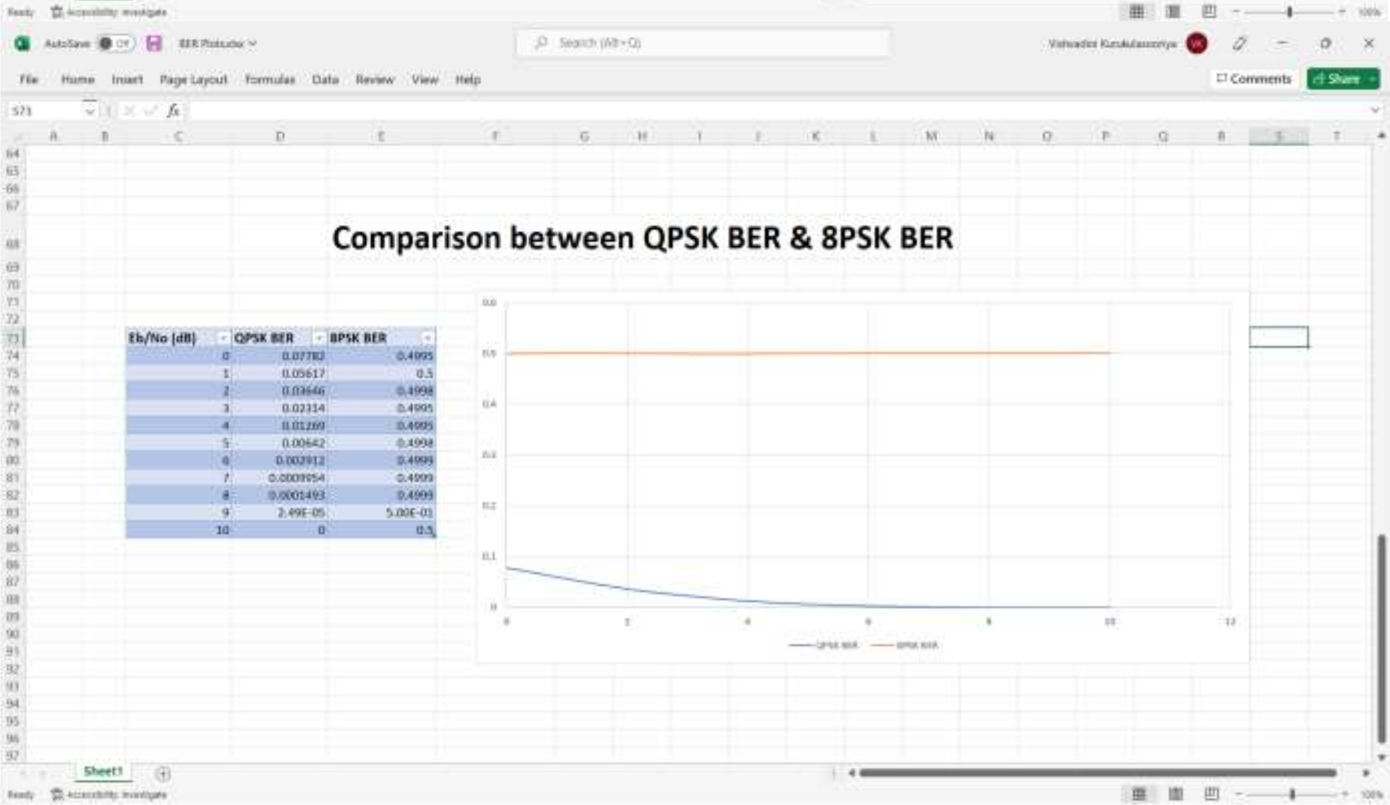
Input and output signal constellation





5. Repeat part (3) with 8-PSK modulation and compare the BER for the two modulation schemes. Briefly discuss your observations.





It is shown that for all the given instances of SNR, the BER value for 8PSK is significantly higher than QPSK's. So we can conclude that the BER performance (recoverability of the transmitted signal) of 8PSK is comparatively lower though it supports about 1.5 times a data rate of QPSK.