

In the Name of God

Report of Communication System I Project

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Teacher: Dr. Farhang

First Part:

Applying functions on a sinusoidal waveform to see the output signal spectrum:

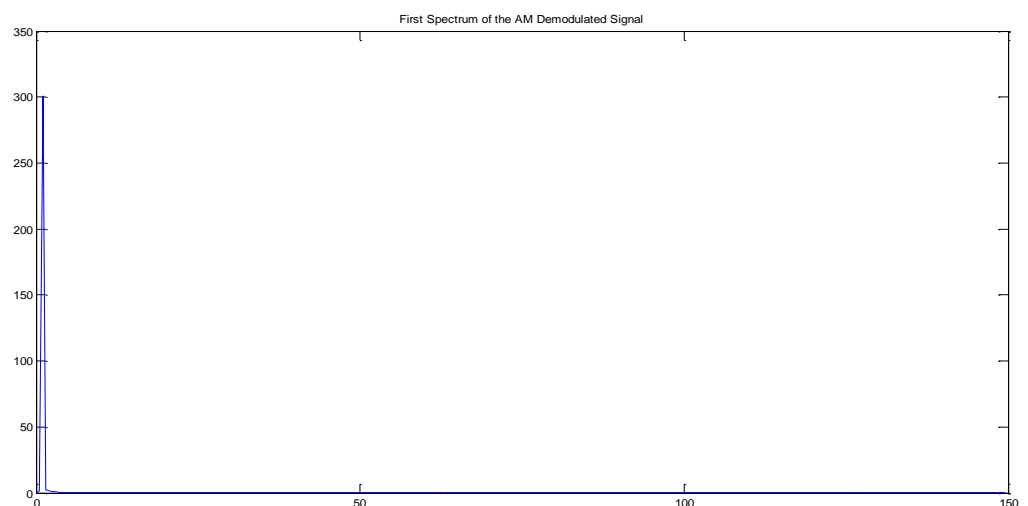
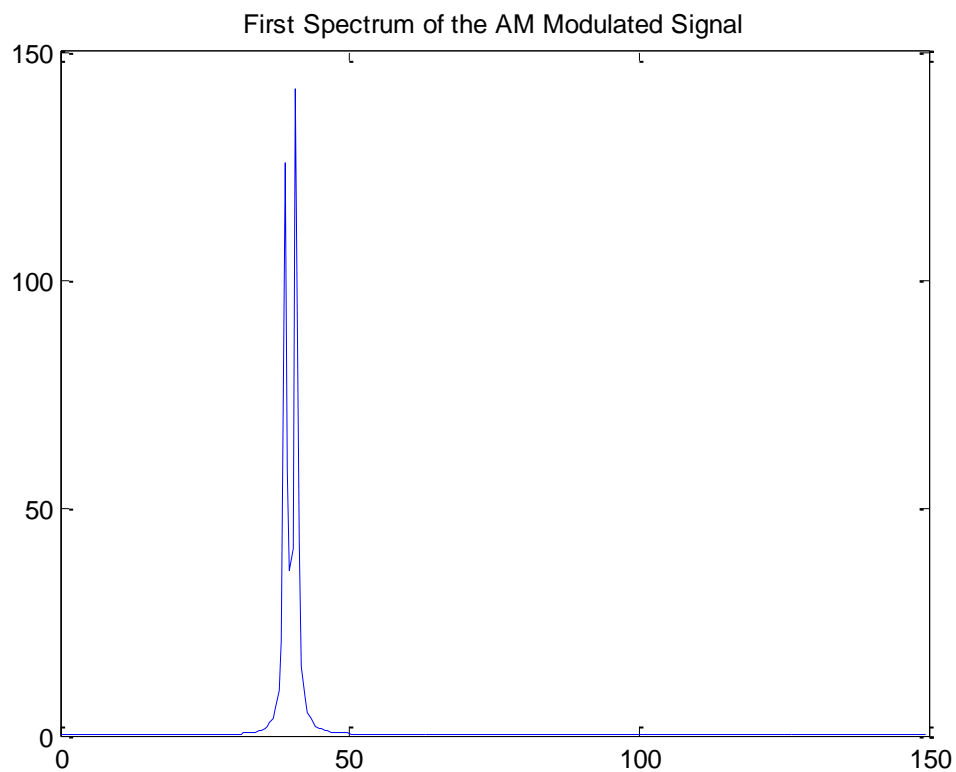
Imagine our initial (Message) signal is $\sin(2\pi t)$

A) AM Modulation and AM Demodulation:

Sampling rate = 300 sample per second

Carrier signal Frequency = 40 Hz

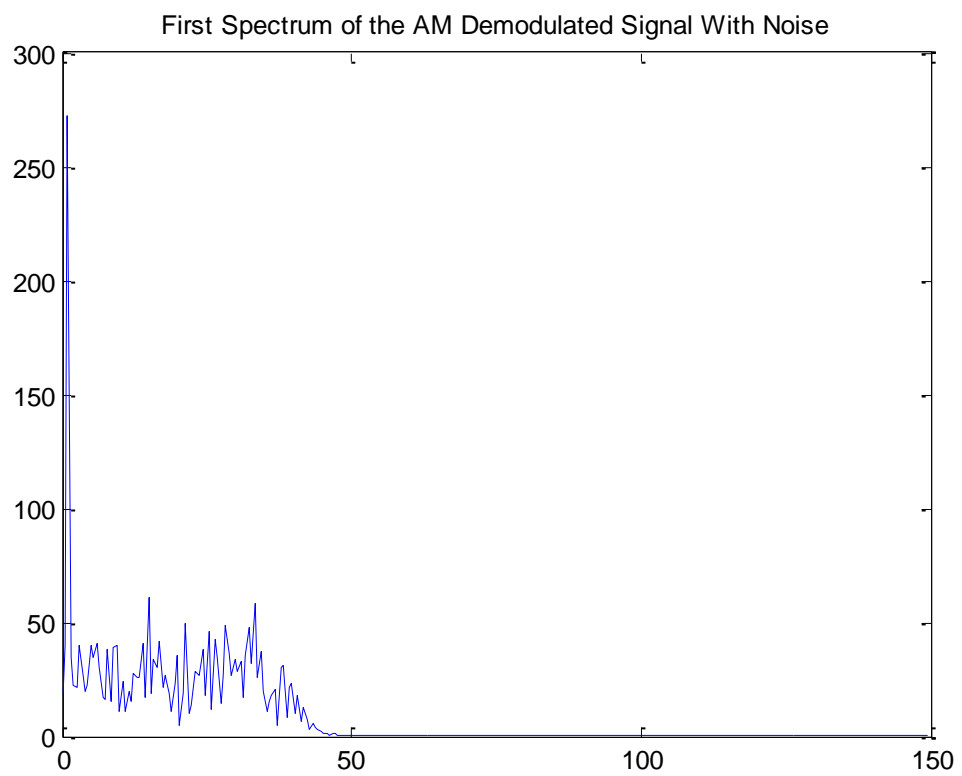
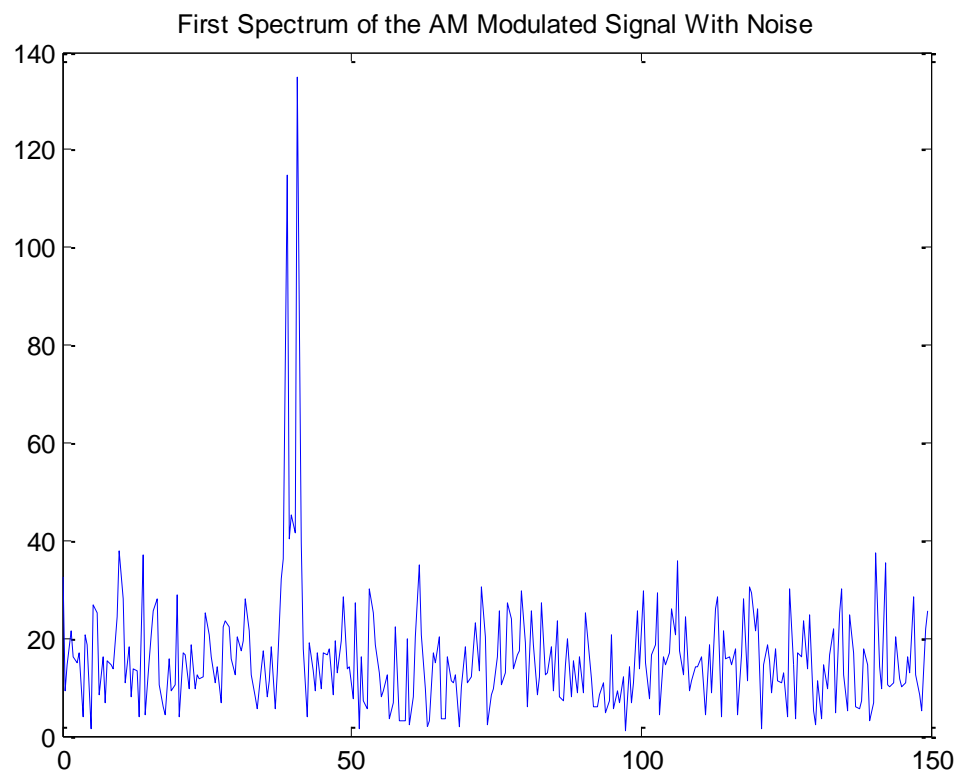
Without Noise:



Sampling rate = 300 sample per second

Carrier signal Frequency = 40 Hz

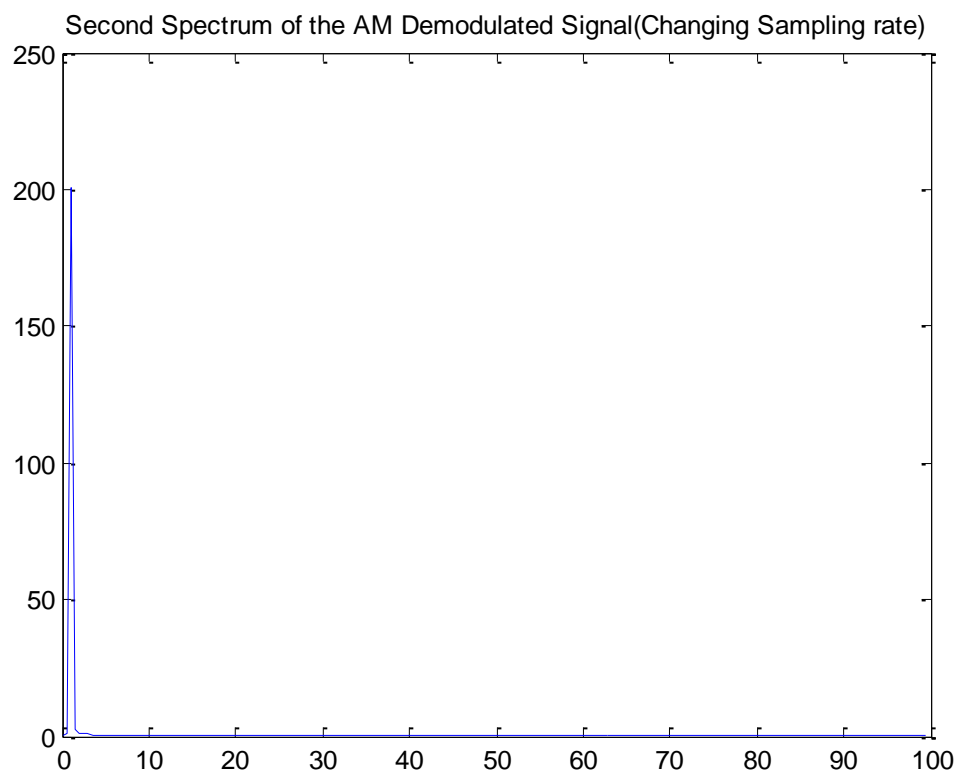
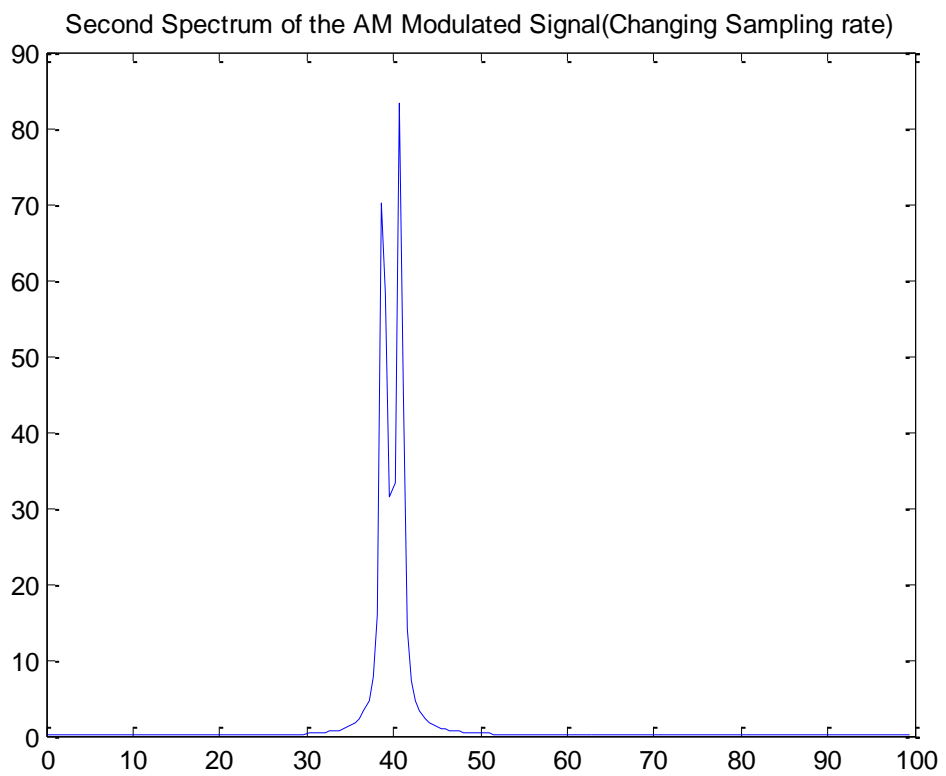
With Noise:



Sampling rate = 200 sample per second

Carrier Frequency = 40 Hz

Without Noise:

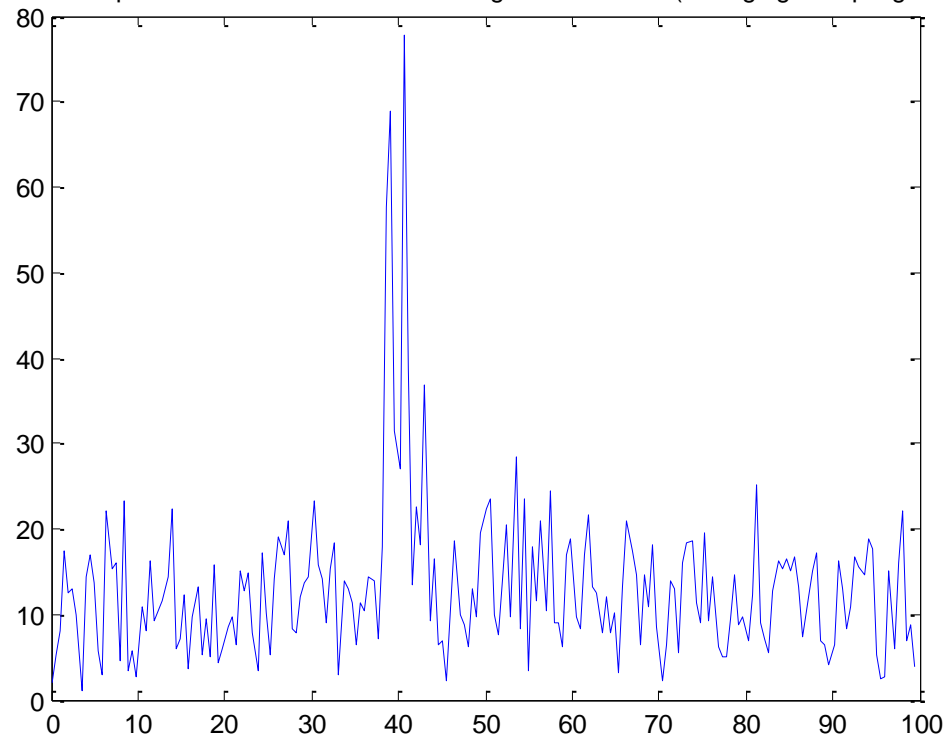


Sampling rate = 200 sample per second

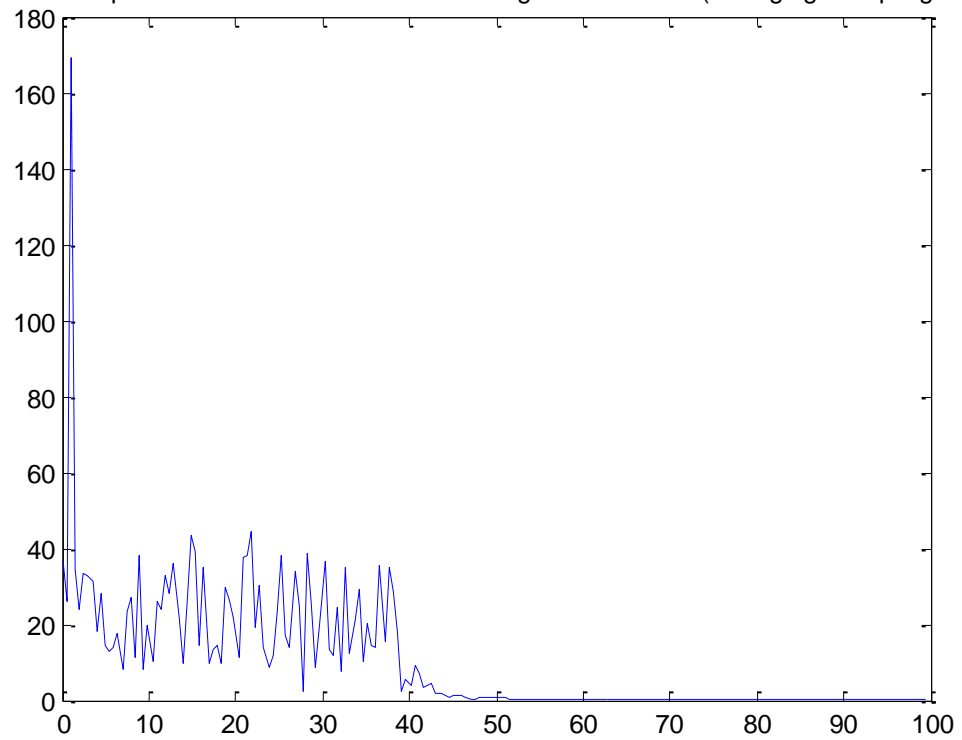
Carrier Frequency = 40 Hz

With Noise:

Second Spectrum of the AM Modulated Signal With Noise(Changing Sampling rate)



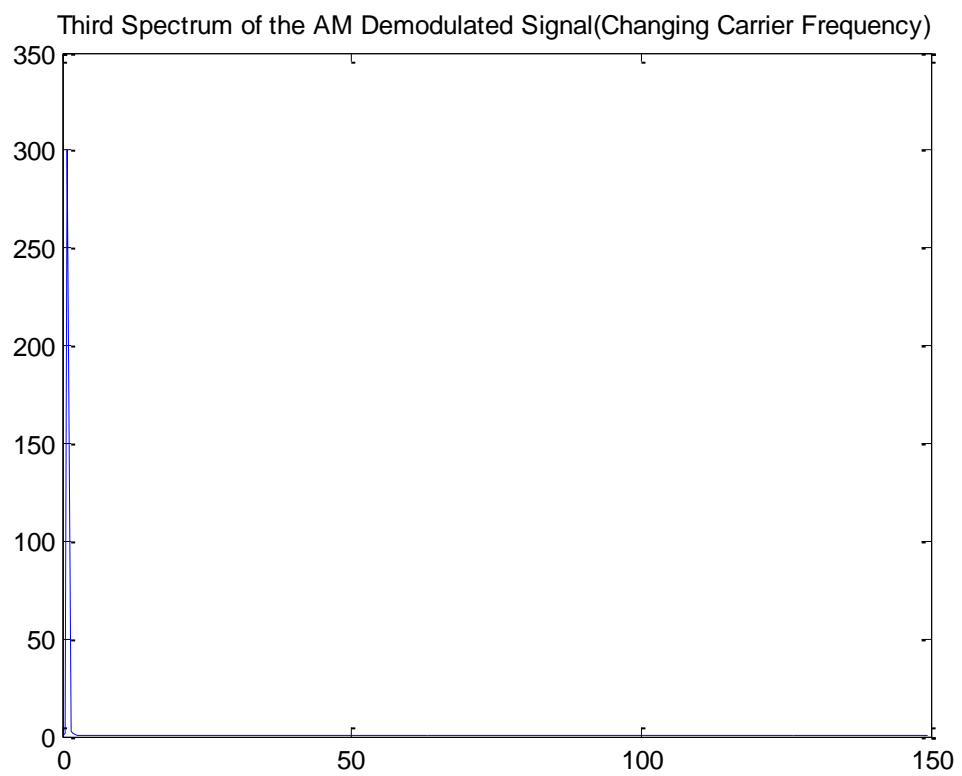
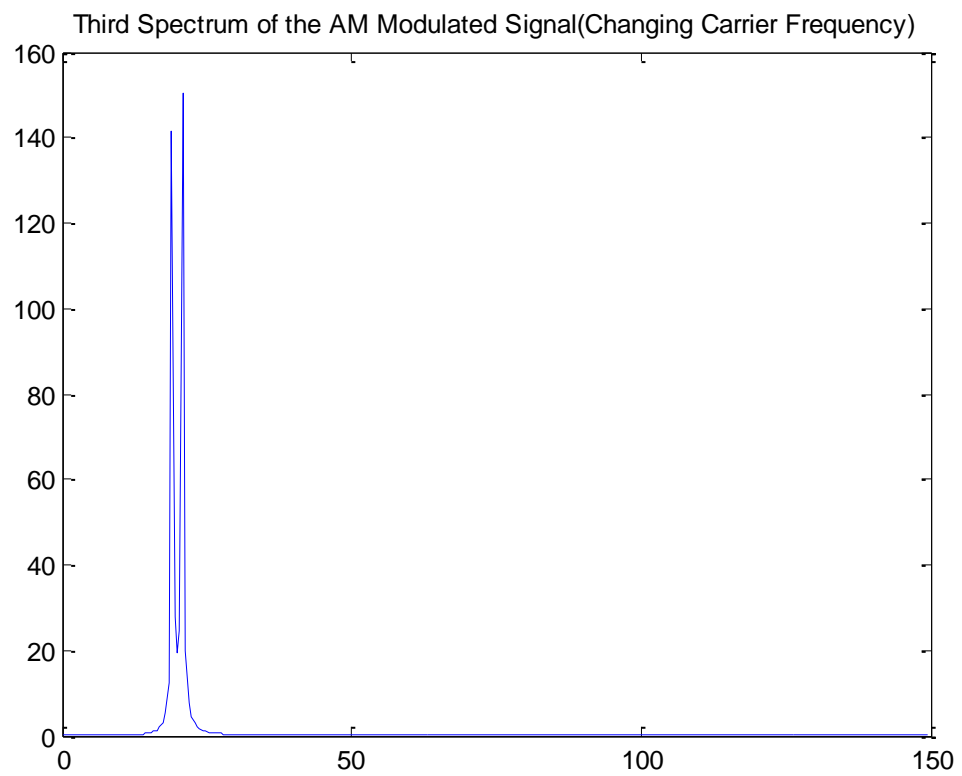
Second Spectrum of the AM Demodulated Signal With Noise(Changing Sampling rate)



Sampling rate = 300 sample per second

Carrier frequency = 20 Hz

Without Noise:

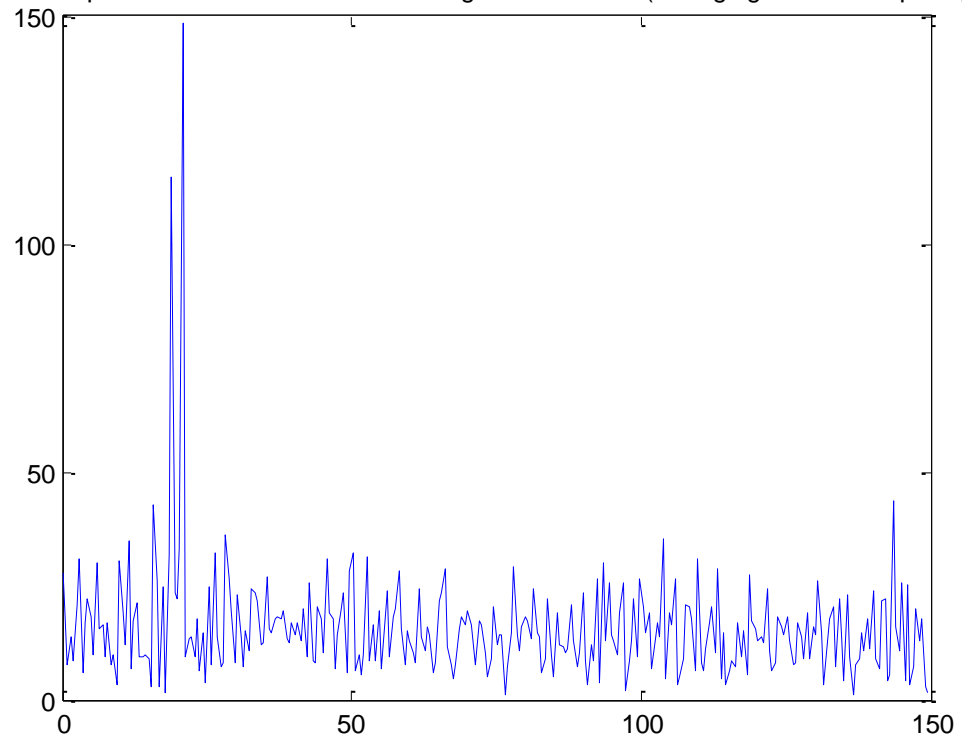


Sampling rate = 300 sample per second

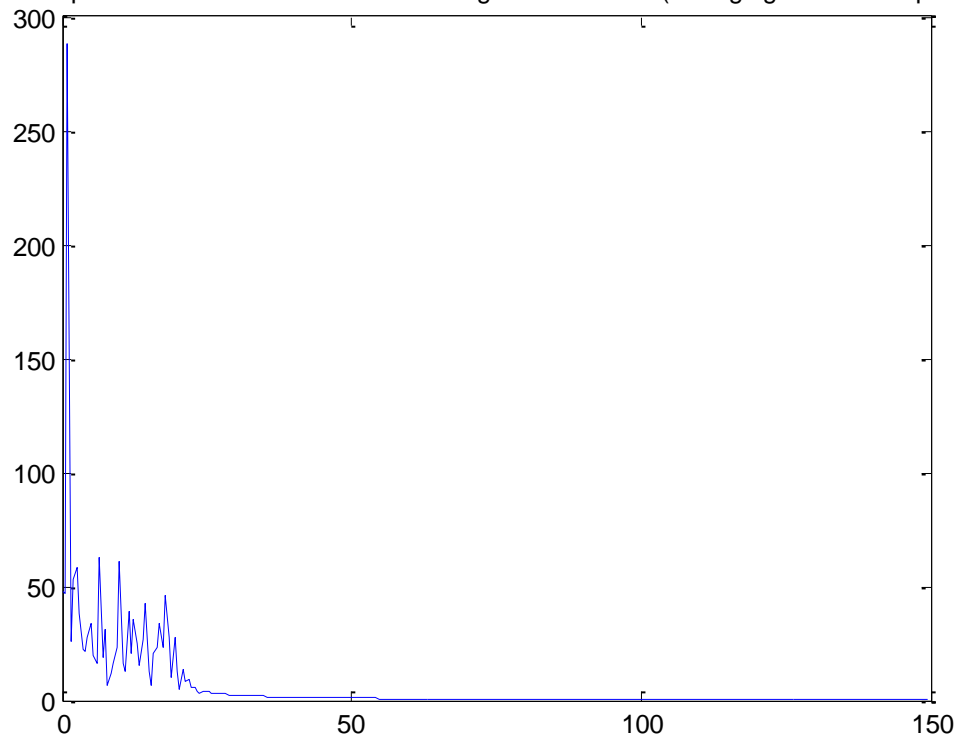
Carrier frequency = 20 Hz

With Noise:

Third Spectrum of the AM Modulated Signal With Noise(Changing Carrier Frequency)



Third Spectrum of the AM Demodulated Signal With Noise(Changing Carrier Frequency)

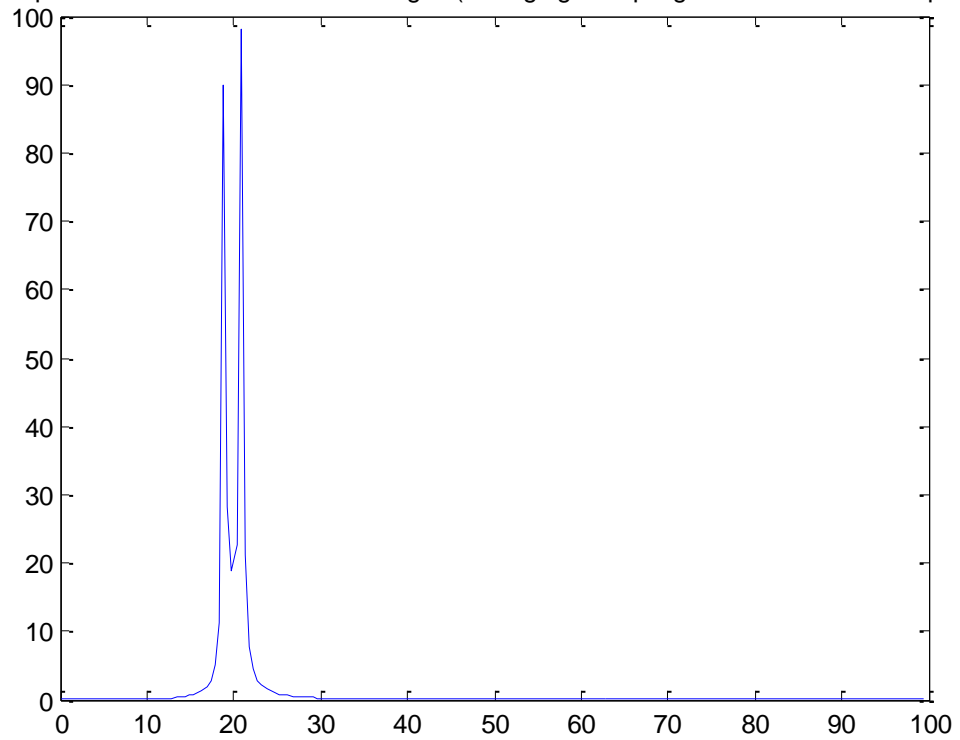


Sampling rate = 200 sample per second

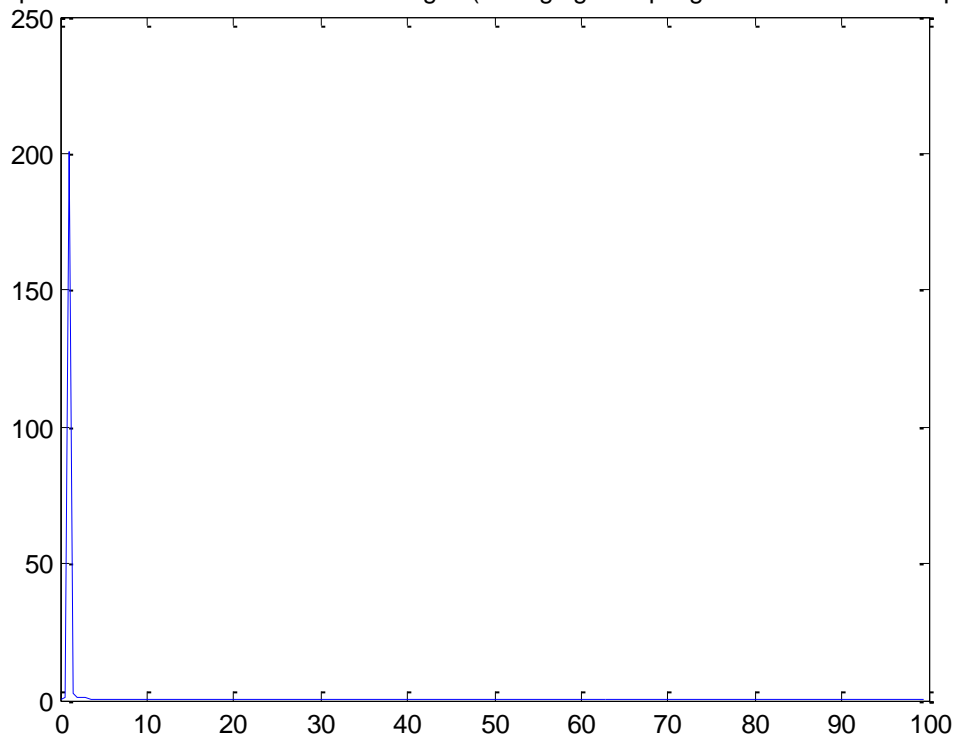
Carrier frequency = 20 Hz

Without Noise:

4th Spectrum of the AM Modulated Signal(Changing Sampling rate and Carrier Frequency)



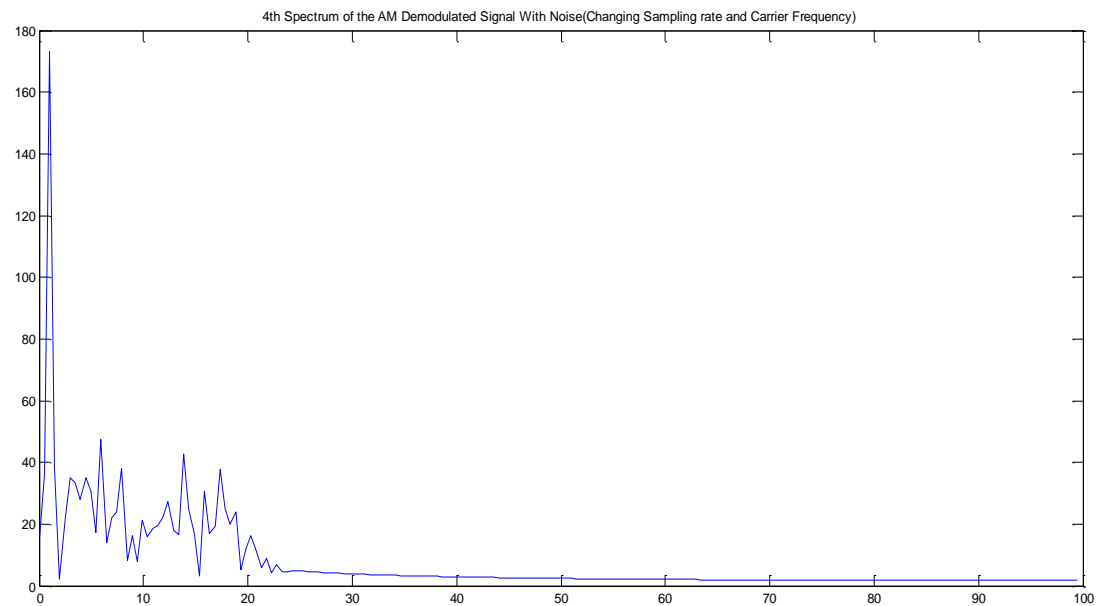
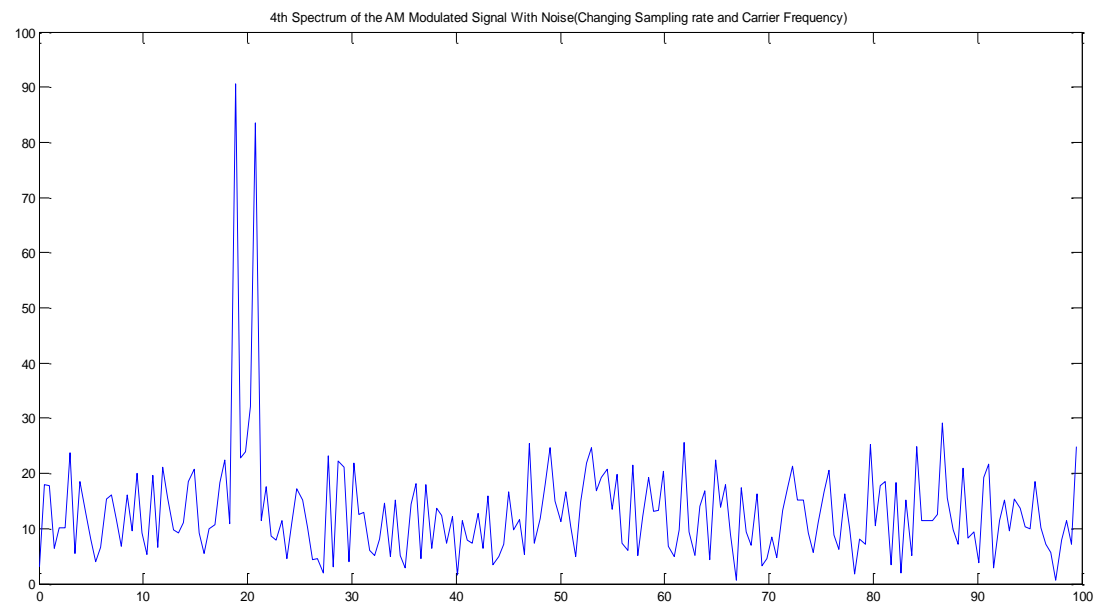
4th Spectrum of the AM Demodulated Signal(Changing Sampling rate and Carrier Frequency)



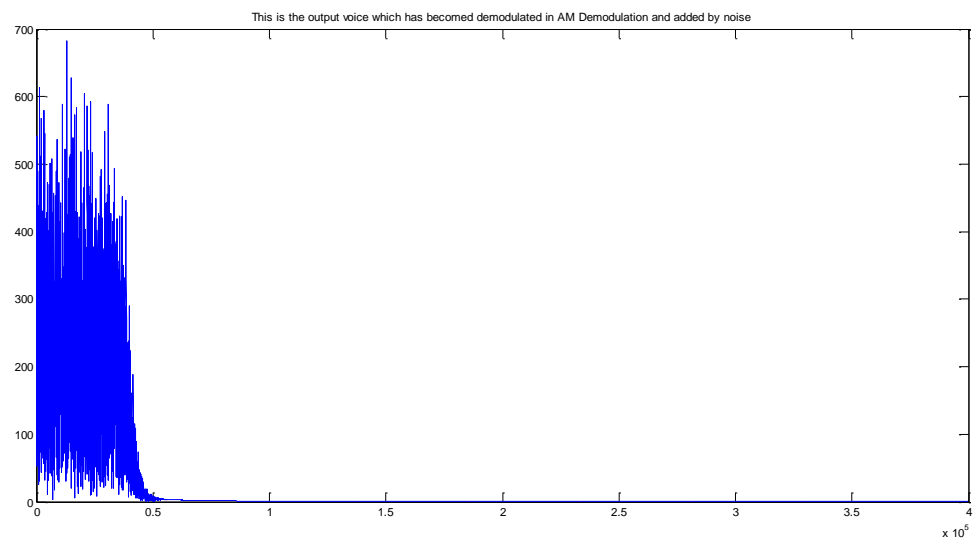
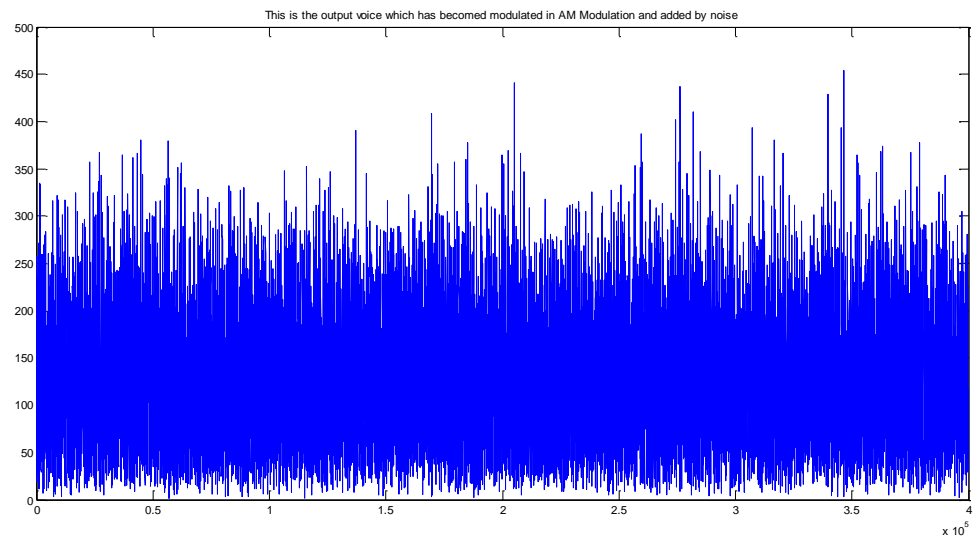
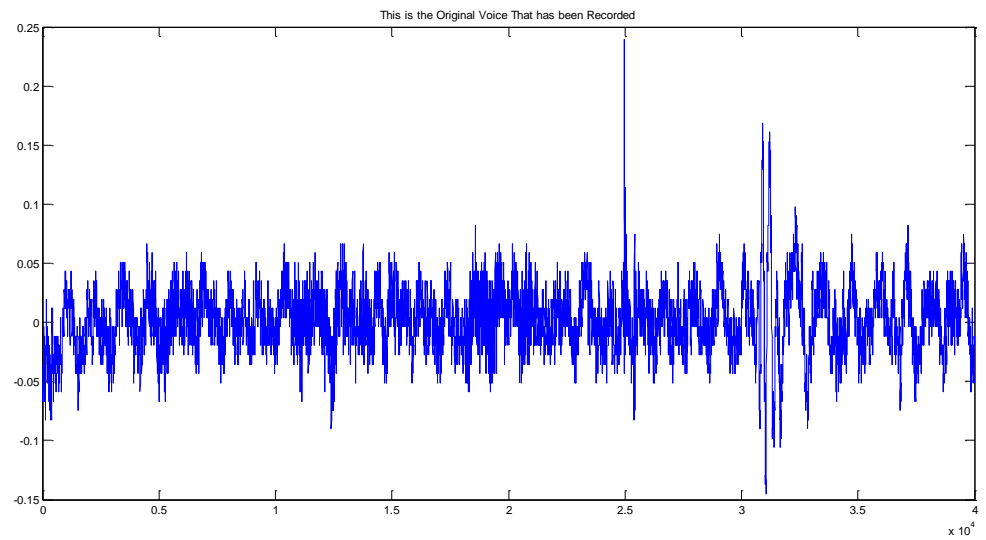
Sampling rate = 200 sample per second

Carrier frequency = 20 Hz

With Noise:



Recorded Voice with Noise and $f_c = 40KHz$ and $f_s = 800KHz$
This is the original signal (message signal that we want to send it)



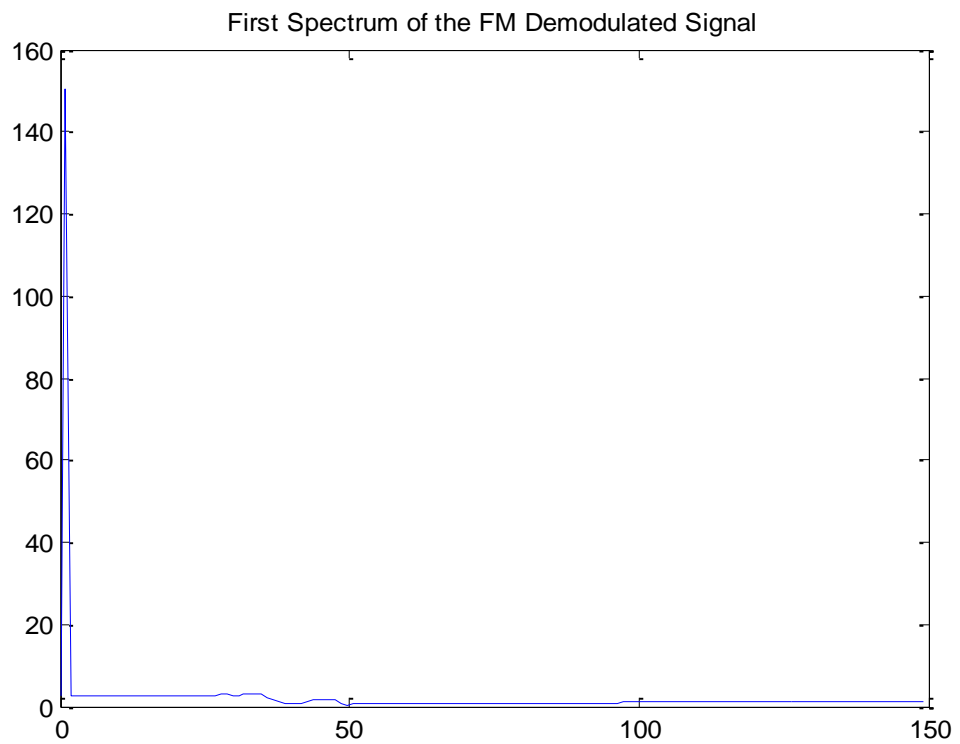
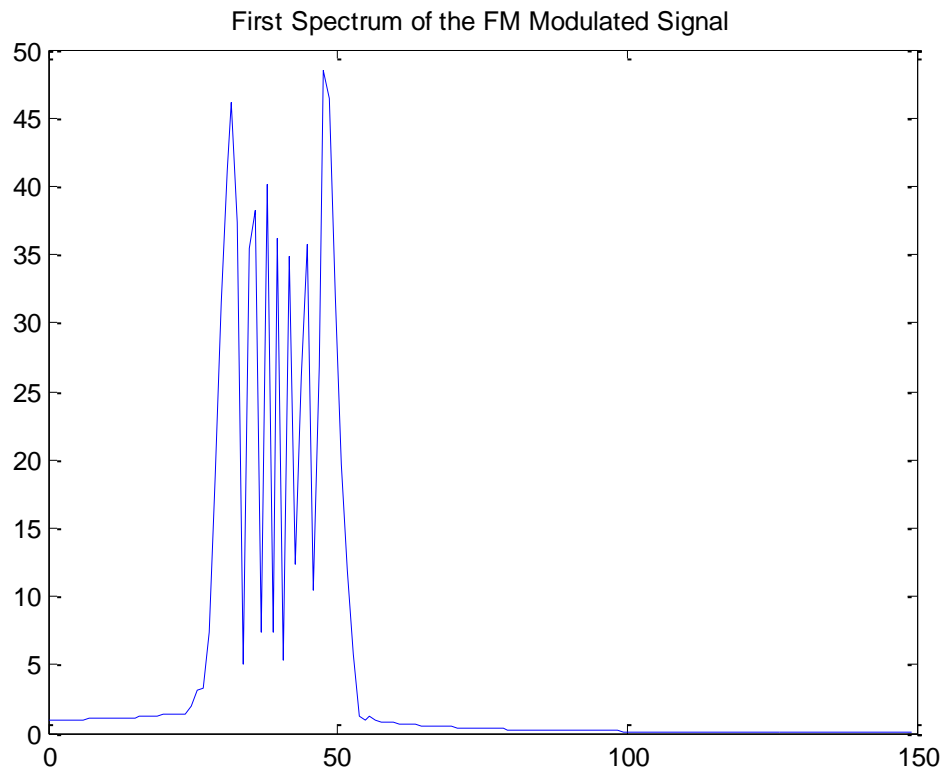
B) FM Modulation and Demodulation

Sampling rate = 300 sample per second

Carrier Frequency = 40 Hz

Frequency Deviation = 10

Without Noise:

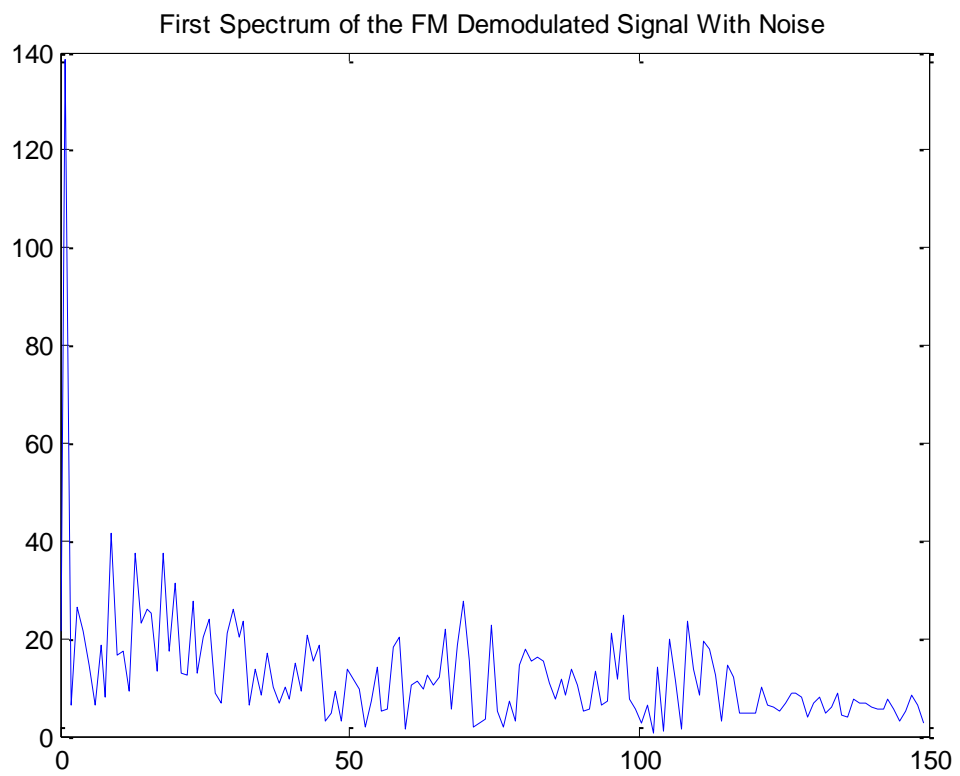
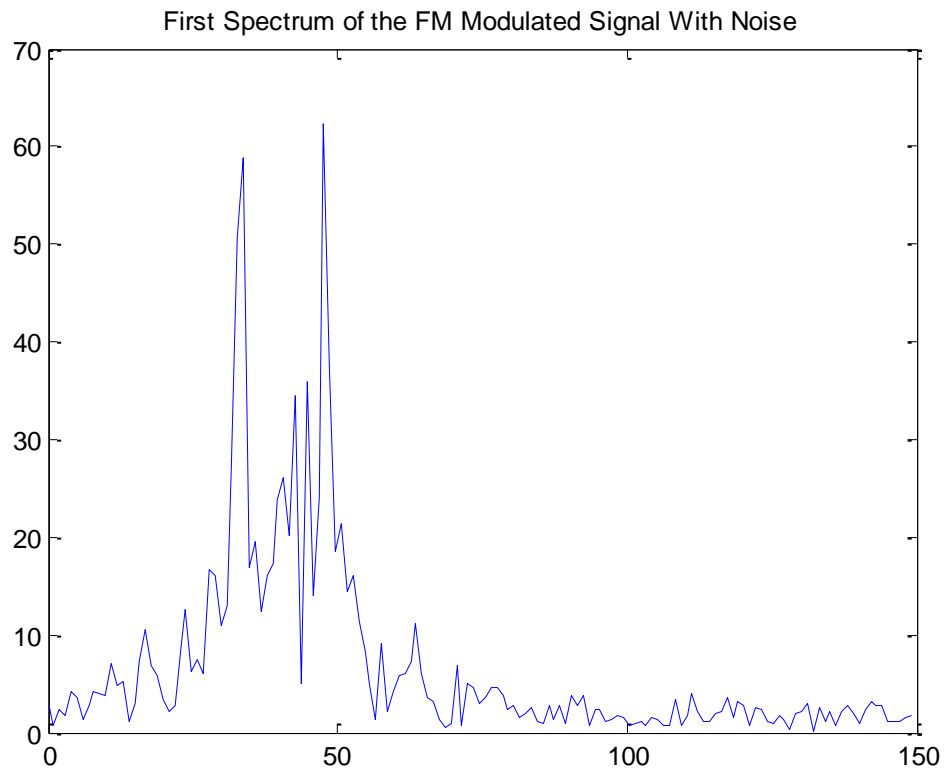


Sampling rate = 300 sample per second

Carrier Frequency = 40 Hz

Frequency Deviation = 10

With Noise:

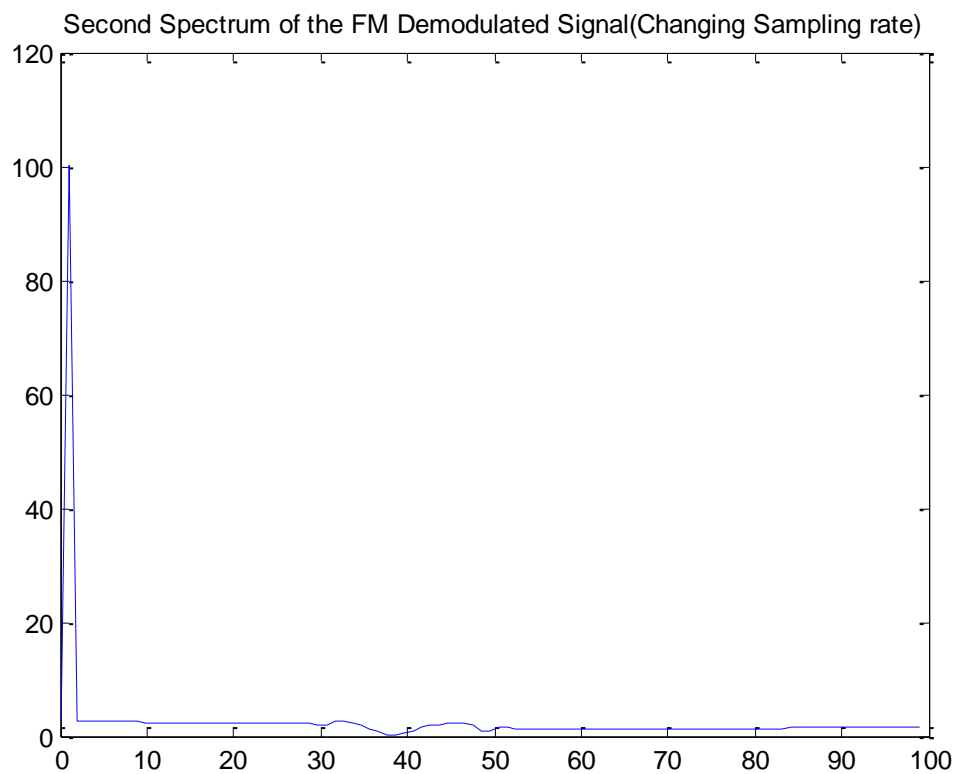
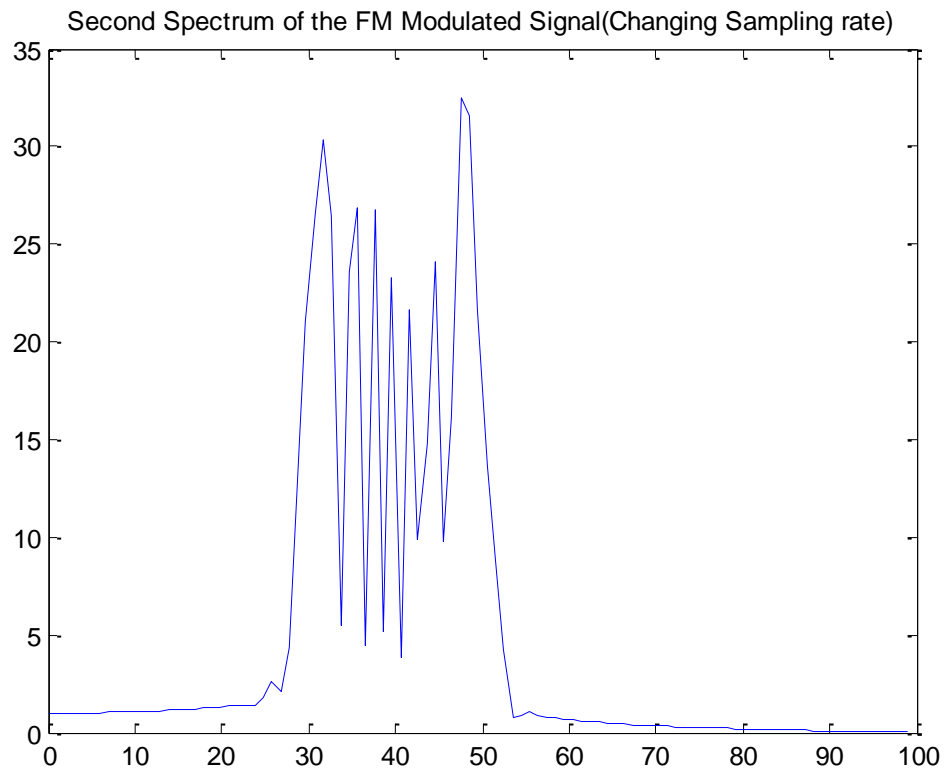


Sampling rate = 200 sample per second

Carrier Frequency = 40 Hz

Frequency Deviation = 10

Without Noise:



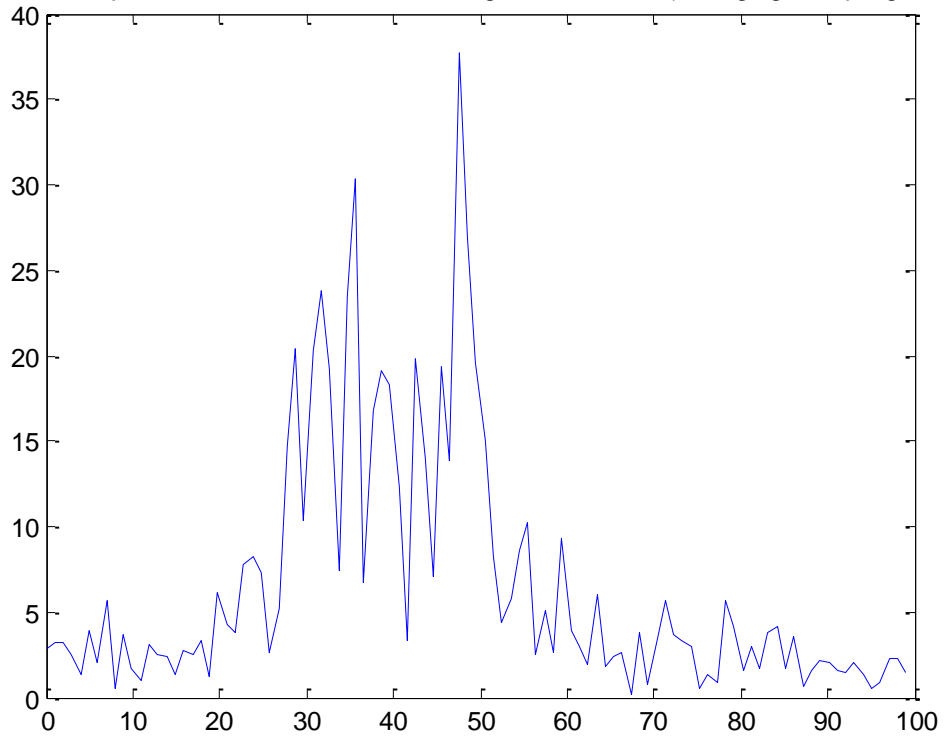
Sampling rate = 200 sample per second

Carrier Frequency = 40 Hz

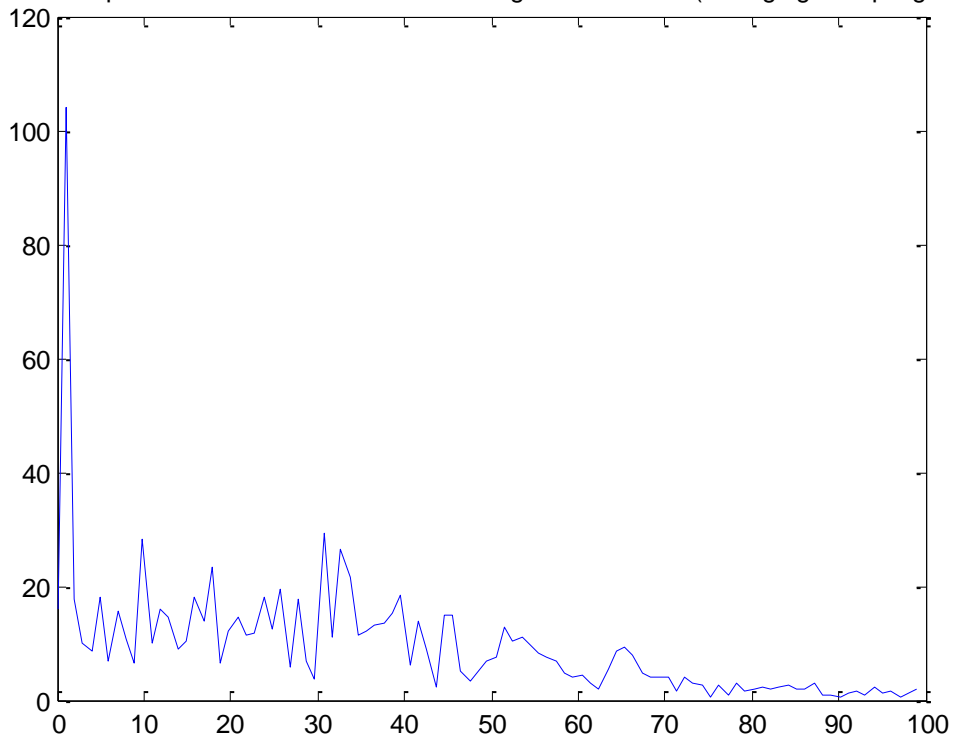
Frequency Deviation = 10

With Noise:

Second Spectrum of the FM Modulated Signal With Noise(Changing Sampling rate)



Second Spectrum of the FM Demodulated Signal With Noise(Changing Sampling rate)

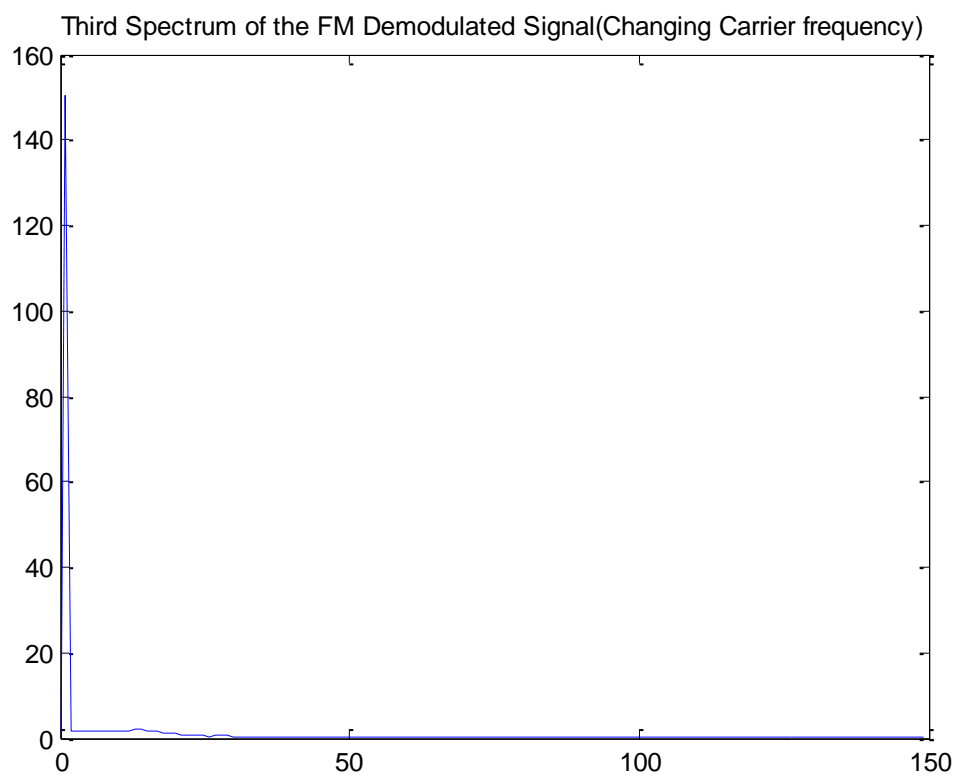
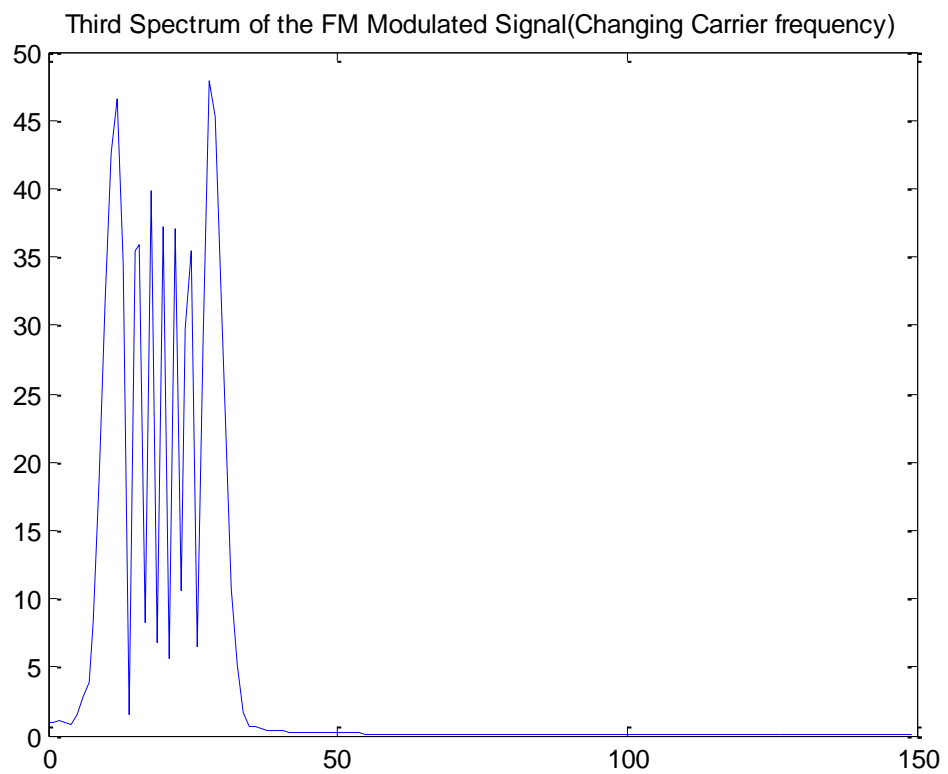


Sampling rate = 300 sample per second

Carrier Frequency = 20 Hz

Frequency Deviation = 10

Without Noise:



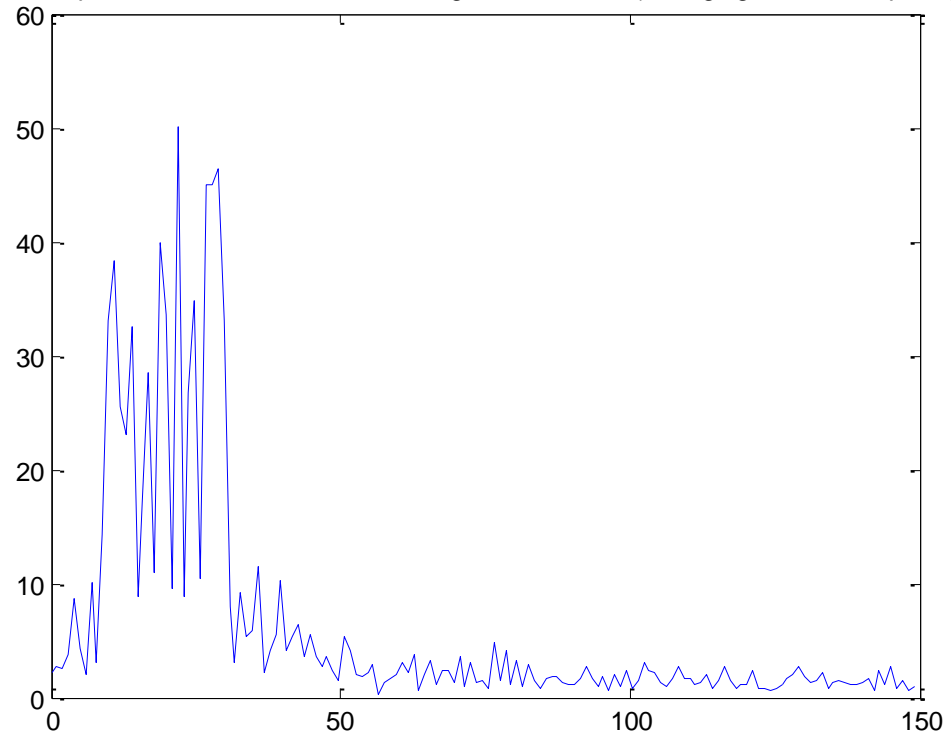
Sampling rate = 300 sample per second

Carrier Frequency = 20 Hz

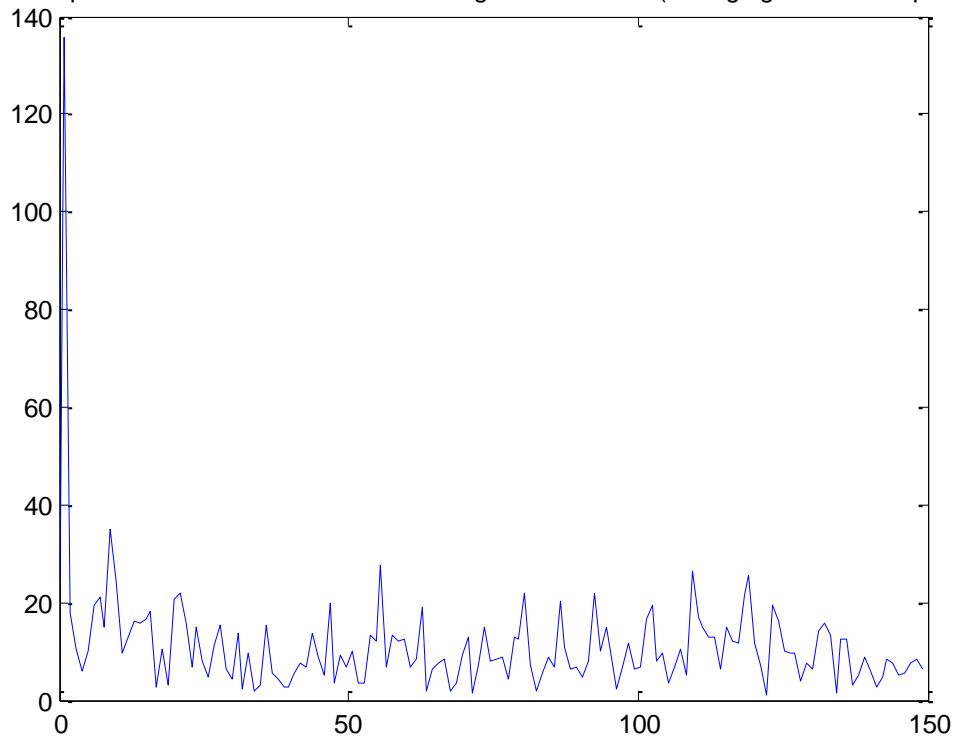
Frequency Deviation = 10

With Noise:

Third Spectrum of the FM Modulated Signal With Noise(Changing Carrier Frequency)



Third Spectrum of the FM Demodulated Signal With Noise(Changing Carrier Frequency)

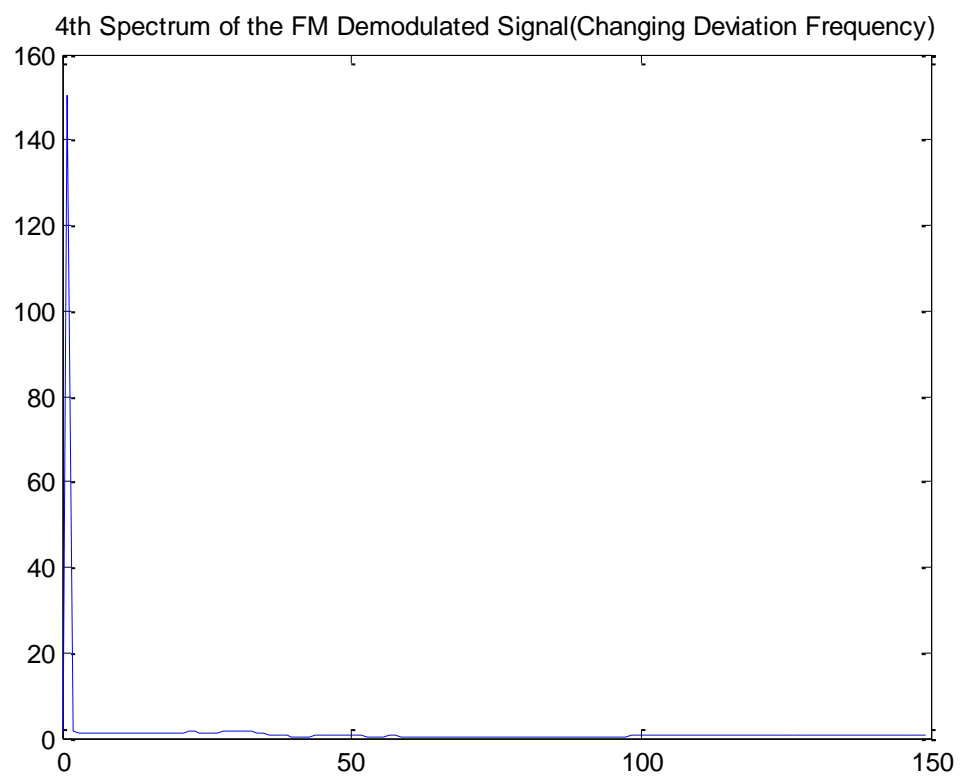
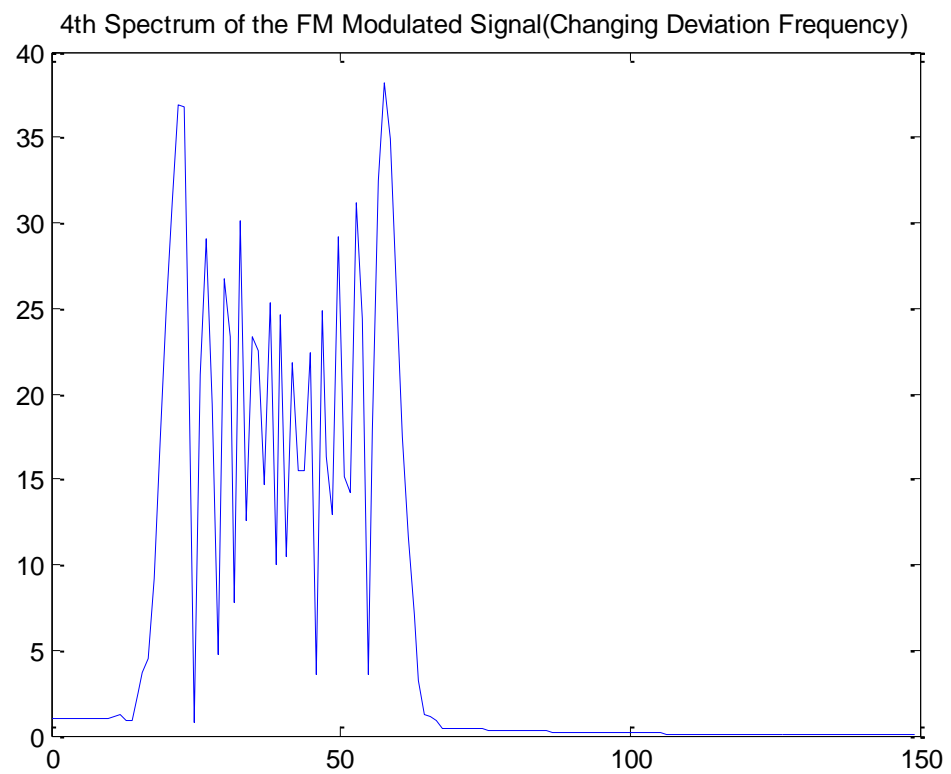


Sampling rate = 300 sample per second

Carrier Frequency = 40 Hz

Frequency Deviation = 20

Without Noise:



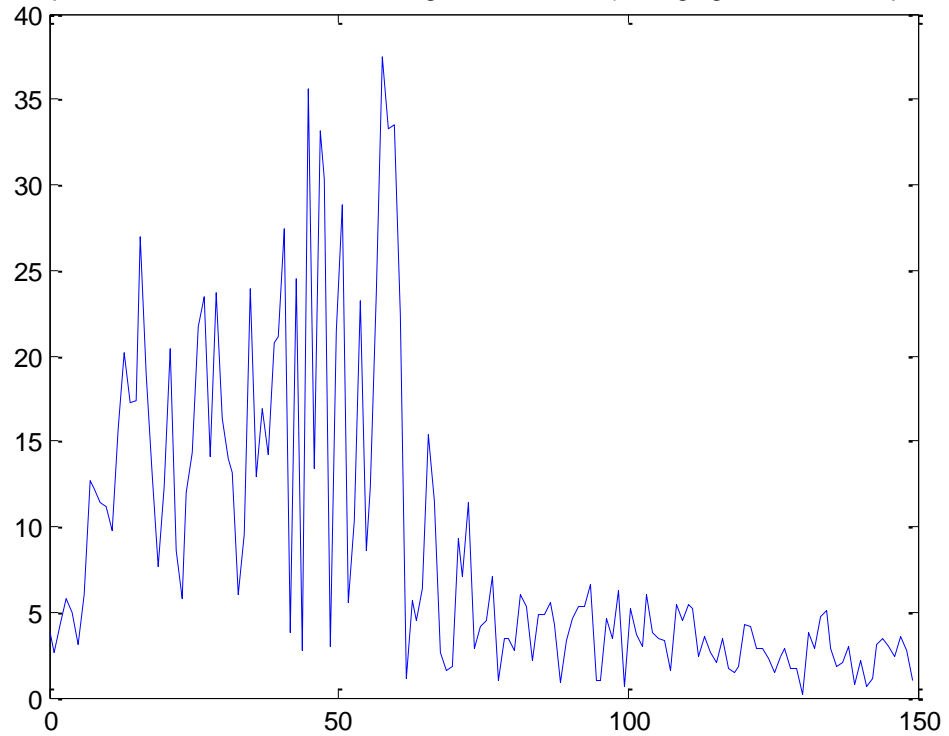
Sampling rate = 300 sample per second

Carrier Frequency = 40 Hz

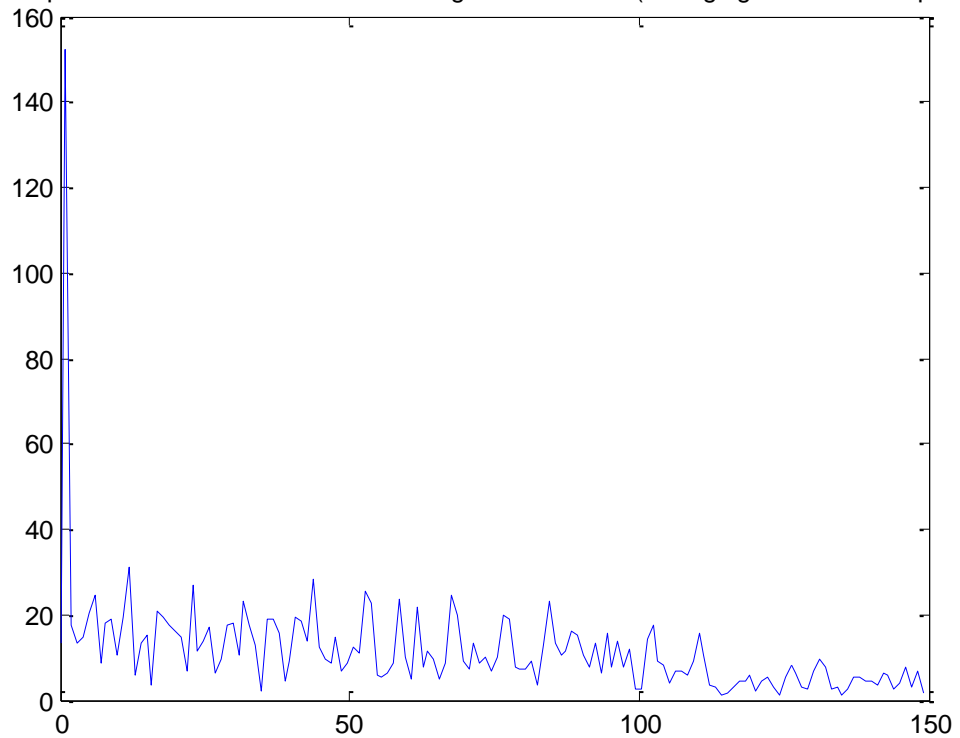
Frequency Deviation = 20

With Noise:

4th Spectrum of the FM Modulated Signal With Noise(Changing Deviation Frequency)



4th Spectrum of the FM Demodulated Signal With Noise(Changing Deviation Frequency)



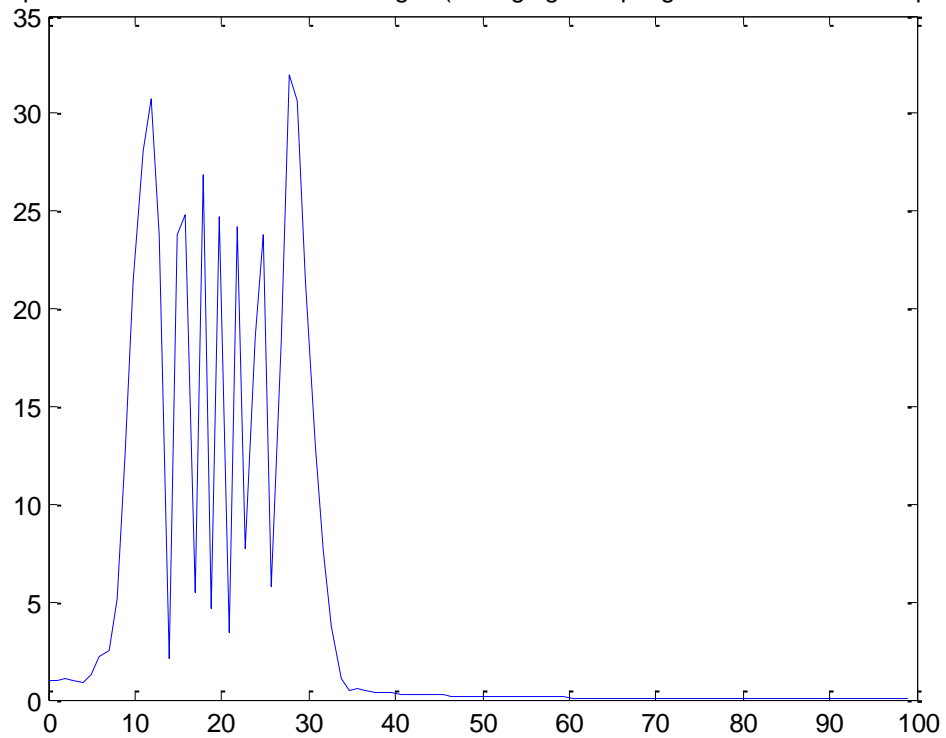
Sampling rate = 200 sample per second

Carrier Frequency = 20 Hz

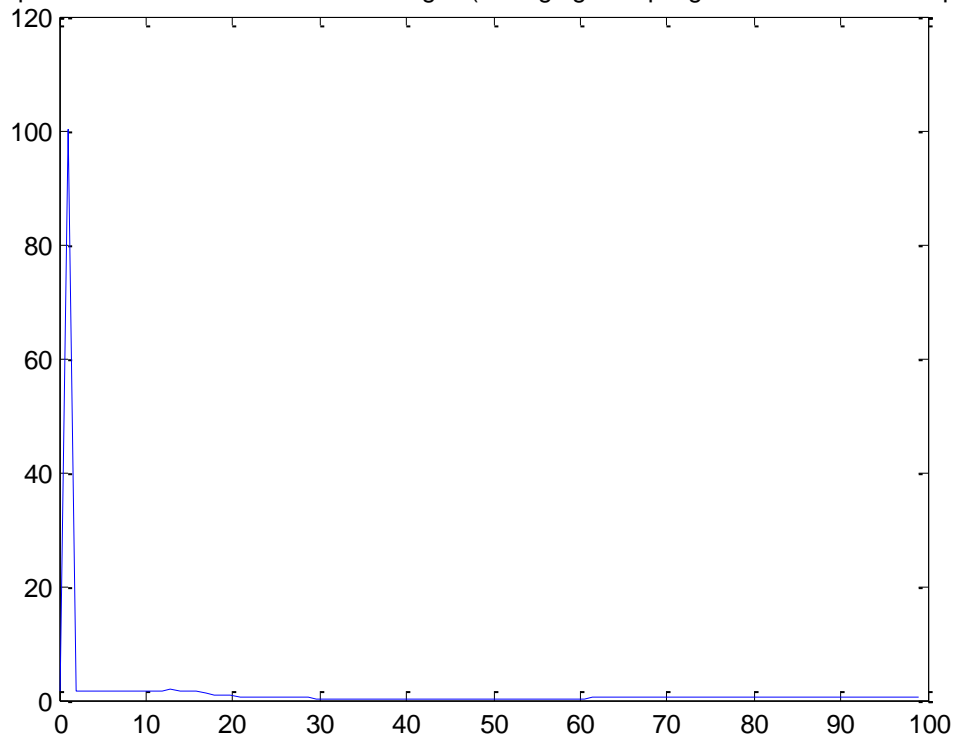
Frequency Deviation = 10

Without Noise:

5th Spectrum of the FM Modulated Signal(Changing Sampling rate and Carrier Frequency)



5th Spectrum of the FM Demodulated Signal(Changing Sampling rate and Carrier Frequency)



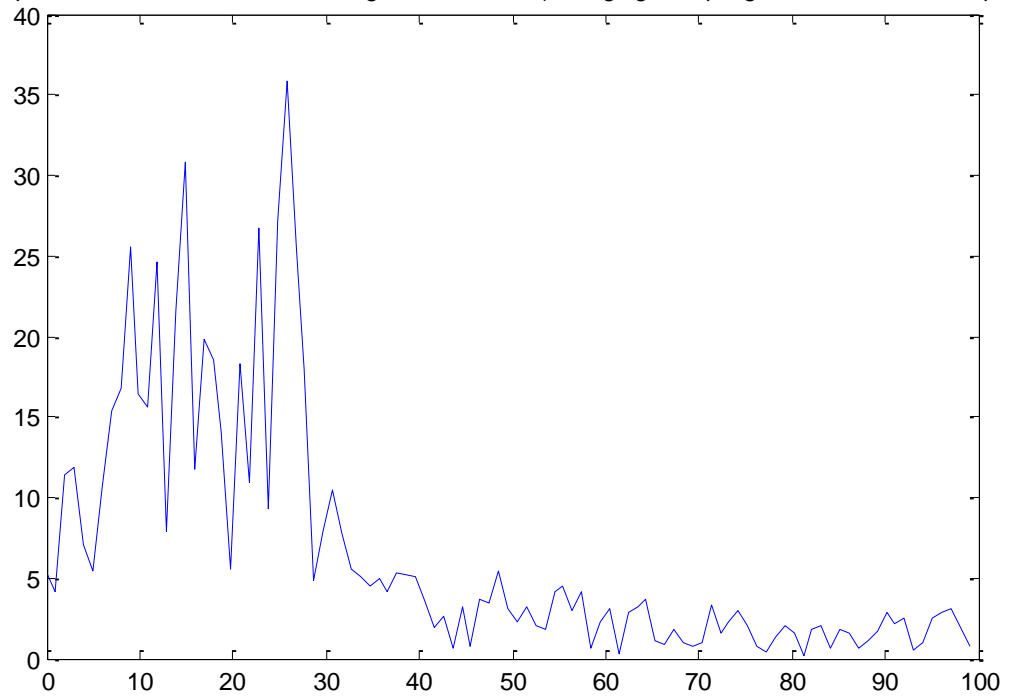
Sampling rate = 200 sample per second

Carrier Frequency = 20 Hz

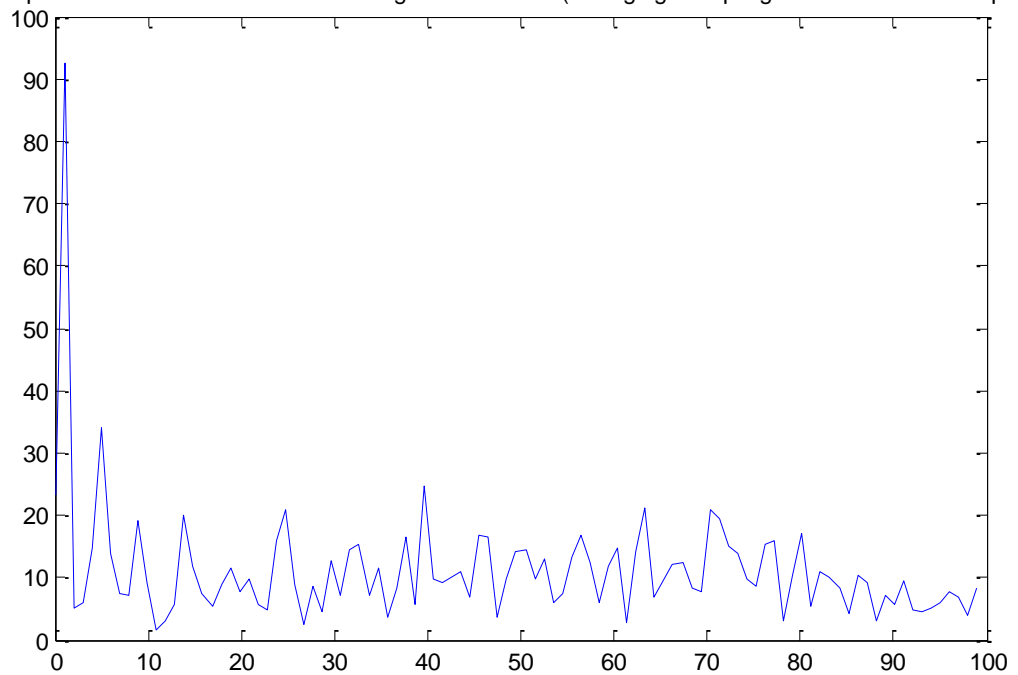
Frequency Deviation = 10

With Noise:

5th Spectrum of the FM Modulated Signal With Noise(Changing Sampling rate and Carrier Frequency)



5th Spectrum of the FM Demodulated Signal With Noise(Changing Sampling rate and Carrier Frequency)



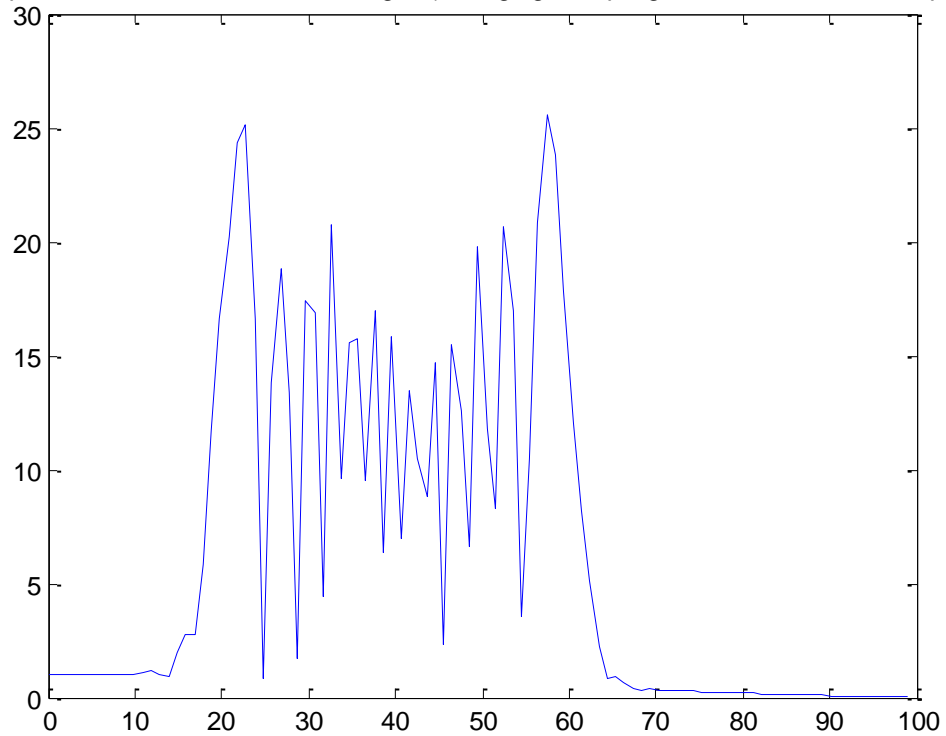
Sampling rate = 200 sample per second

Carrier Frequency = 40 Hz

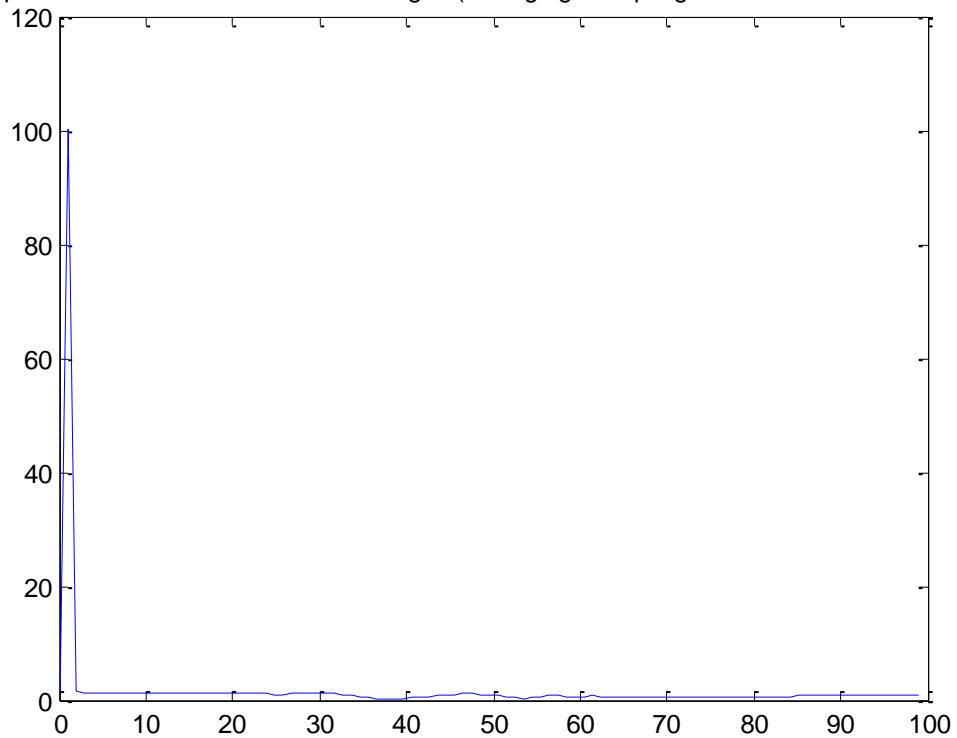
Frequency Deviation = 20

Without Noise:

6th Spectrum of the FM Modulated Signal(Changing Sampling rate and Deviation Frequency)



6th Spectrum of the FM Demodulated Signal(Changing Sampling rate and Deviation Frequency)



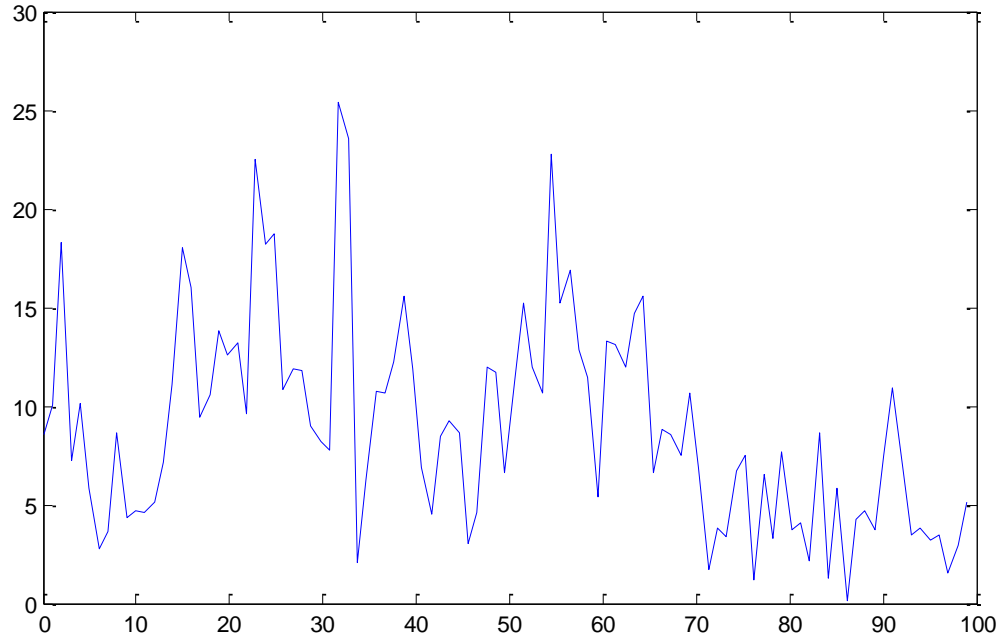
Sampling rate = 200 sample per second

Carrier Frequency = 40 Hz

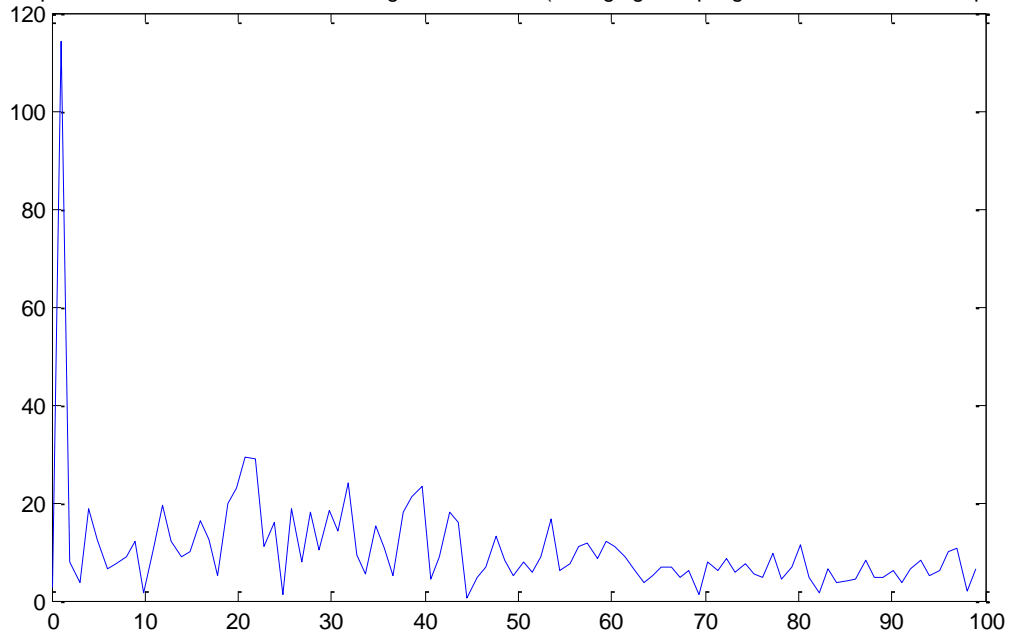
Frequency Deviation = 20

With Noise:

6th Spectrum of the FM Modulated Signal With Noise(Changing Sampling rate and Deviation Frequency)



6th Spectrum of the FM Demodulated Signal With Noise(Changing Sampling rate and Deviation Frequency)



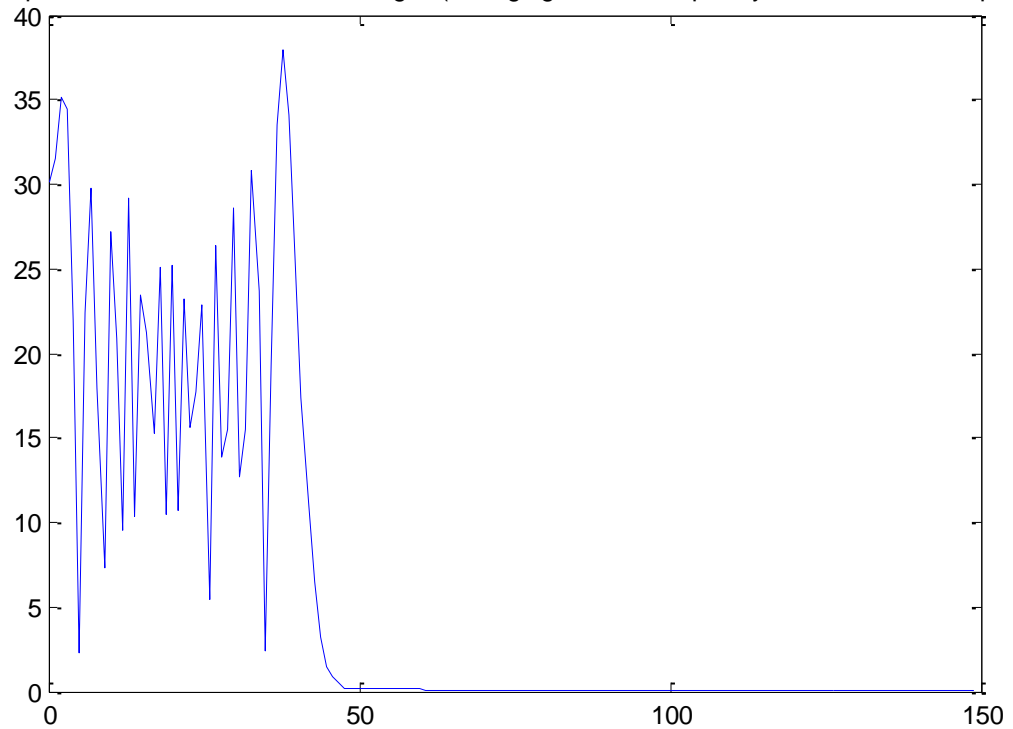
Sampling rate = 300 sample per second

Carrier Frequency = 20 Hz

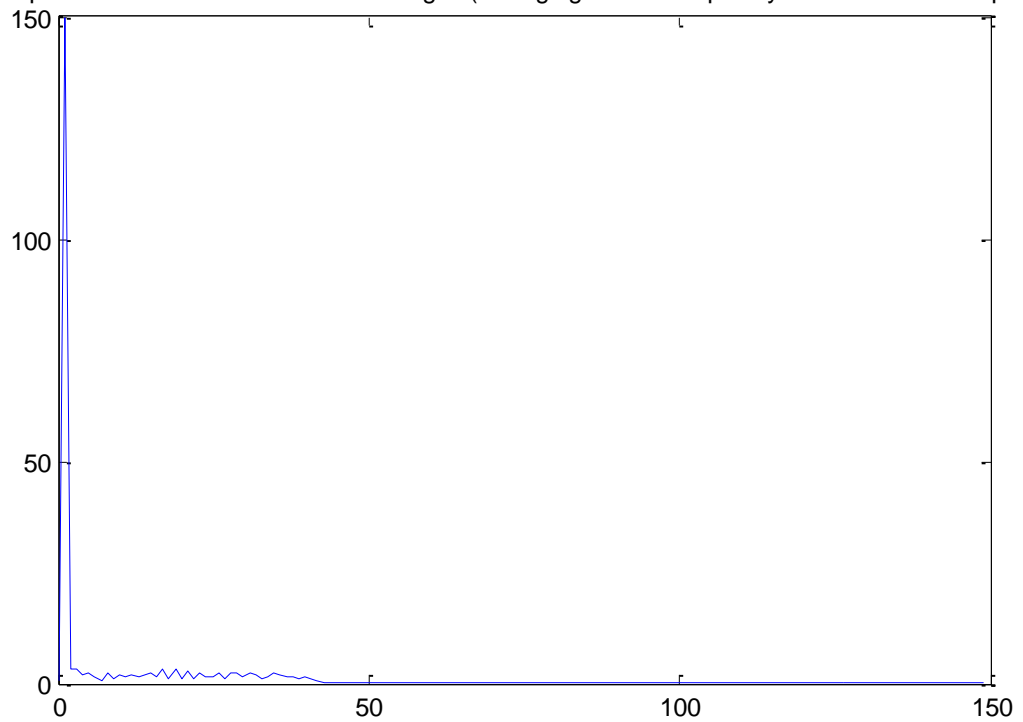
Frequency Deviation = 20

Without Noise:

7th Spectrum of the FM Modulated Signal(Changing Carrier Frequency and Deviation Frequency)



7th Spectrum of the FM Demodulated Signal(Changing Carrier frequency and Deviation Frequency)



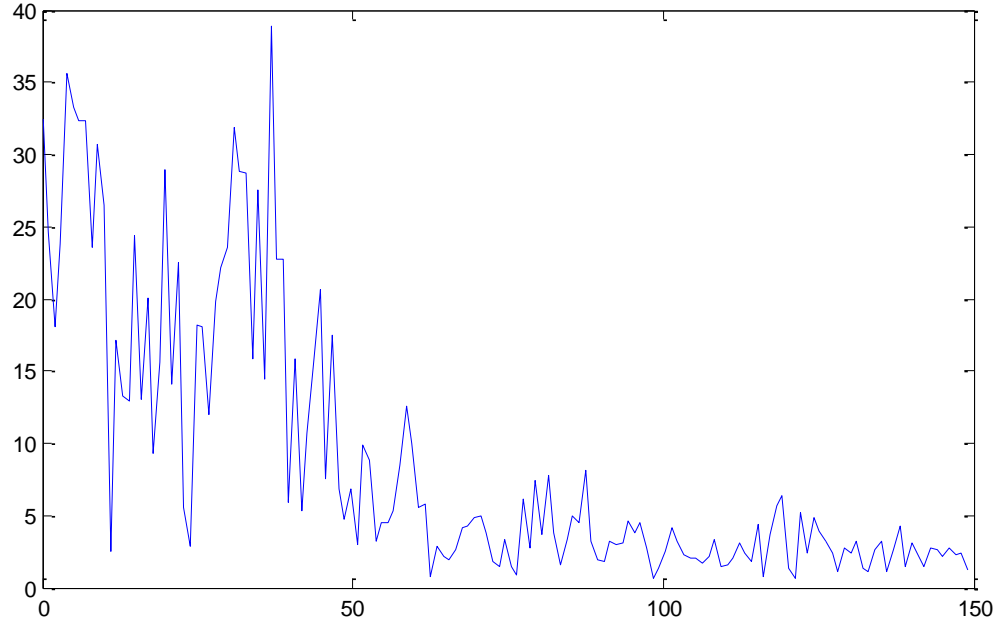
Sampling rate = 300 sample per second

Carrier Frequency = 20 Hz

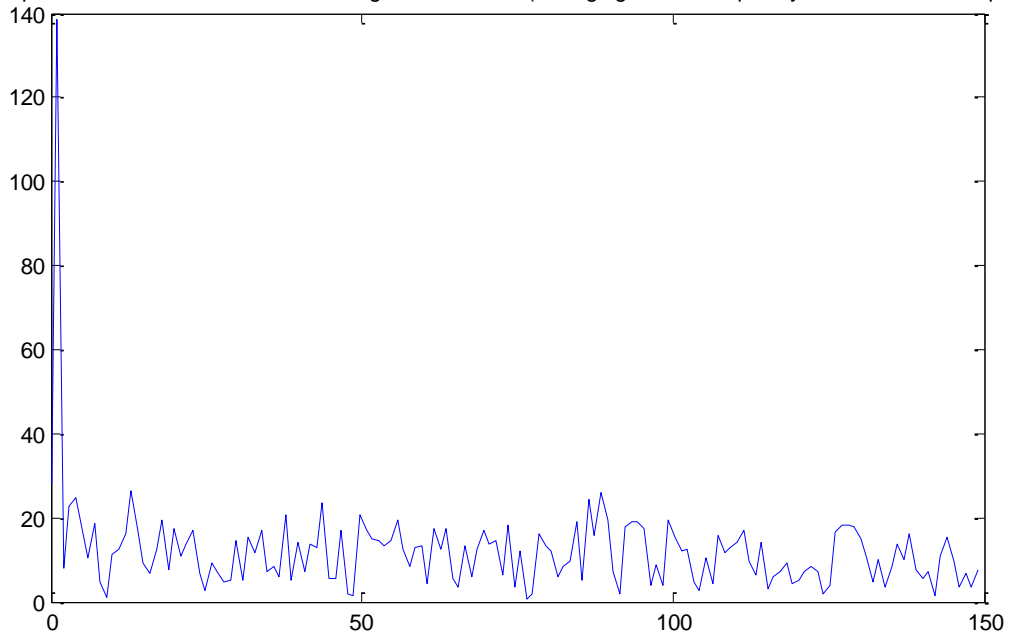
Frequency Deviation = 20

With Noise:

7th Spectrum of the FM Modulated Signal With Noise(Changing Carrier Frequency and Deviation Frequency)



7th Spectrum of the FM Demodulated Signal With Noise(Changing Carrier frequency and Deviation Frequency)

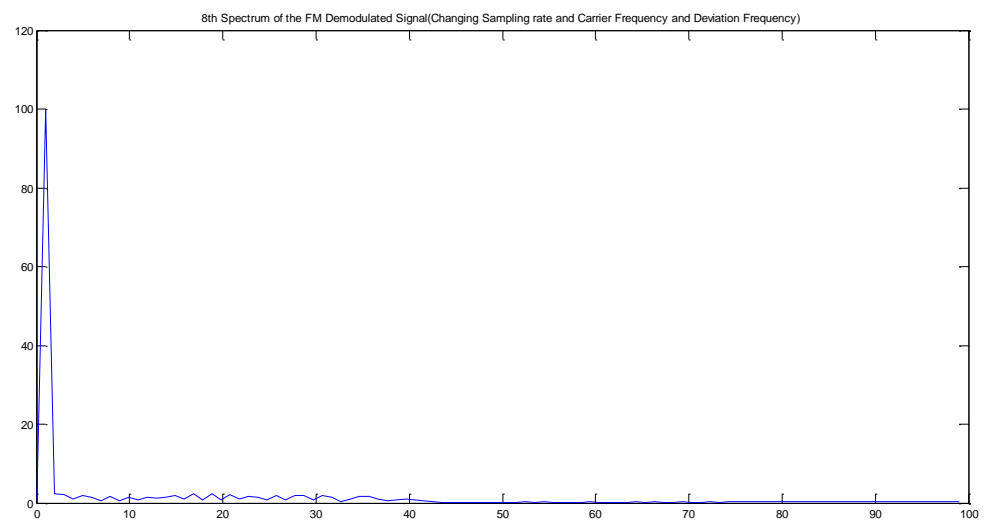
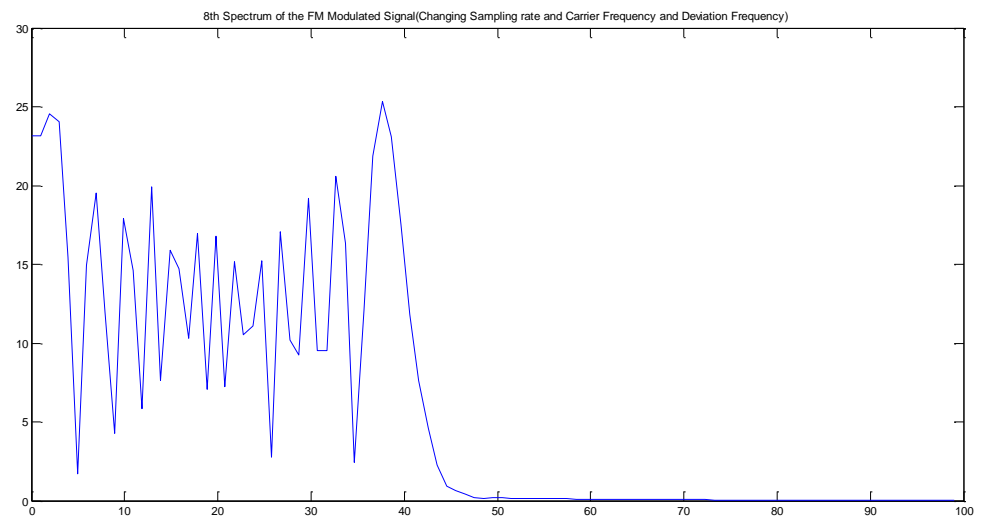


Sampling rate = 200 sample per second

Carrier Frequency = 20 Hz

Frequency Deviation = 20

Without Noise:



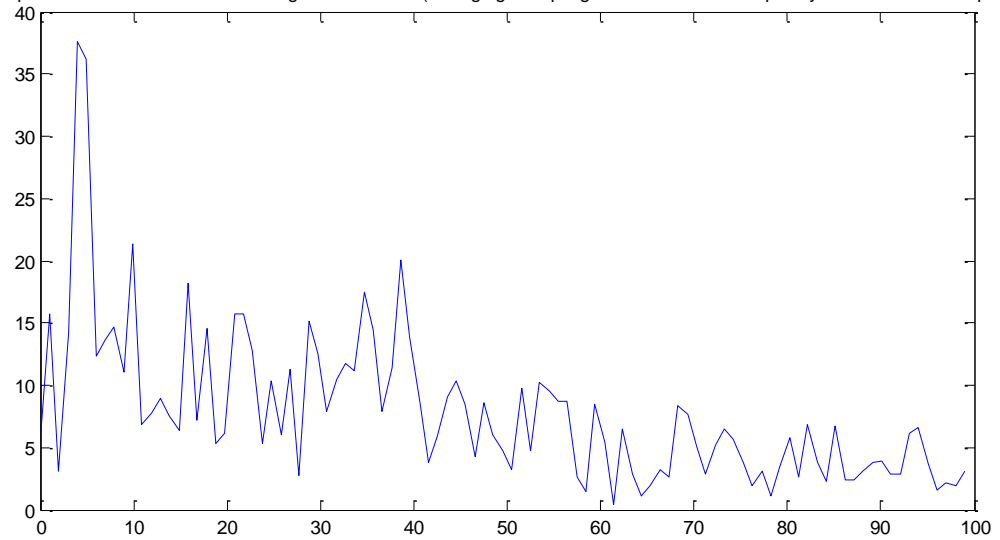
Sampling rate = 200 sample per second

Carrier Frequency = 20 Hz

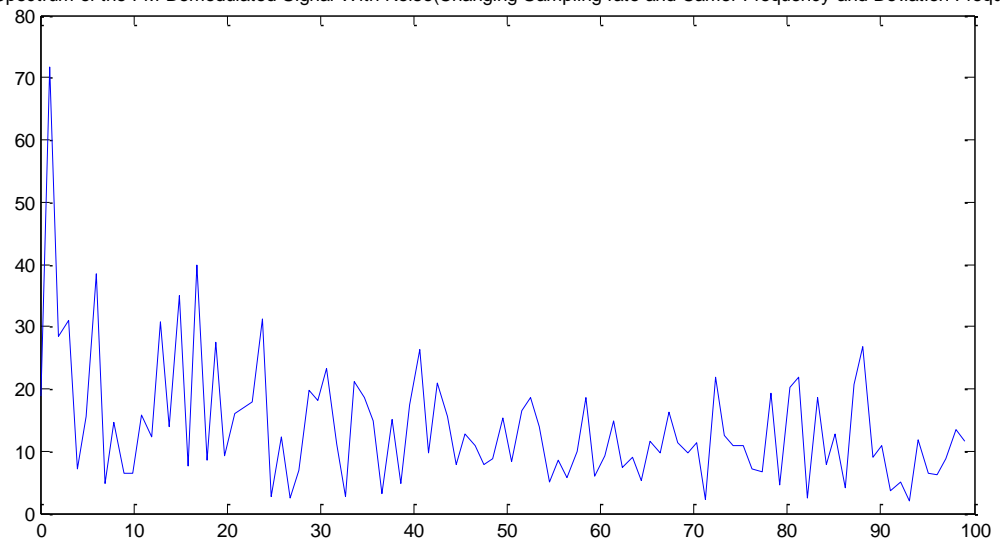
Frequency Deviation = 20

With Noise:

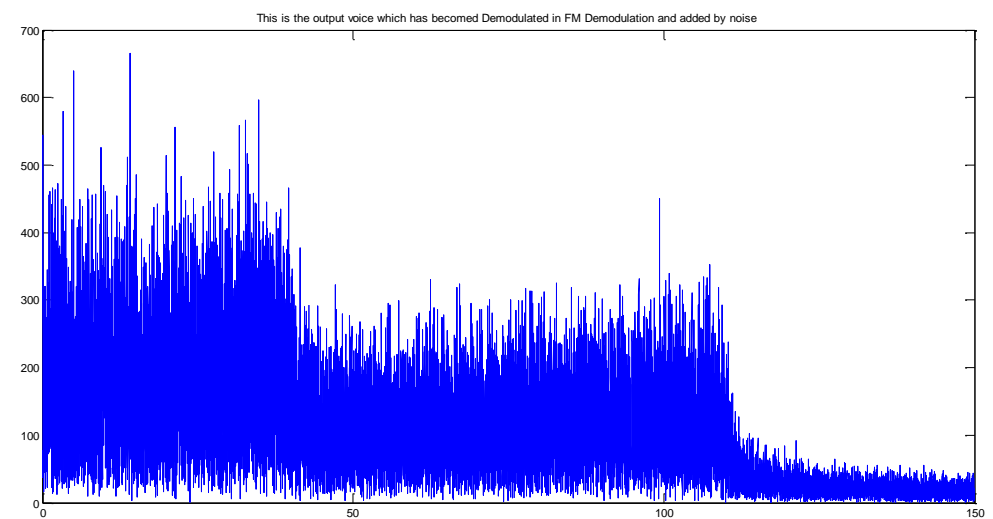
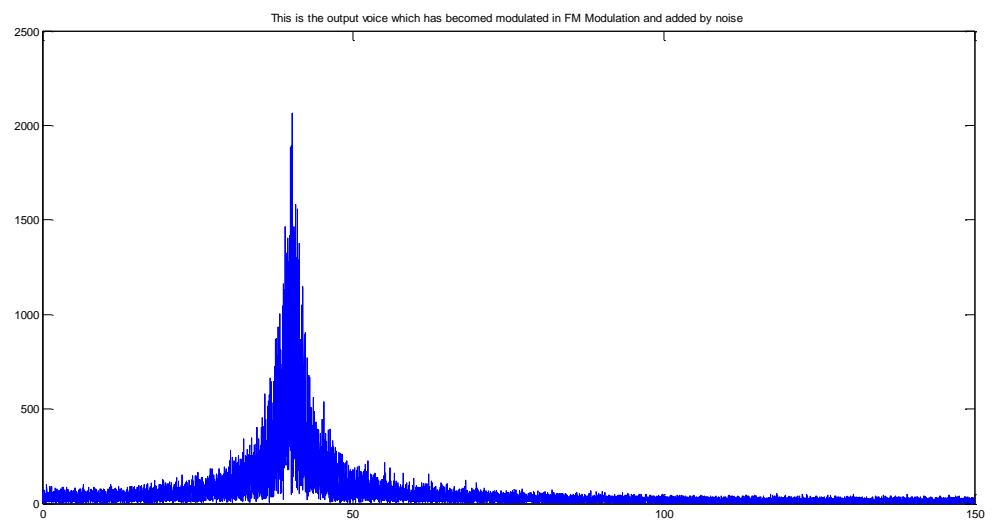
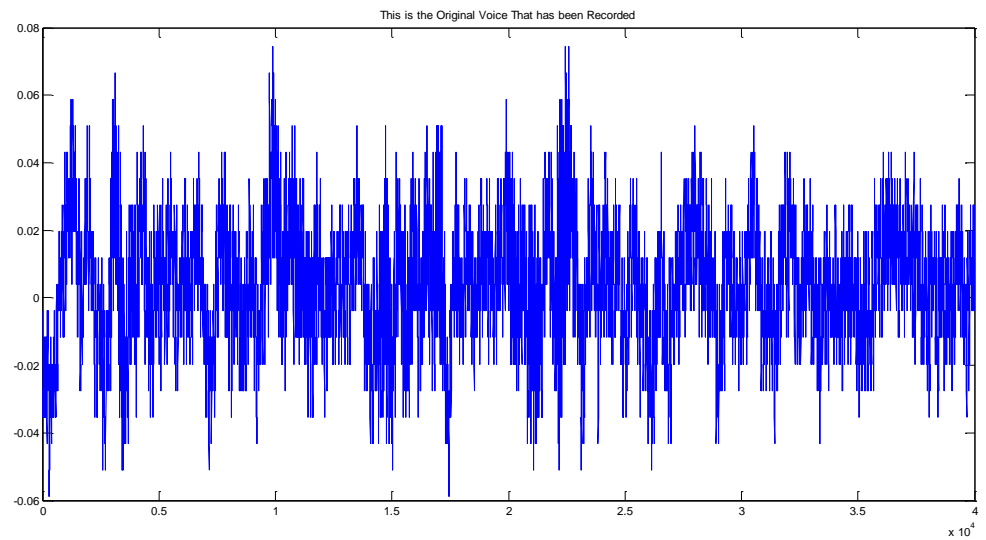
8th Spectrum of the FM Modulated Signal With Noise(Changing Sampling rate and Carrier Frequency and Deviation Frequency)



8th Spectrum of the FM Demodulated Signal With Noise(Changing Sampling rate and Carrier Frequency and Deviation Frequency)



**Recorded Voice with Noise and $f_c = 40 \text{ Hz}$ and $f_s = 300 \text{ sample per second}$
And Frequency Deviation = 10**



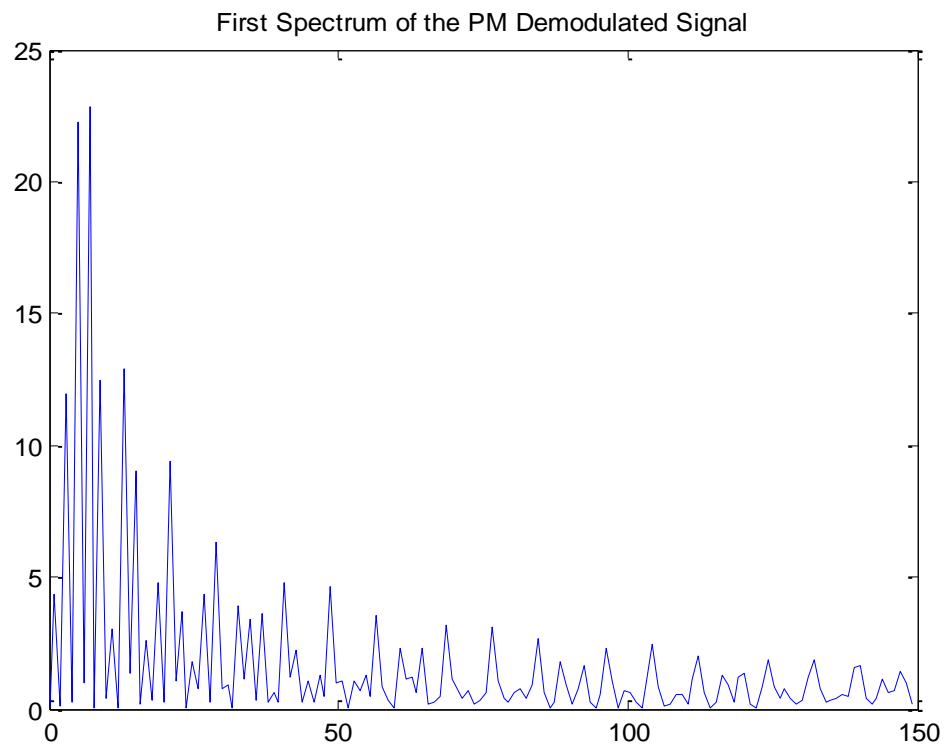
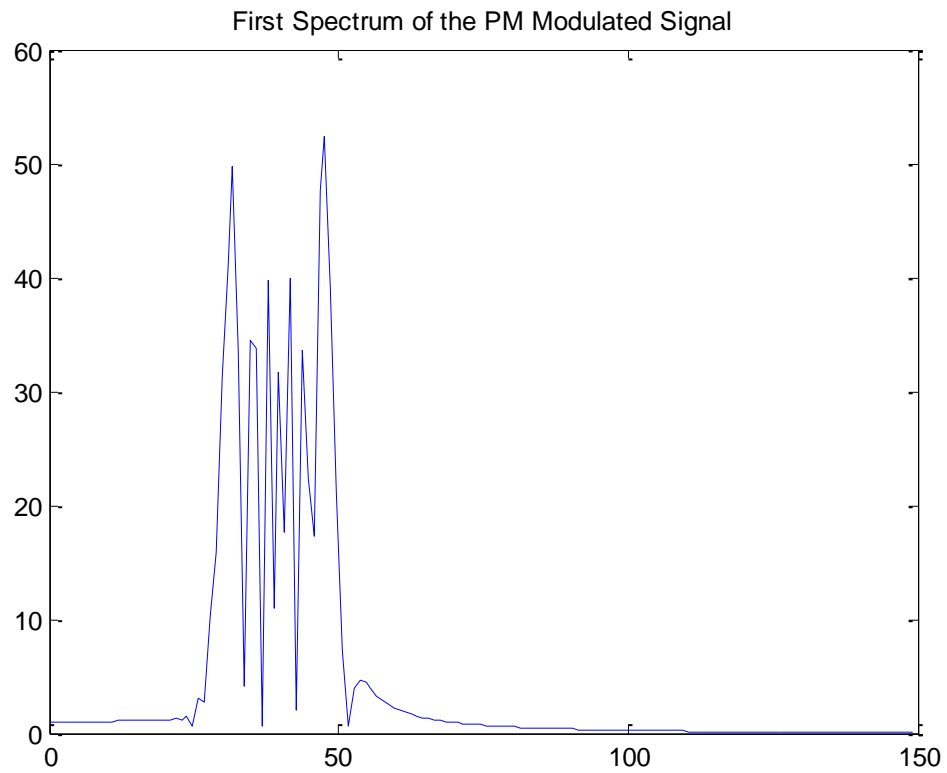
C) PM Modulation and Demodulation

Sampling rate = 300 sample per second

Carrier Frequency = 40 Hz

Phase Deviation = 10

Without Noise:

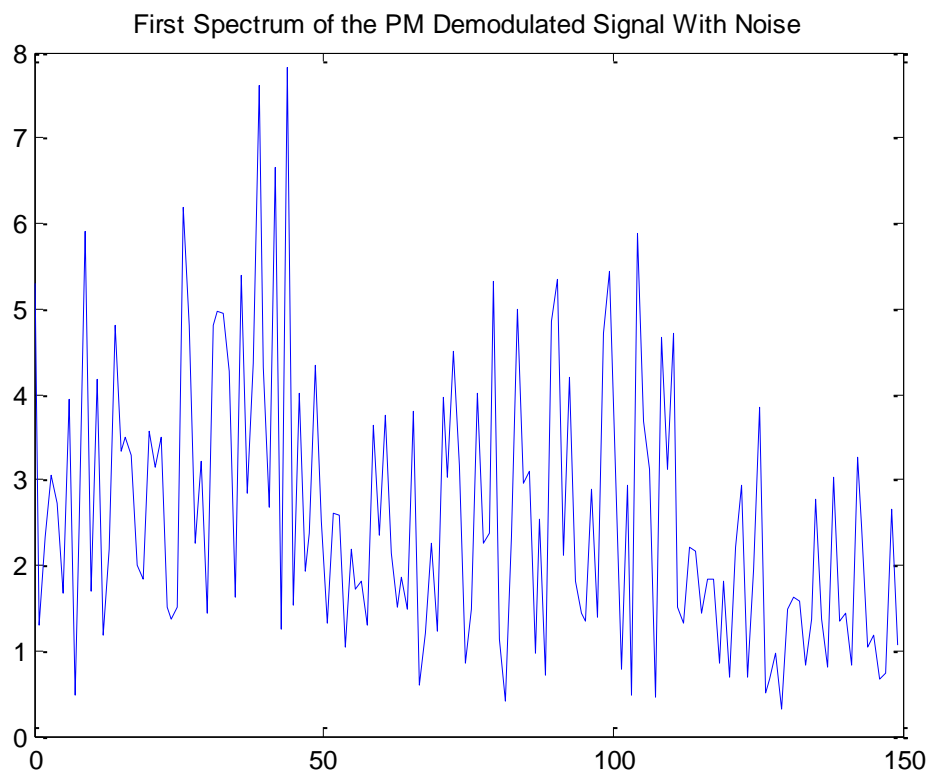
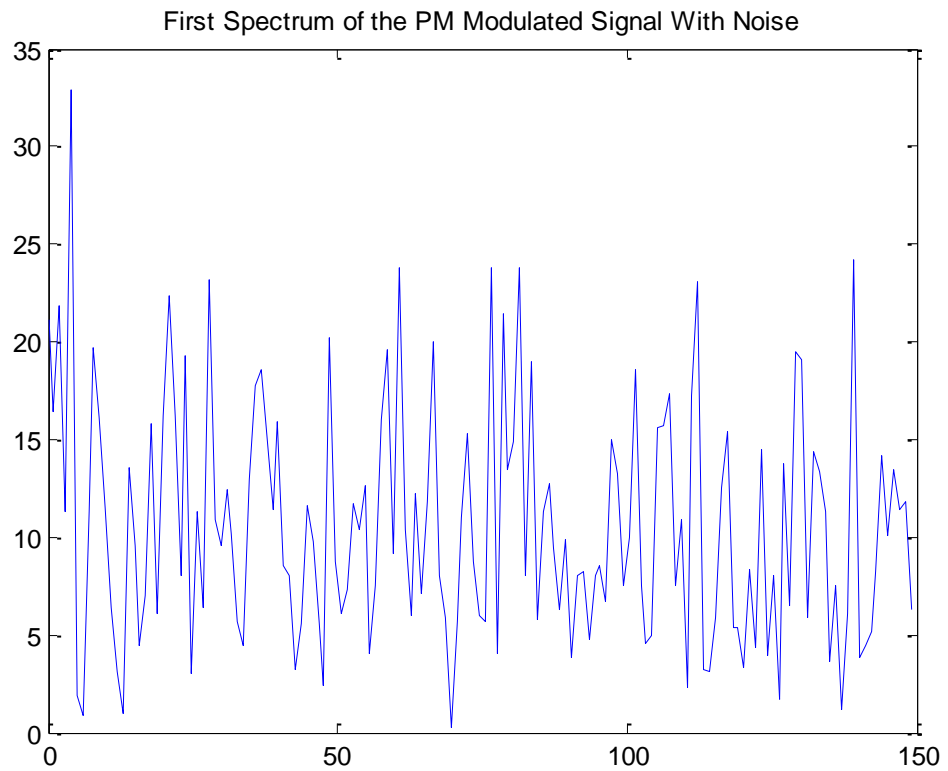


Sampling rate = 300 sample per second

Carrier Frequency = 40 Hz

Phase Deviation = 10

With Noise:

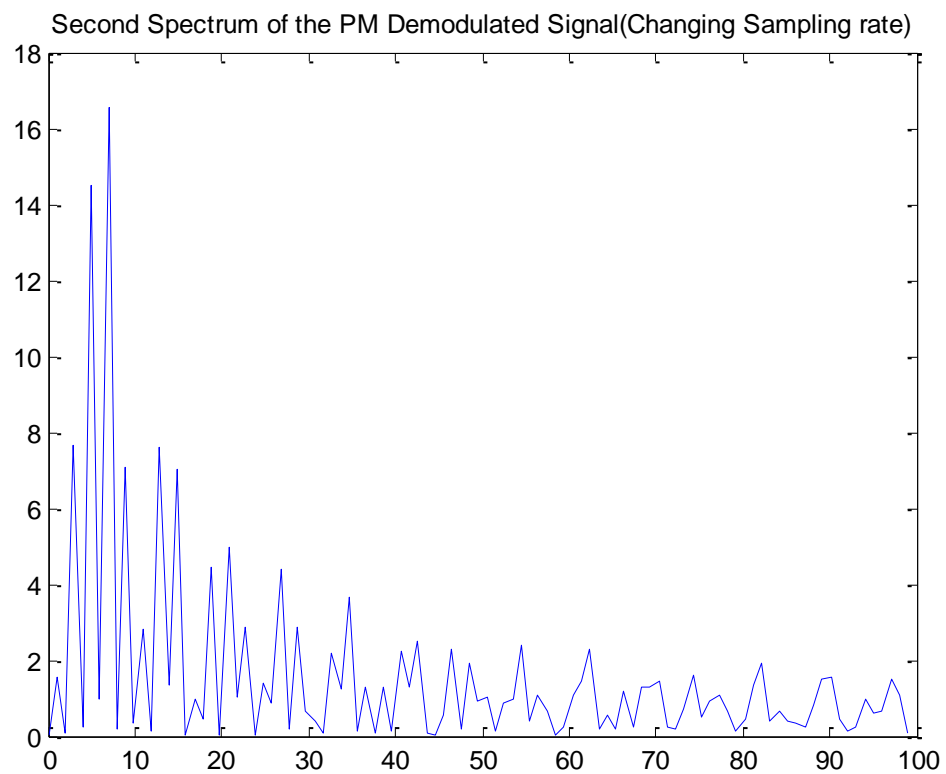
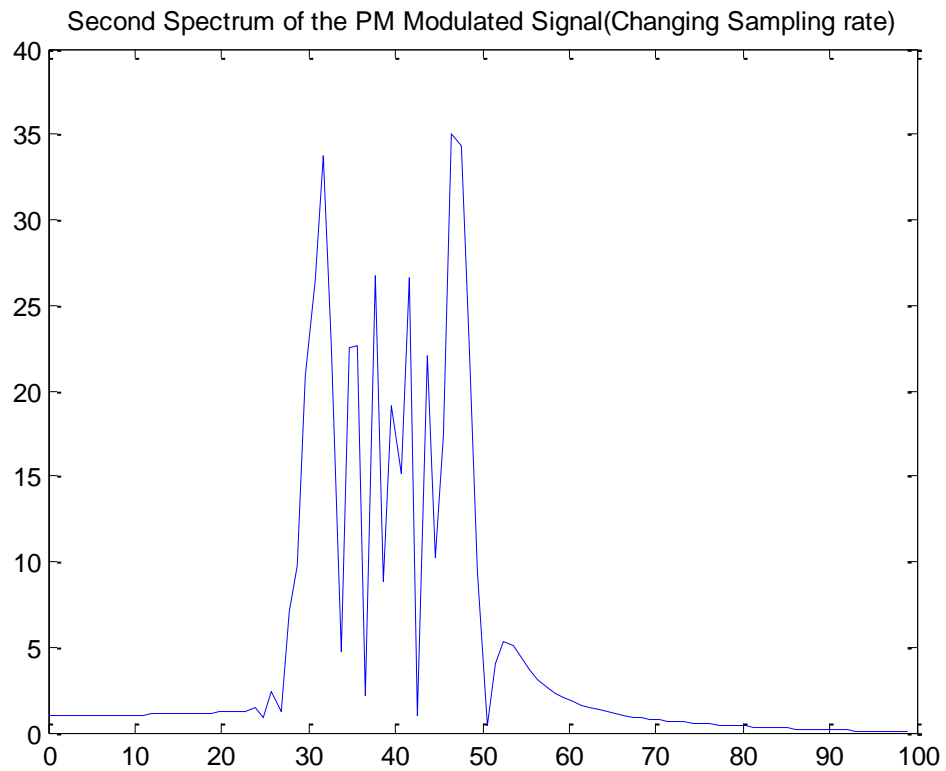


Sampling rate = 200 sample per second

Carrier Frequency = 40 Hz

Frequency Deviation = 10

Without Noise:



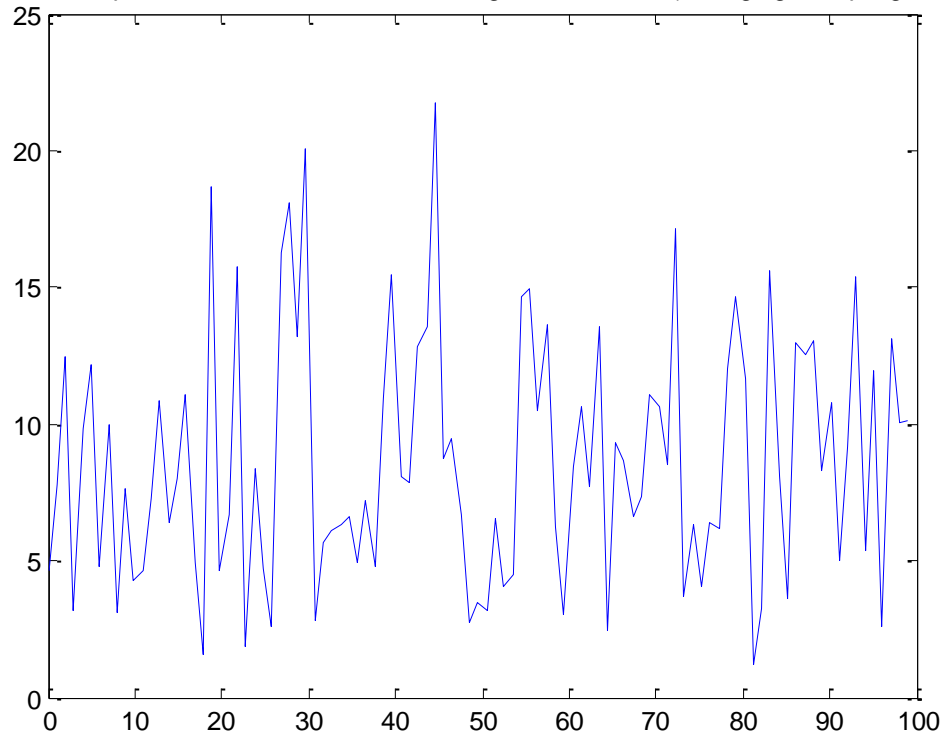
Sampling rate = 200 sample per second

Carrier Frequency = 40 Hz

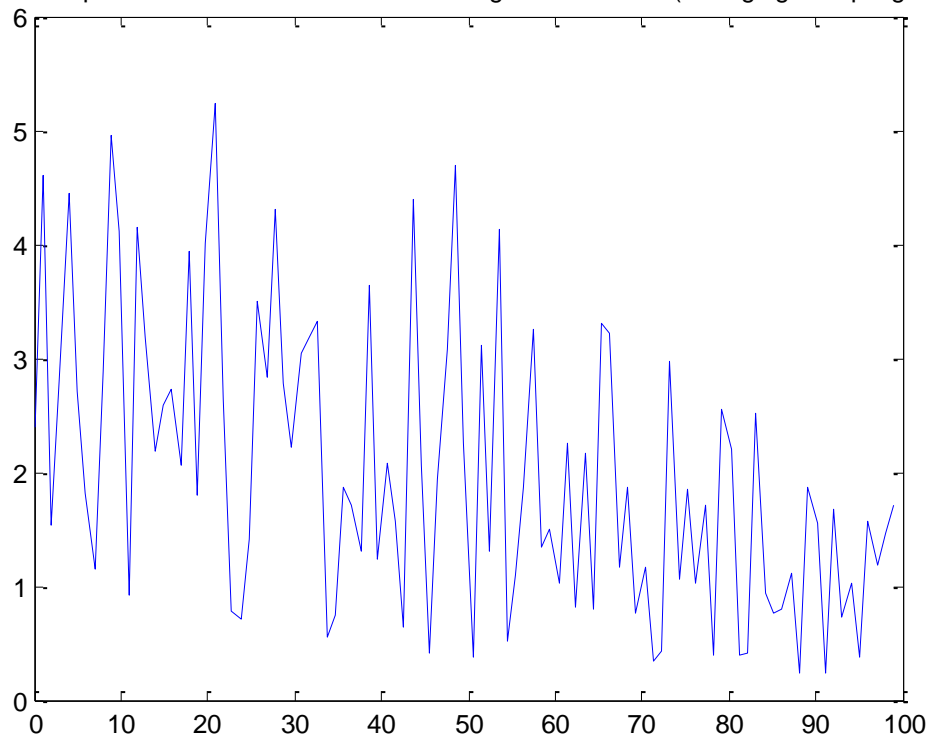
Frequency Deviation = 10

With Noise:

Second Spectrum of the PM Modulated Signal With Noise(Changing Sampling rate)



Second Spectrum of the PM Demodulated Signal With Noise(Changing Sampling rate)

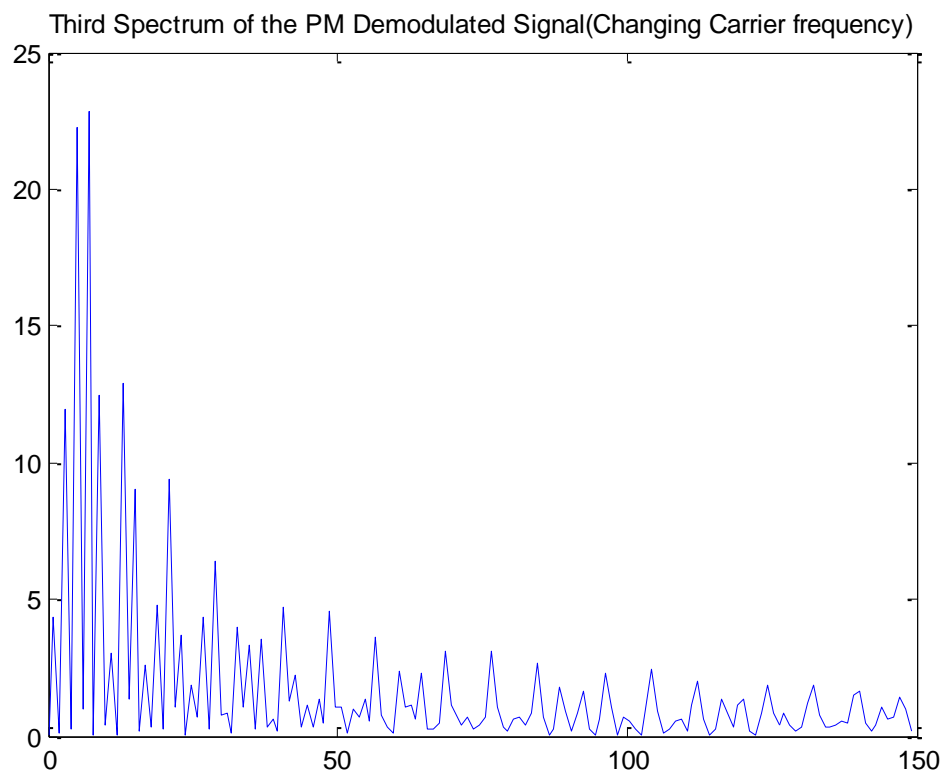
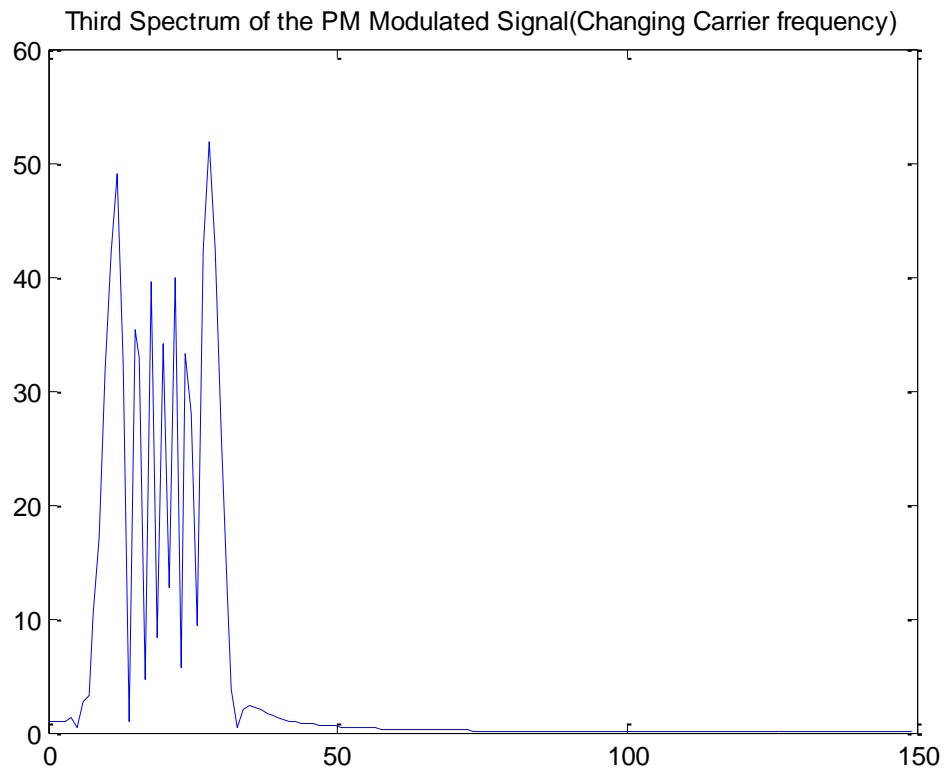


Sampling rate = 300 sample per second

Carrier Frequency = 20 Hz

Frequency Deviation = 10

Without Noise:



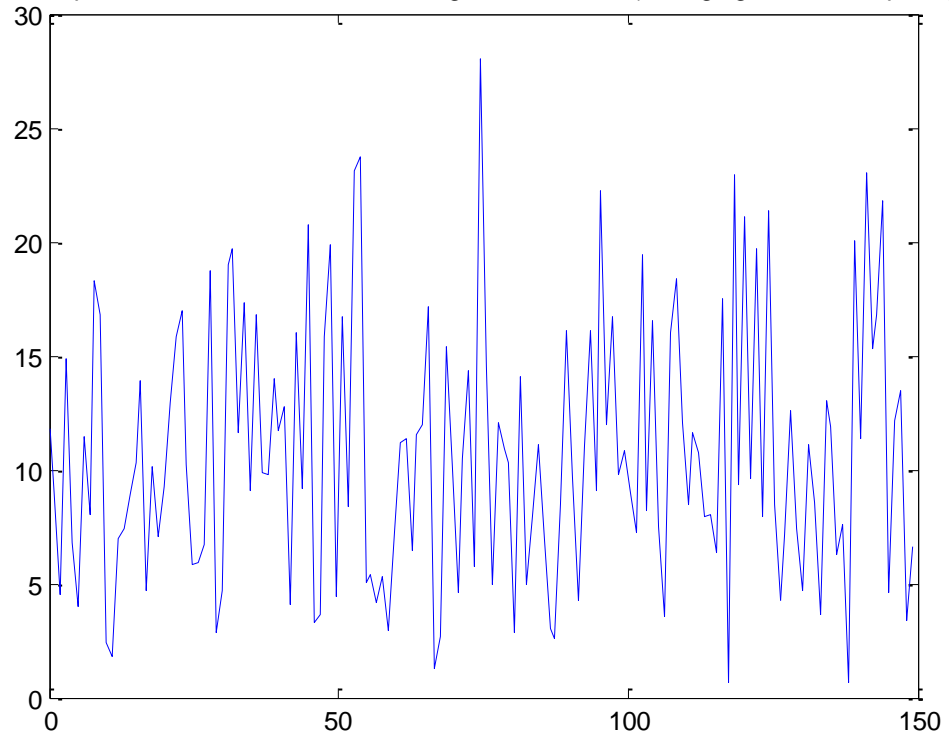
Sampling rate = 300 sample per second

Carrier Frequency = 20 Hz

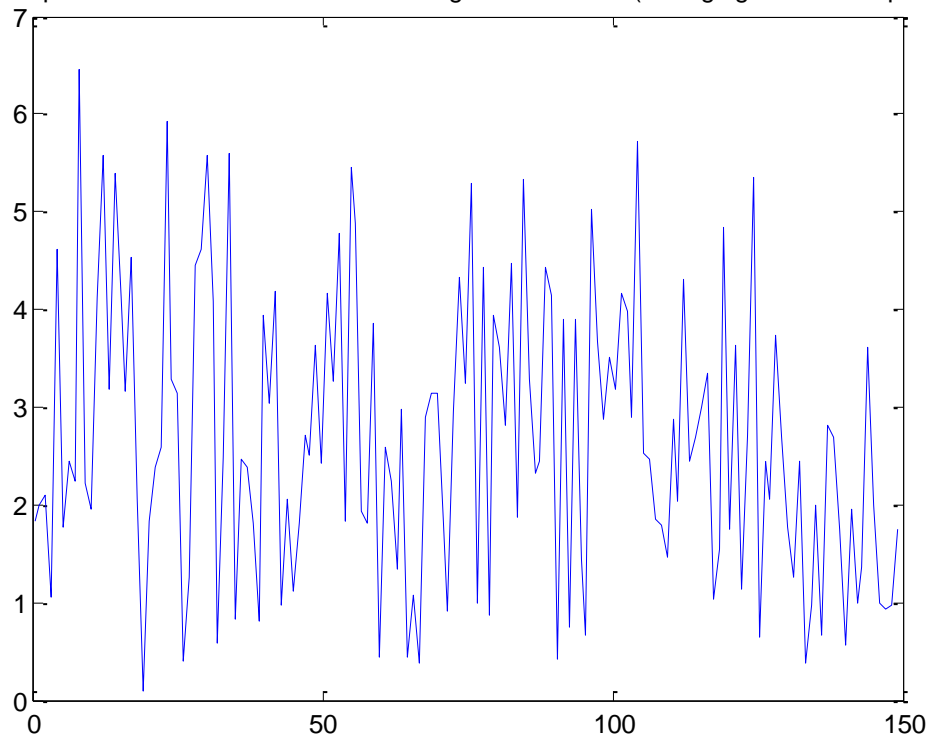
Frequency Deviation = 10

With Noise:

Third Spectrum of the PM Modulated Signal With Noise(Changing Carrier Frequency)



Third Spectrum of the PM Demodulated Signal With Noise(Changing Carrier Frequency)

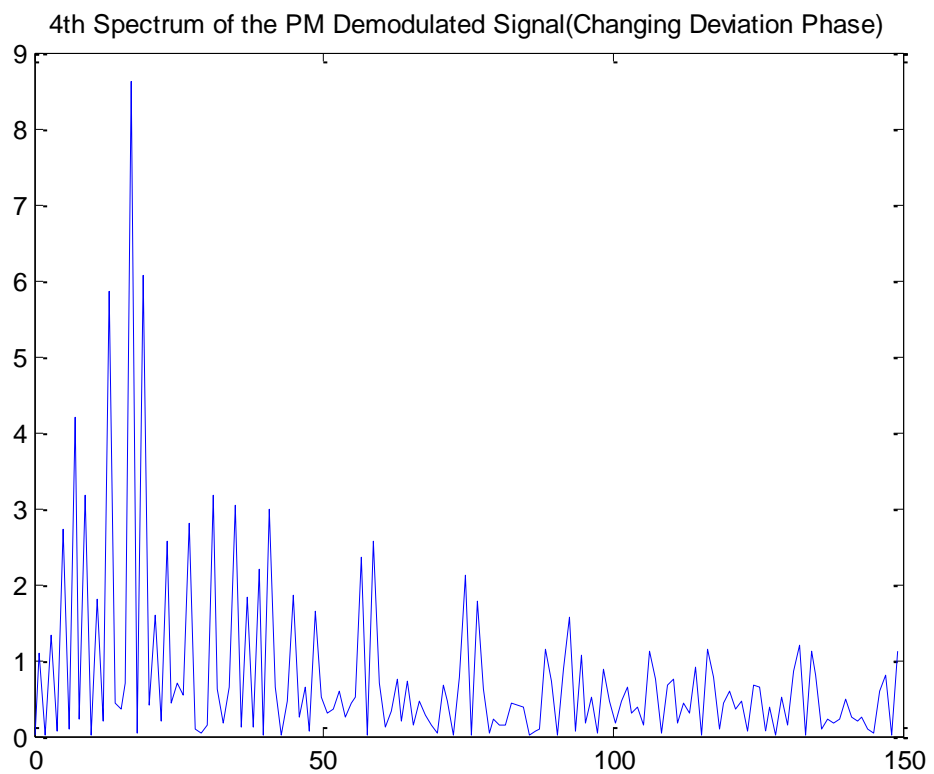
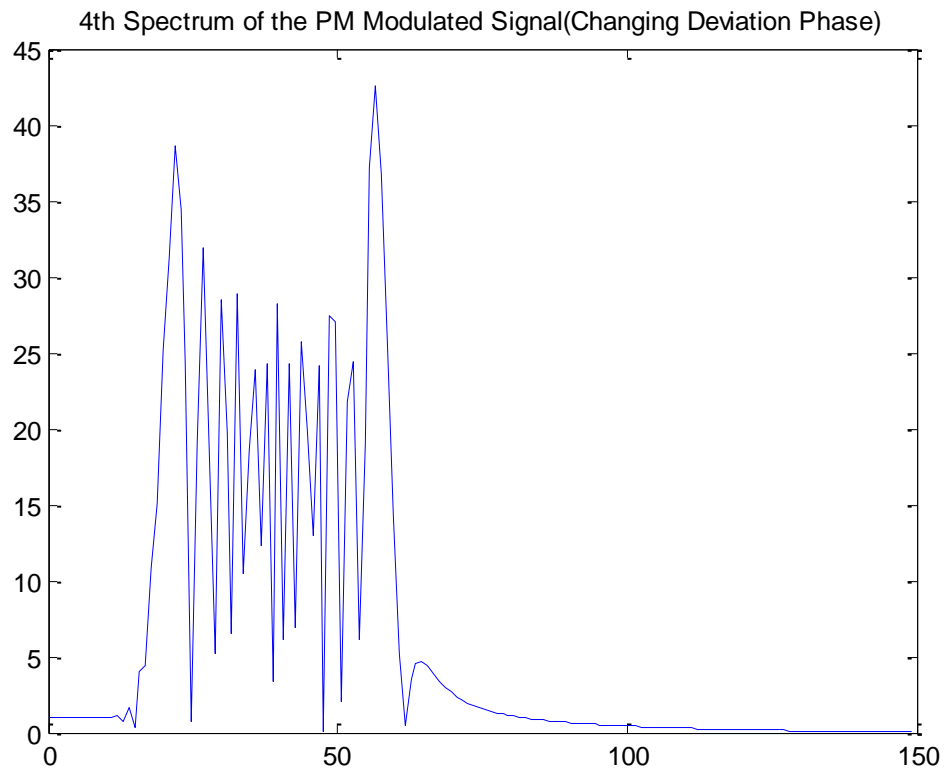


Sampling rate = 300 sample per second

Carrier Frequency = 40 Hz

Frequency Deviation = 20

Without Noise:



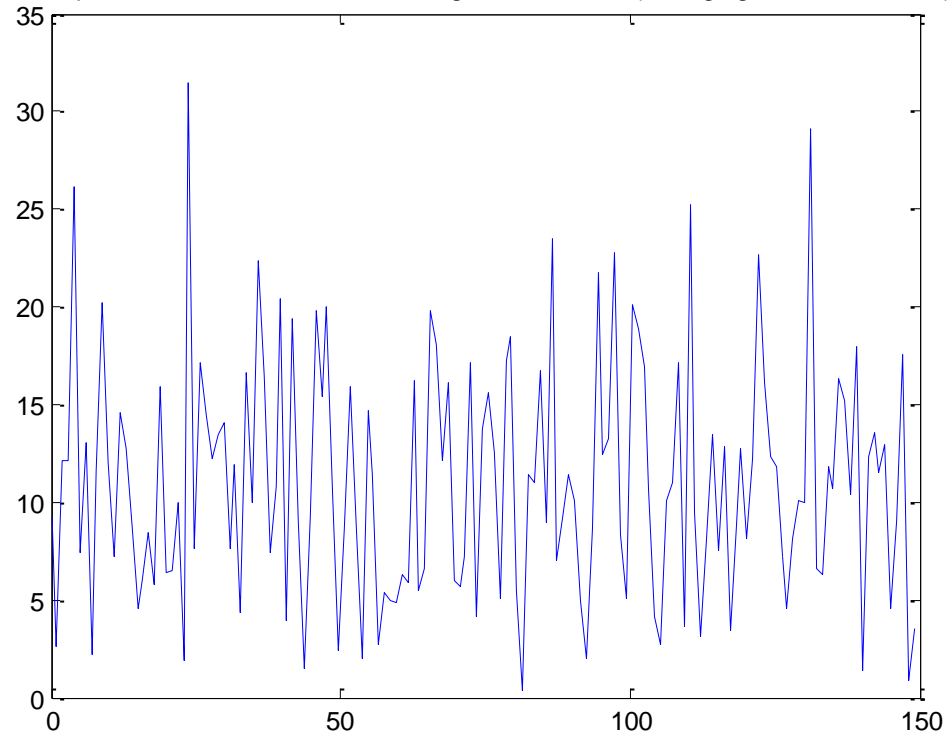
Sampling rate = 300 sample per second

Carrier Frequency = 40 Hz

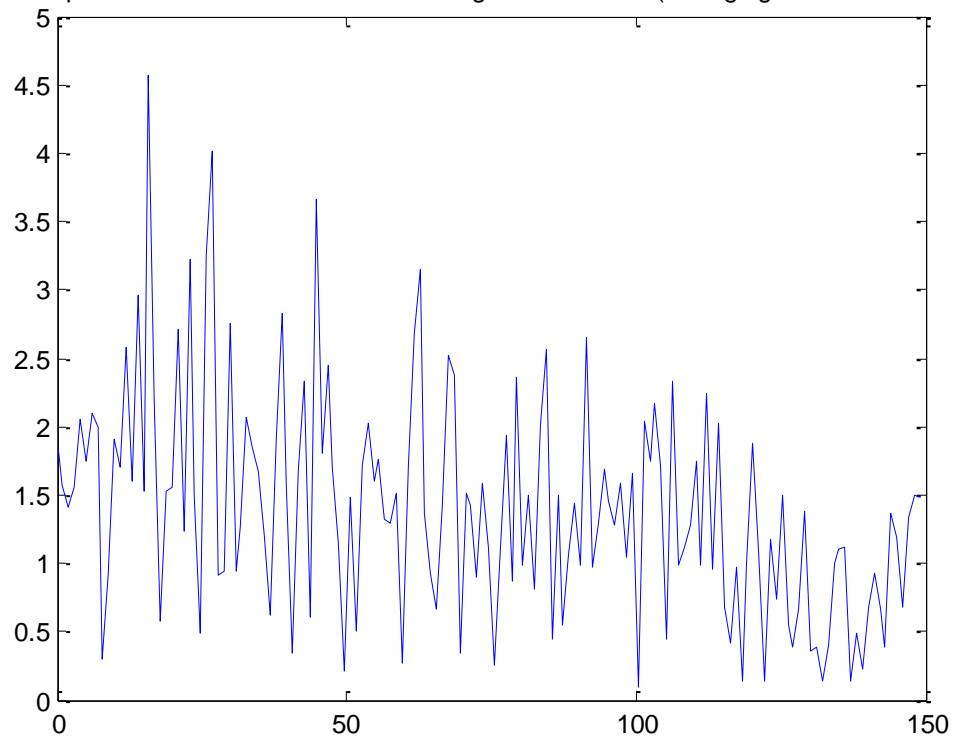
Frequency Deviation = 20

With Noise:

4th Spectrum of the PM Modulated Signal With Noise(Changing Deviation Phase)



4th Spectrum of the PM Demodulated Signal With Noise(Changing Deviation Phase)



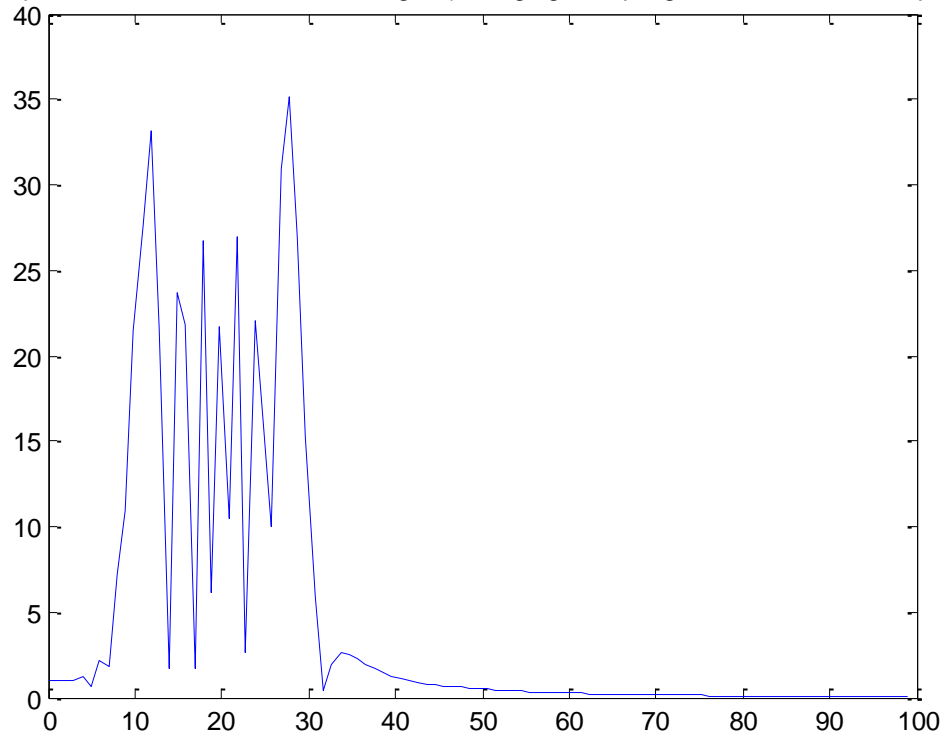
Sampling rate = 200 sample per second

Carrier Frequency = 20 Hz

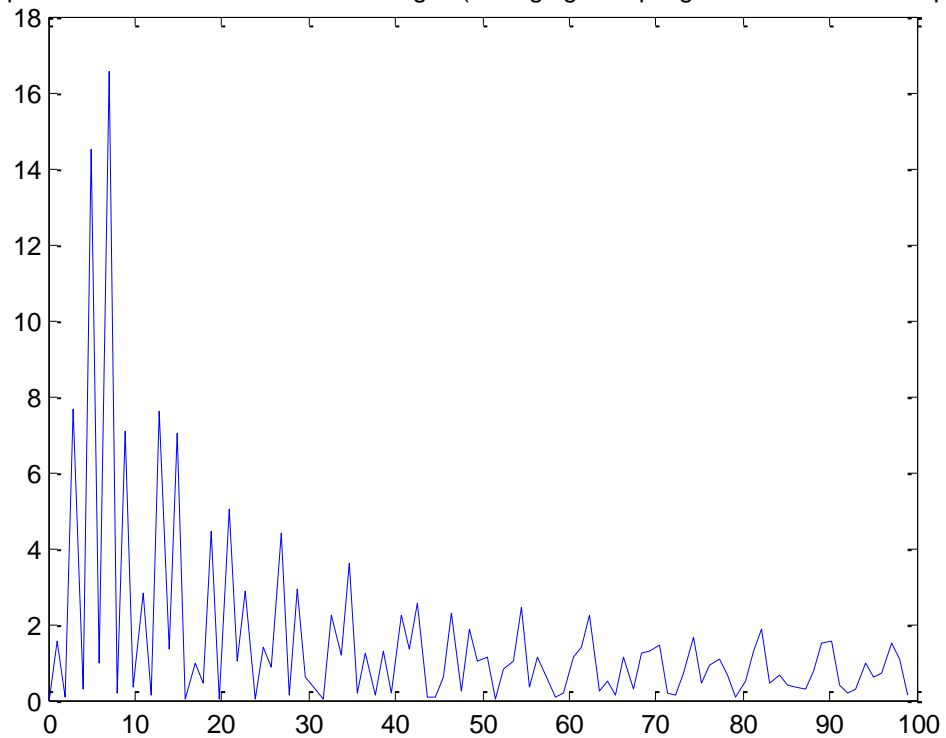
Frequency Deviation = 10

Without Noise:

5th Spectrum of the PM Modulated Signal(Changing Sampling rate and Carrier Frequency)



5th Spectrum of the PM Demodulated Signal(Changing Sampling rate and Carrier Frequency)



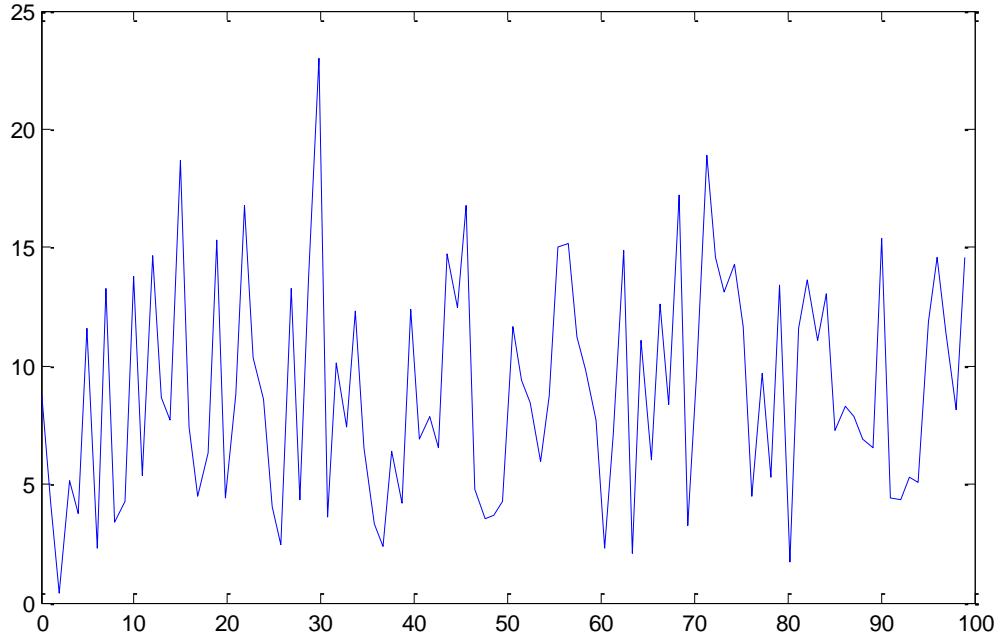
Sampling rate = 200 sample per second

Carrier Frequency = 20 Hz

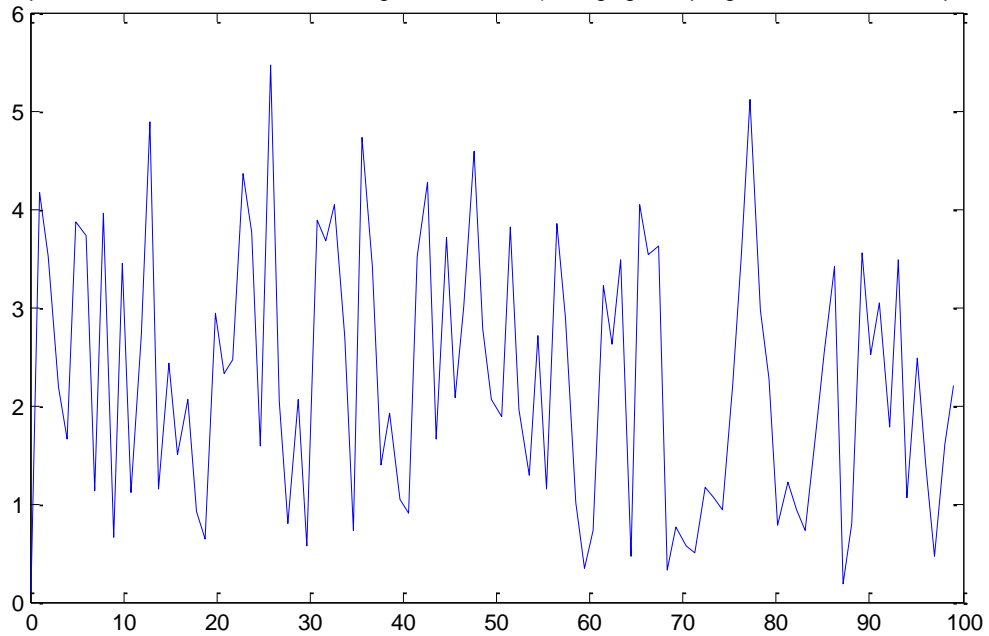
Frequency Deviation = 10

With Noise:

5th Spectrum of the PM Modulated Signal With Noise(Changing Sampling rate and Carrier Frequency)



5th Spectrum of the PM Demodulated Signal With Noise(Changing Sampling rate and Carrier Frequency)



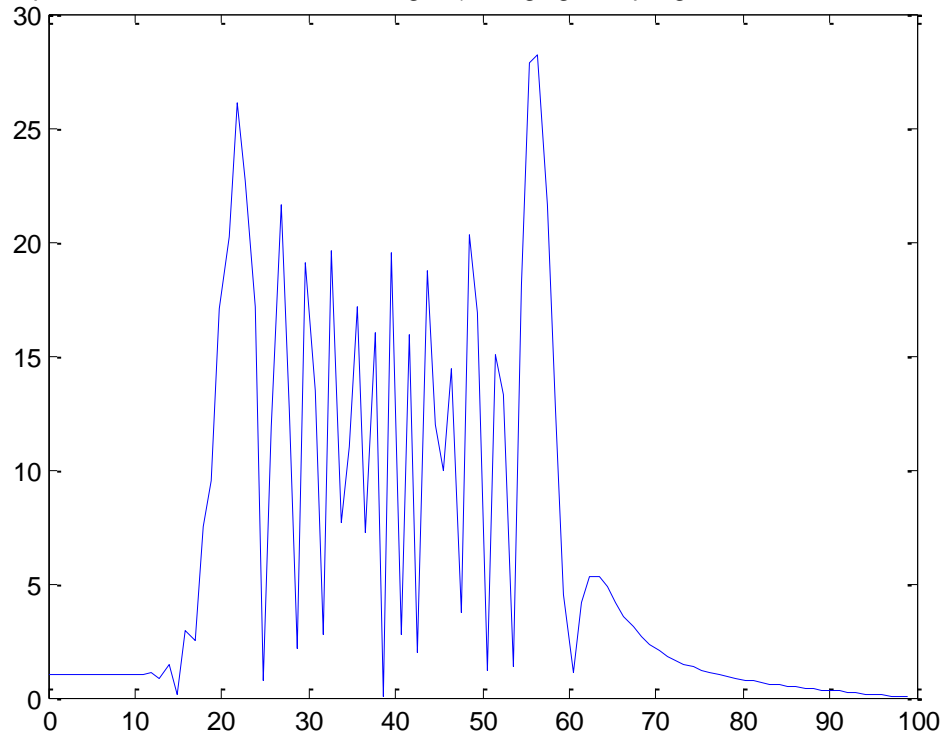
Sampling rate = 200 sample per second

Carrier Frequency = 40 Hz

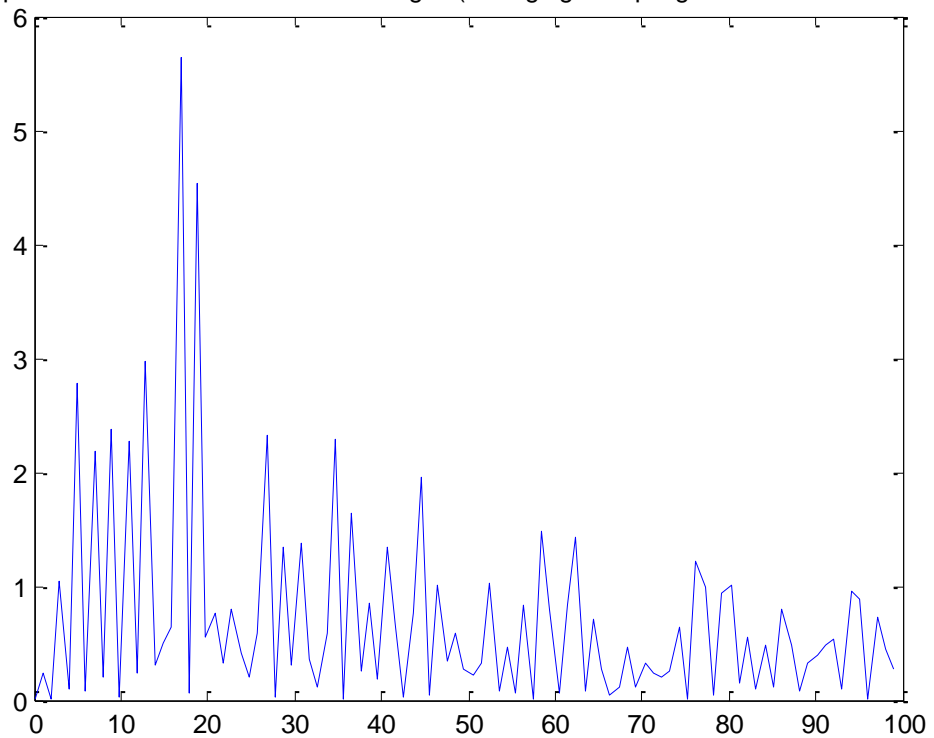
Frequency Deviation = 20

Without Noise:

6th Spectrum of the PM Modulated Signal(Changing Sampling rate and Deviation Phase)



6th Spectrum of the PM Demodulated Signal(Changing Sampling rate and Deviation Phase)



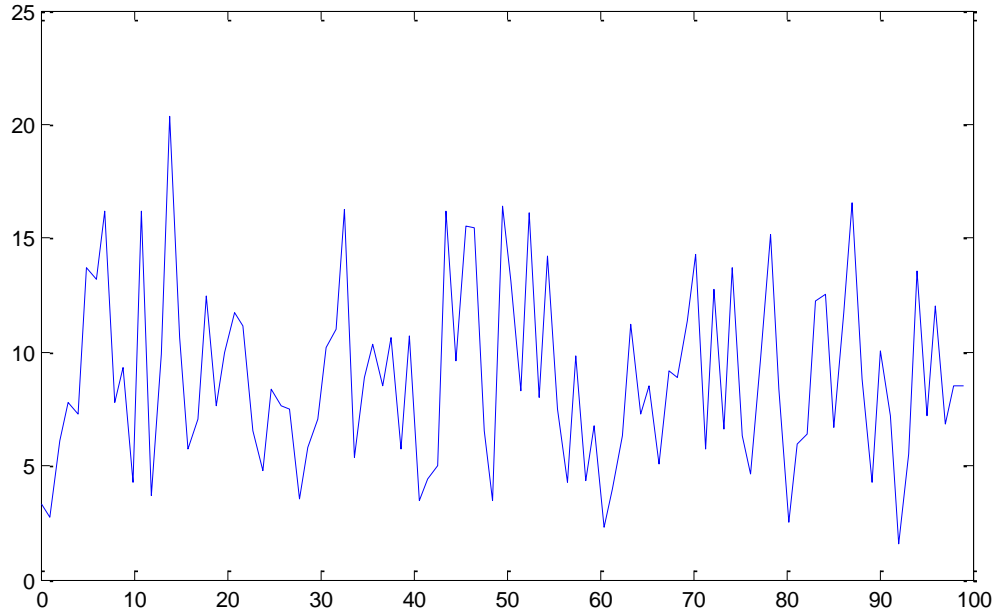
Sampling rate = 200 sample per second

Carrier Frequency = 40 Hz

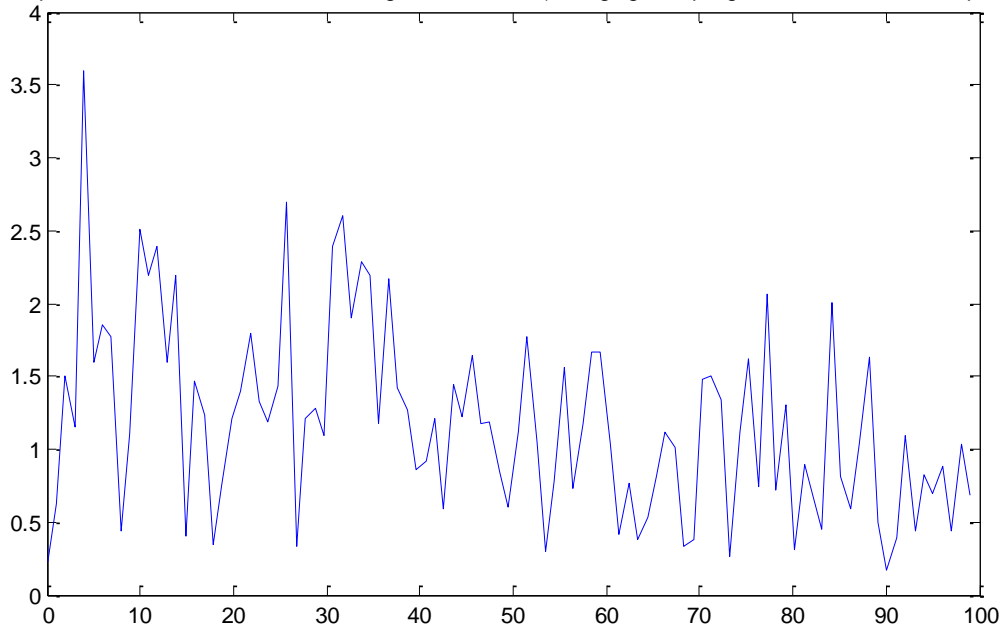
Frequency Deviation = 20

With Noise:

6th Spectrum of the PM Modulated Signal With Noise(Changing Sampling rate and Deviation Frequency)



6th Spectrum of the PM Demodulated Signal With Noise(Changing Sampling rate and Deviation Frequency)



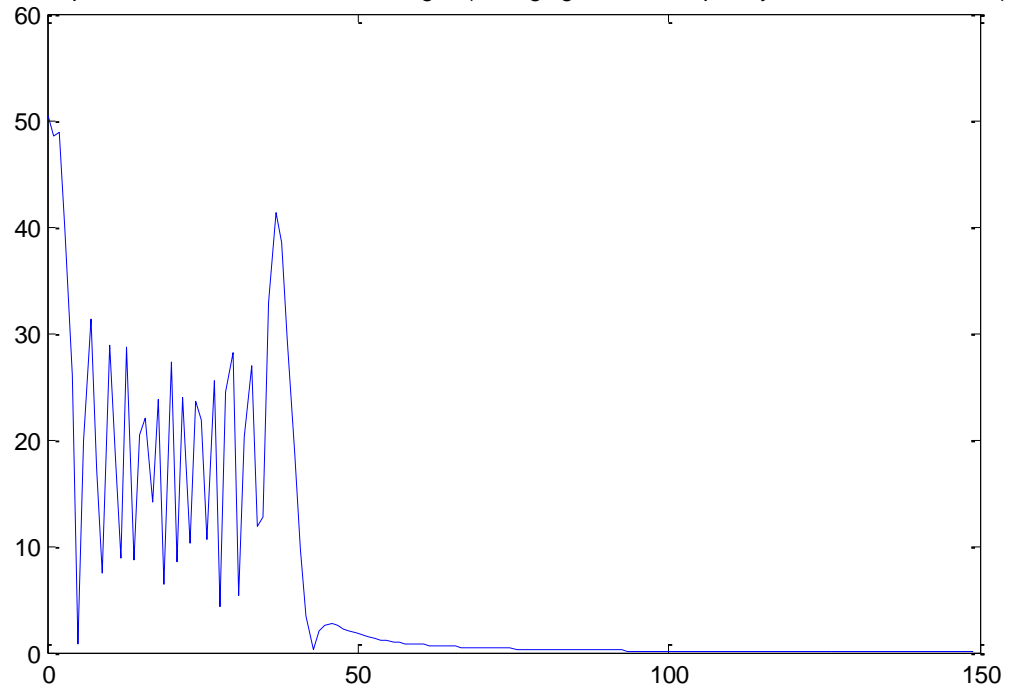
Sampling rate = 300 sample per second

Carrier Frequency = 20 Hz

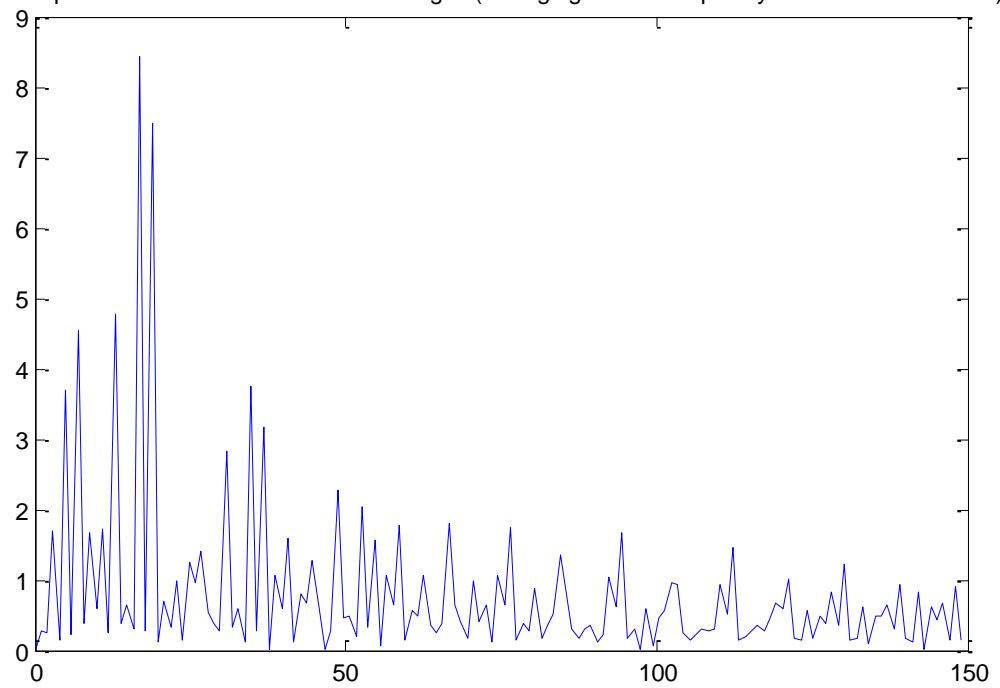
Frequency Deviation = 20

Without Noise:

7th Spectrum of the PM Modulated Signal(Changing Carrier Frequency and Deviation Phase)



7th Spectrum of the PM Demodulated Signal(Changing Carrier frequency and Deviation Phase)



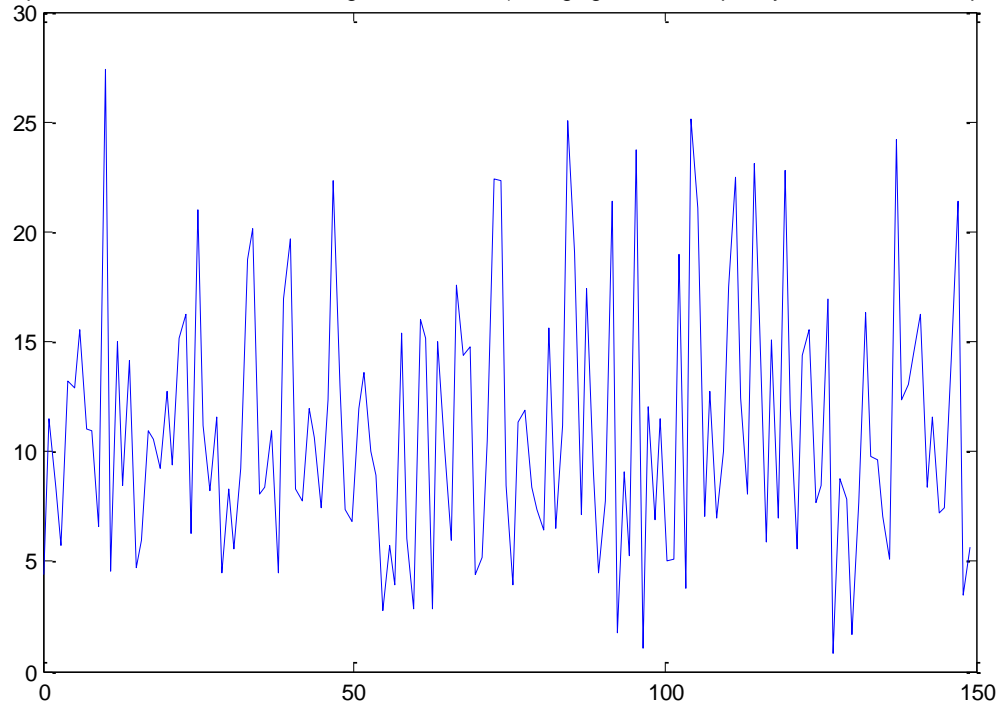
Sampling rate = 300 sample per second

Carrier Frequency = 20 Hz

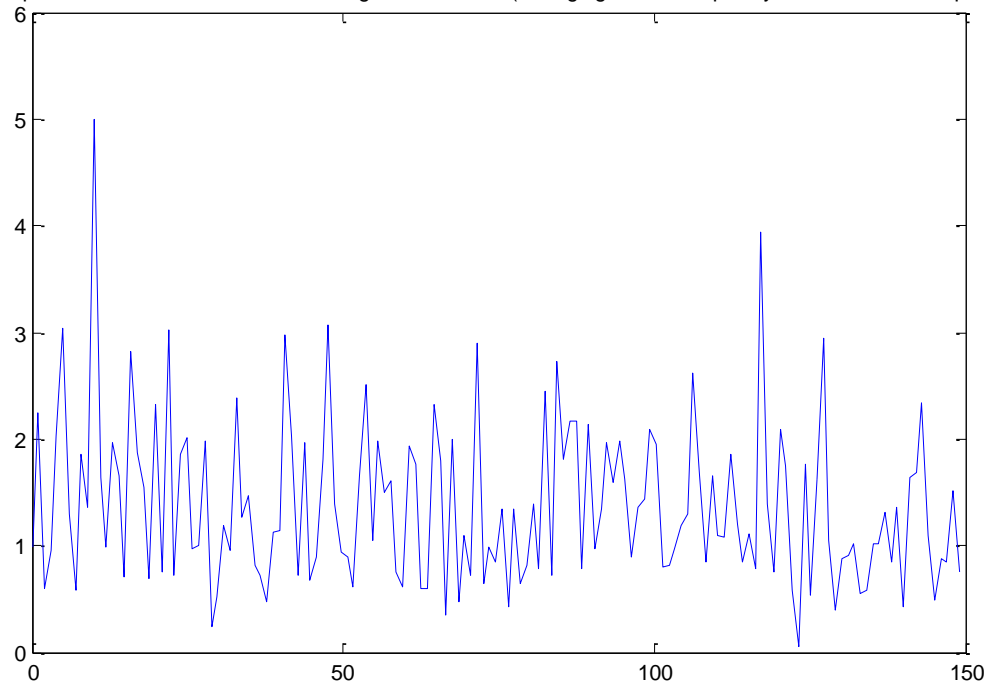
Frequency Deviation = 20

With Noise:

7th Spectrum of the PM Modulated Signal With Noise(Changing Carrier Frequency and Deviation Frequency)



7th Spectrum of the PM Demodulated Signal With Noise(Changing Carrier frequency and Deviation Frequency)

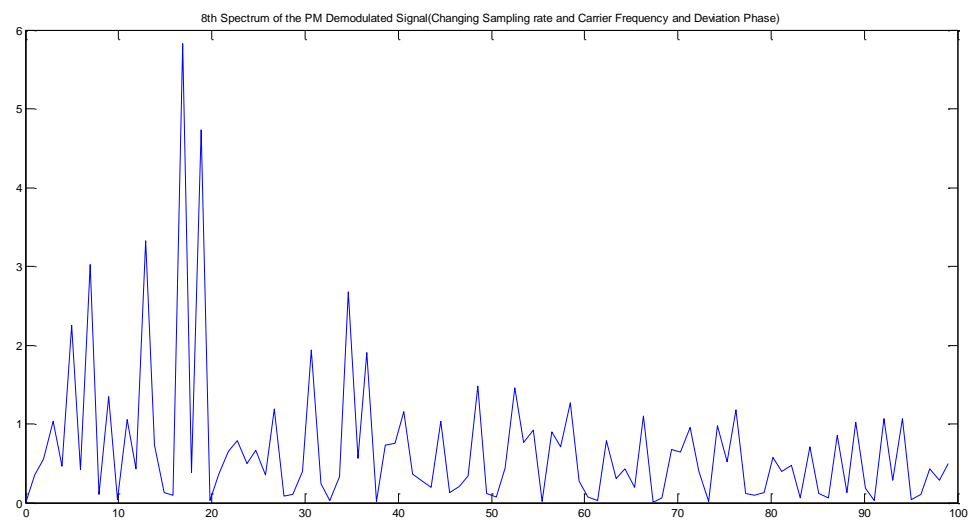
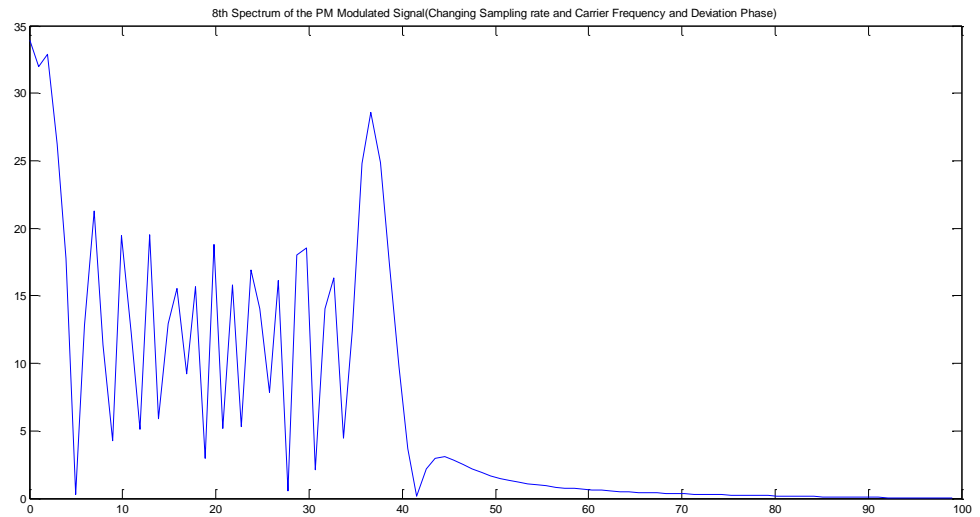


Sampling rate = 200 sample per second

Carrier Frequency = 20 Hz

Frequency Deviation = 20

Without Noise:

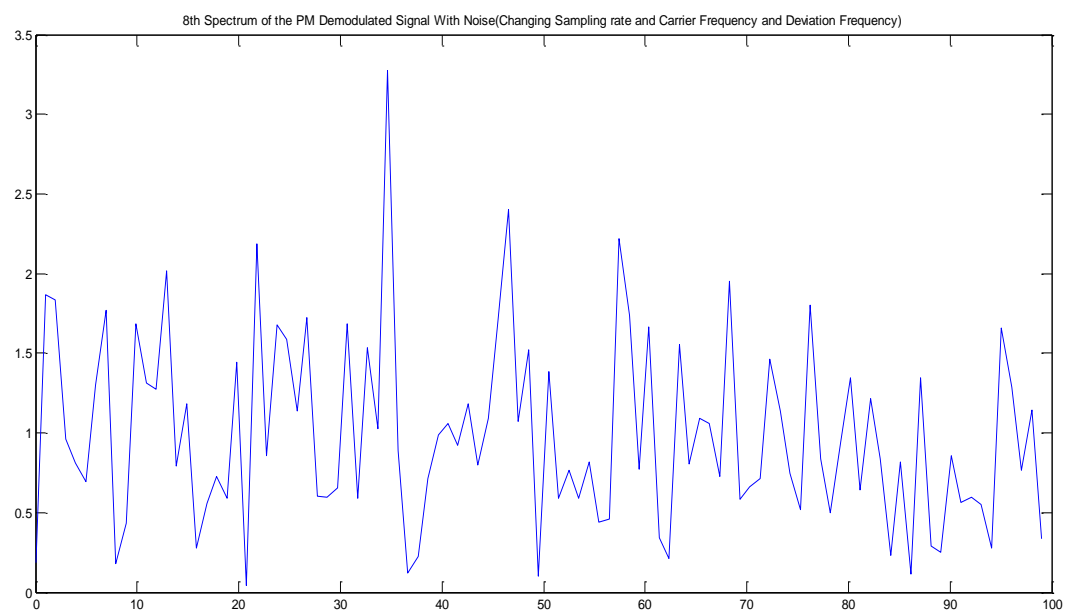
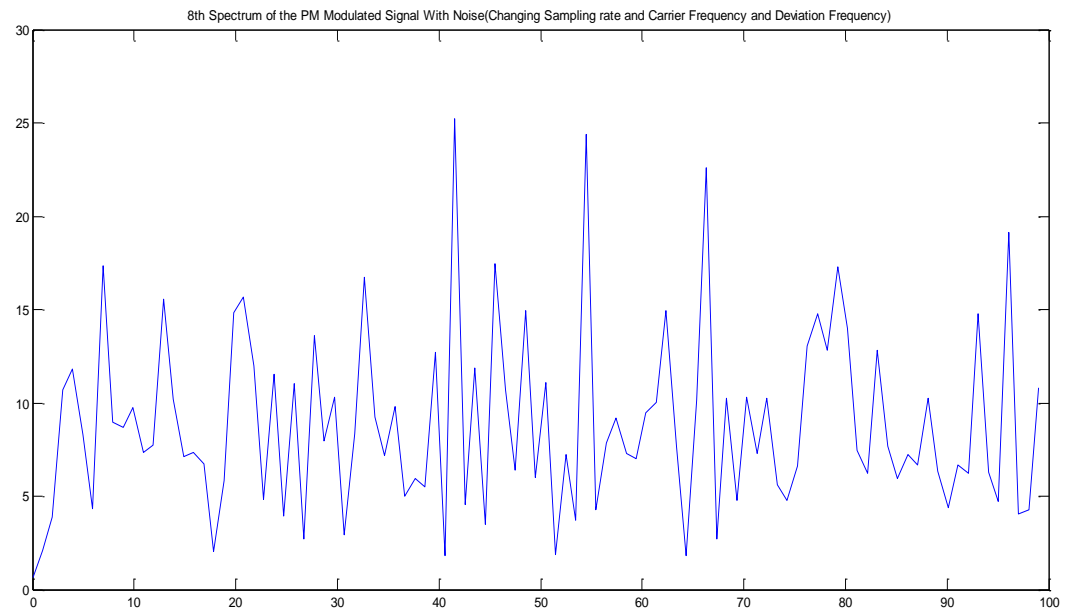


Sampling rate = 200 sample per second

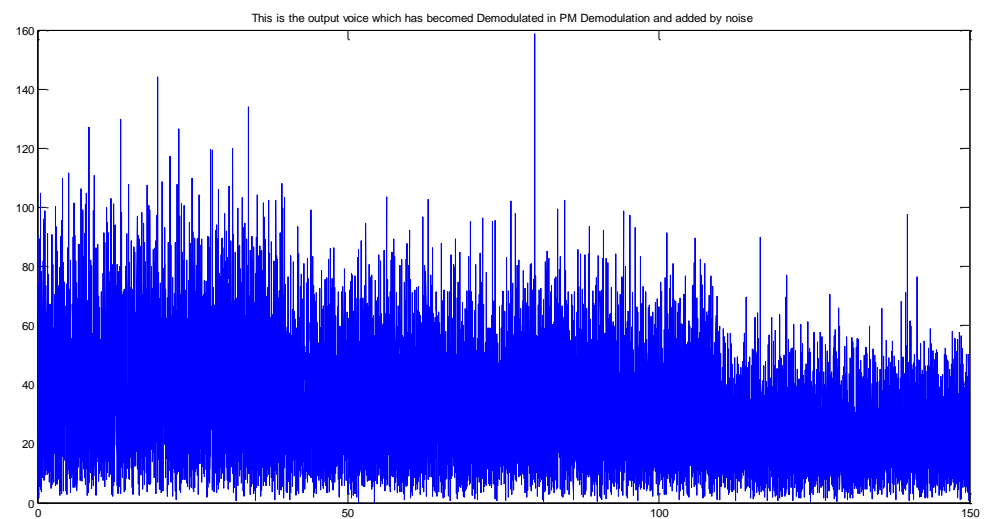
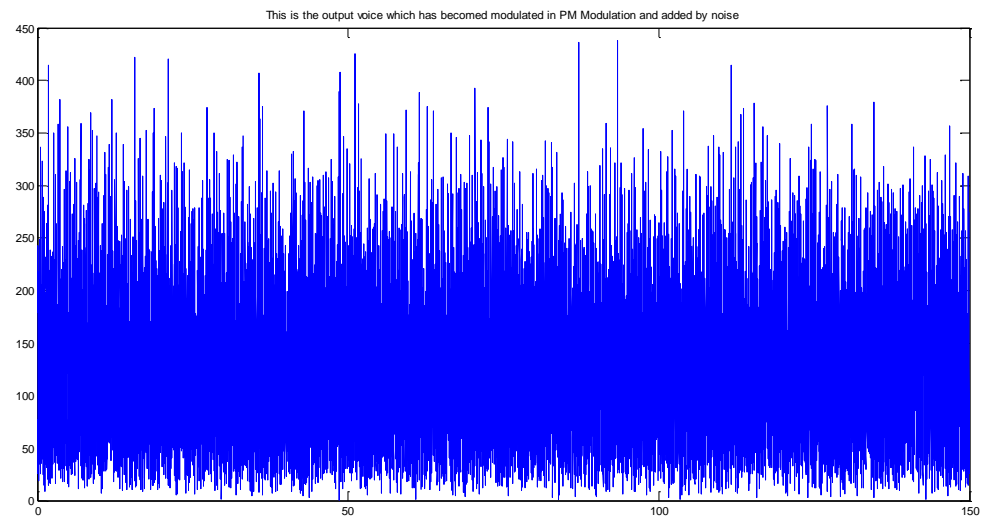
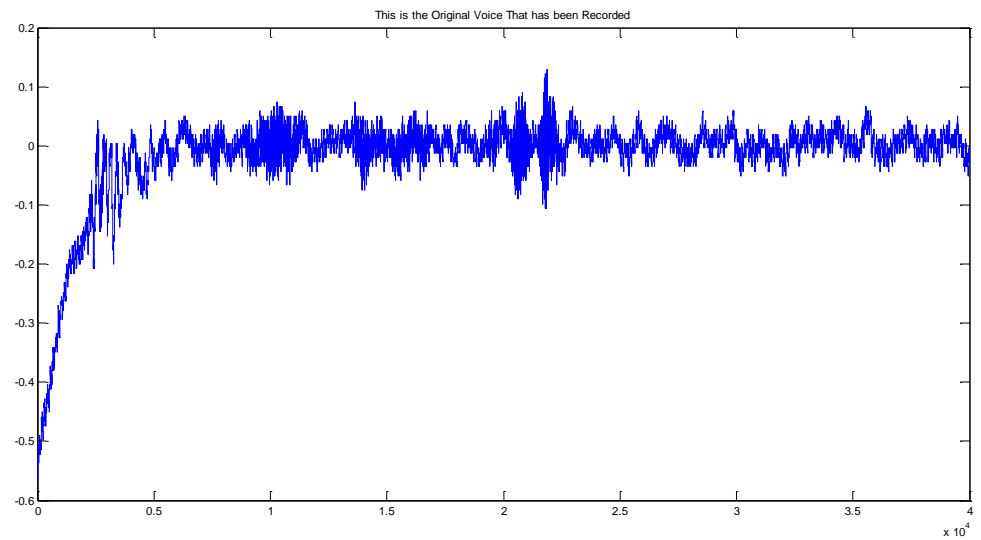
Carrier Frequency = 20 Hz

Frequency Deviation = 20

With Noise:



**Recorded Voice with Noise and $f_c = 40 \text{ Hz}$ and $f_s = 300 \text{ sample per second}$
And *Phase Deviation* = 10**

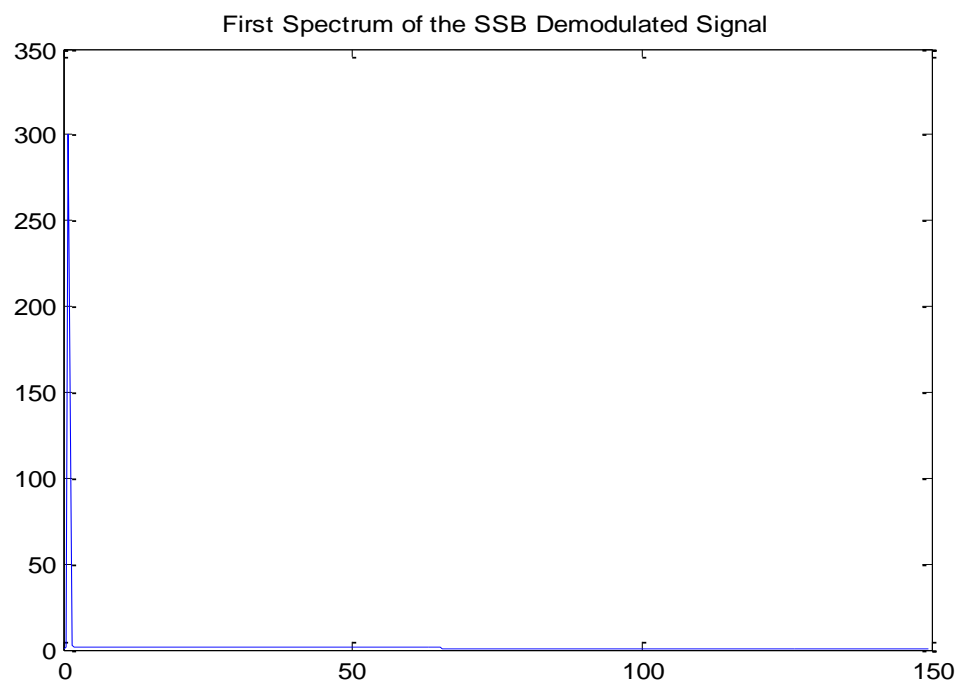
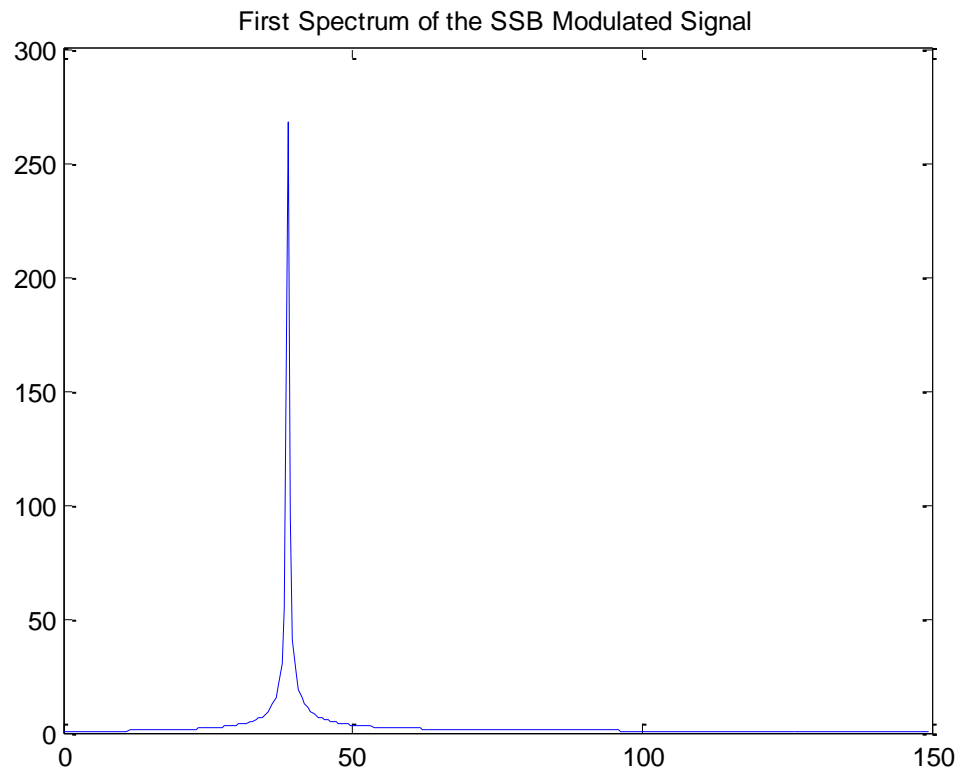


D) SSB Modulation and Demodulation

Our initials assumptions are:

- 1- We send our signal in Lower Band SSB and receive it respectively
- 2- Our initial sampling rate is 300 sample per second
- 3- Our initial carrier frequency is 40 Hz
- 4- Our initial phase is zero

Without Noise:

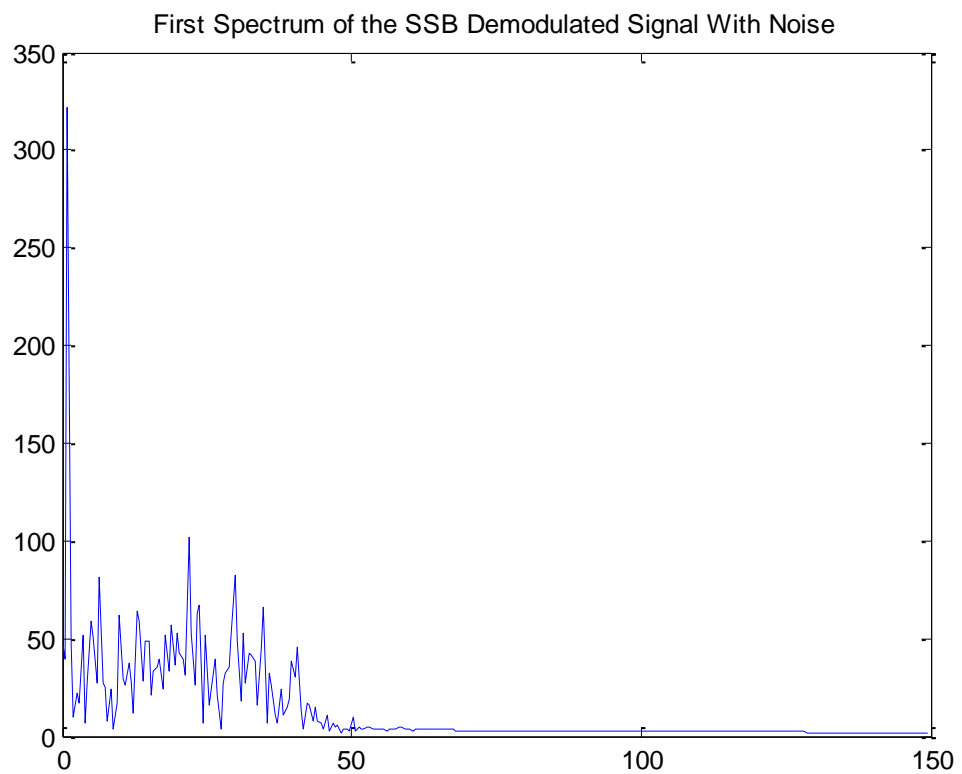
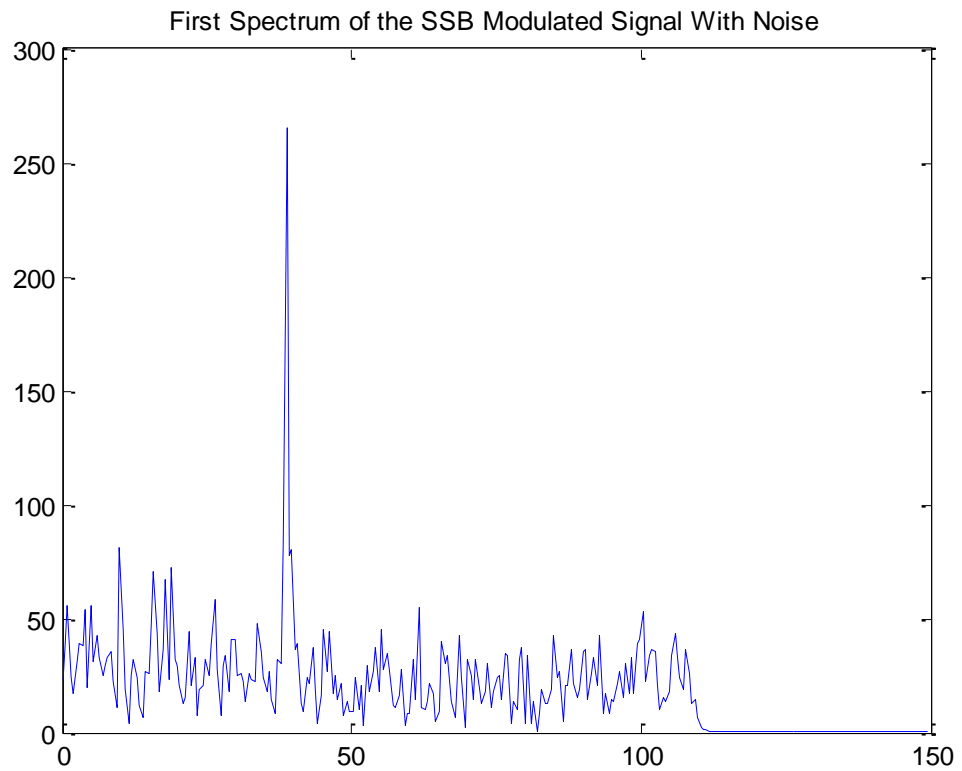


Lower SSB

Sampling rate = 300 sample per second

Carrier Frequency = 40 Hz

With Noise:

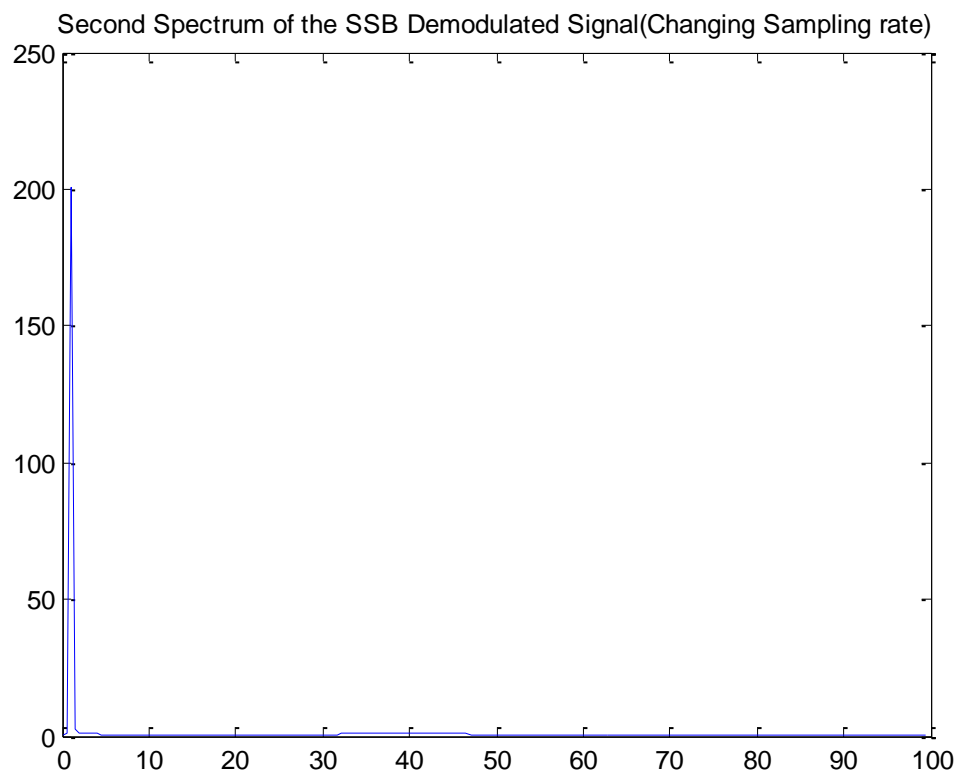
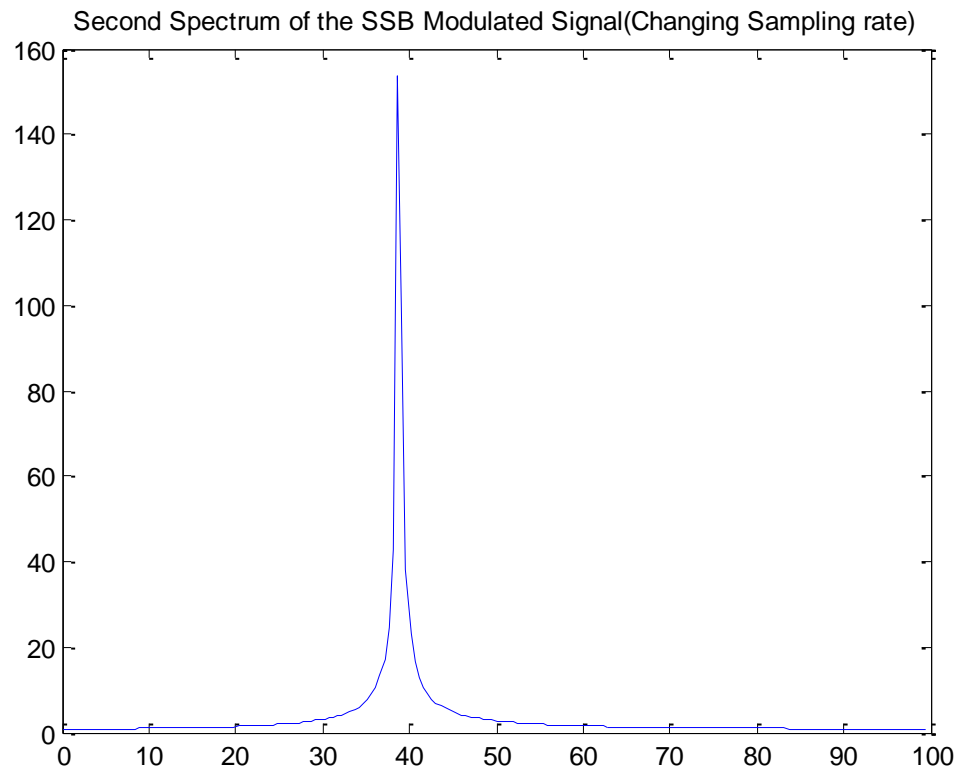


Lower SSB

Sampling rate = 200 sample per second

Carrier Frequency = 40 Hz

Without Noise:



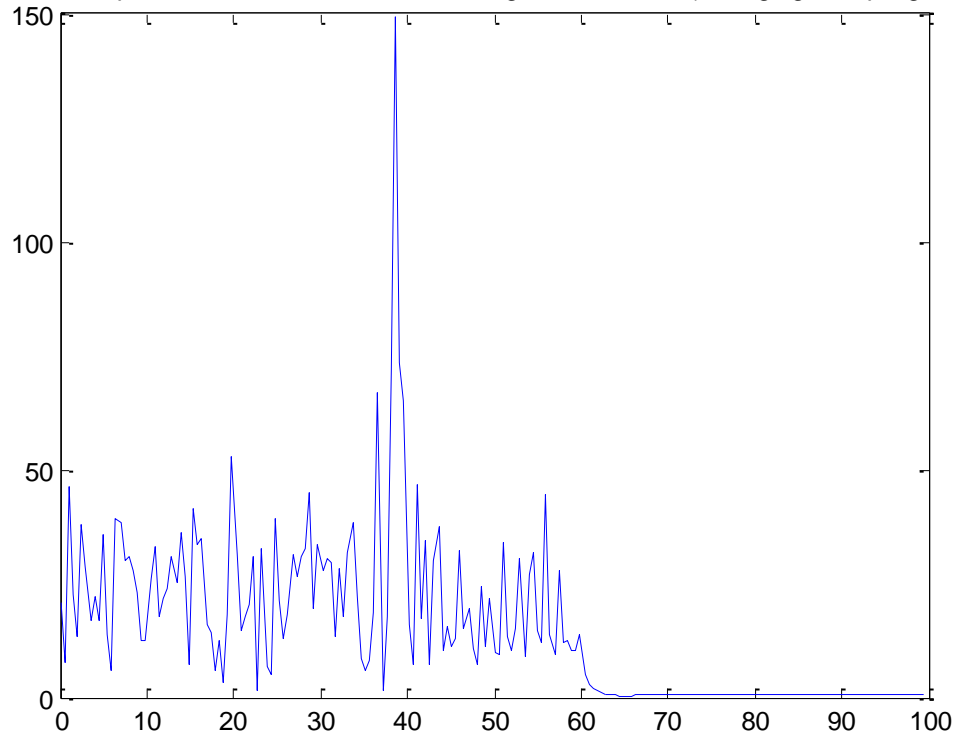
Lower SSB

Sampling rate = 200 sample per second

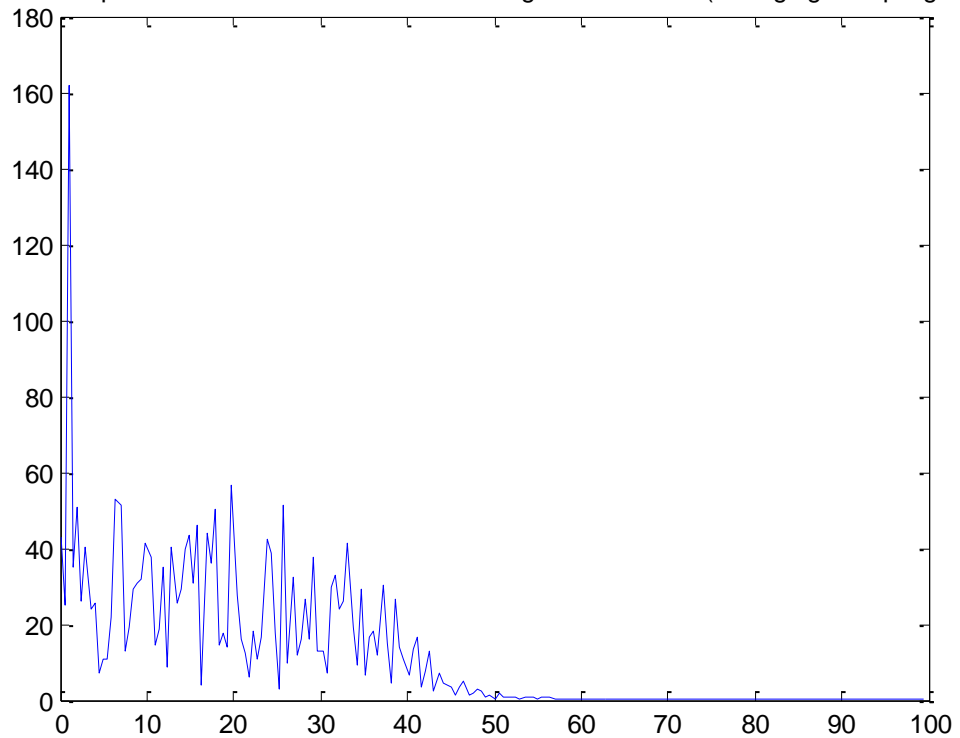
Carrier Frequency = 40 Hz

With Noise:

Second Spectrum of the SSB Modulated Signal With Noise(Changing Sampling rate)



Second Spectrum of the SSB Demodulated Signal With Noise(Changing Sampling rate)

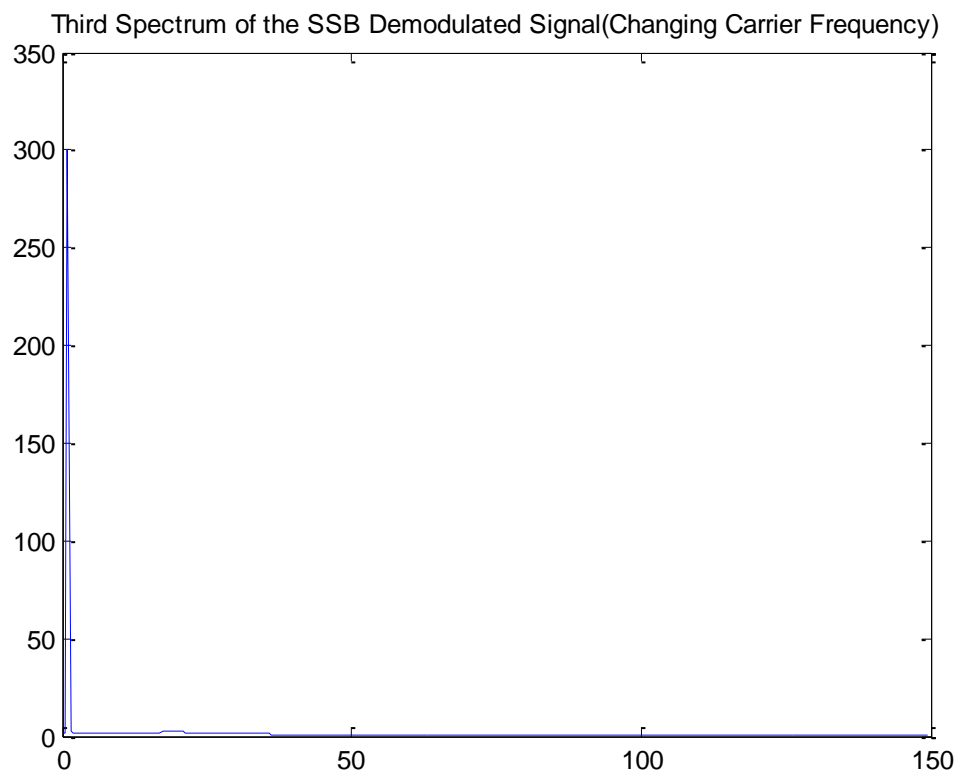
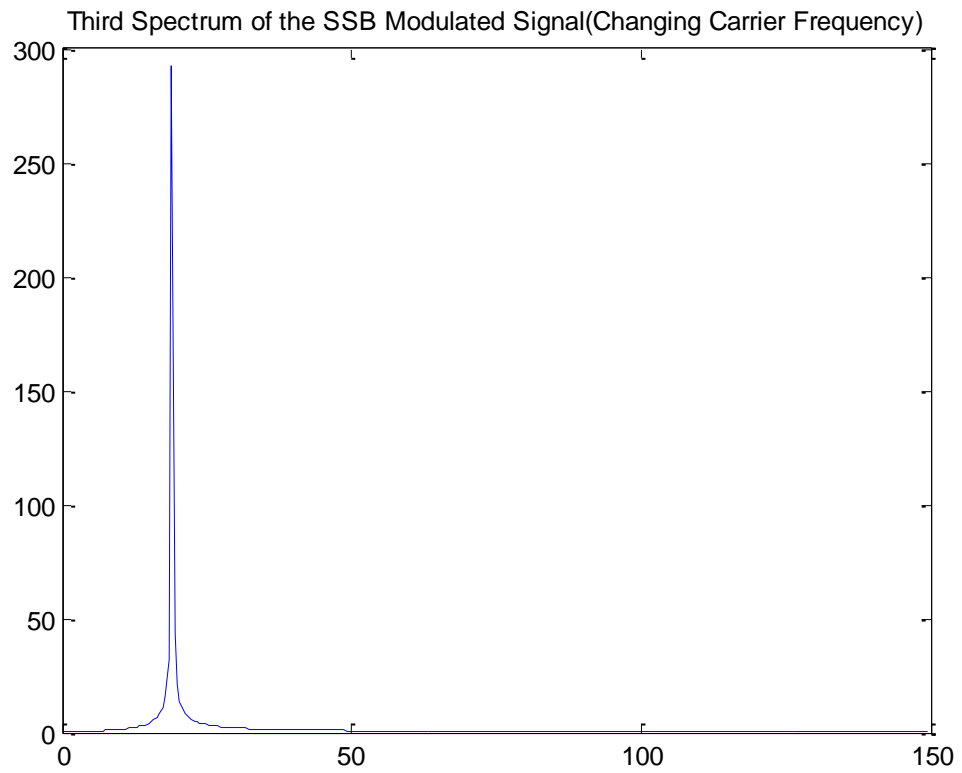


Lower SSB

Sampling rate = 300 sample per second

Carrier frequency = 20 Hz

Without Noise:



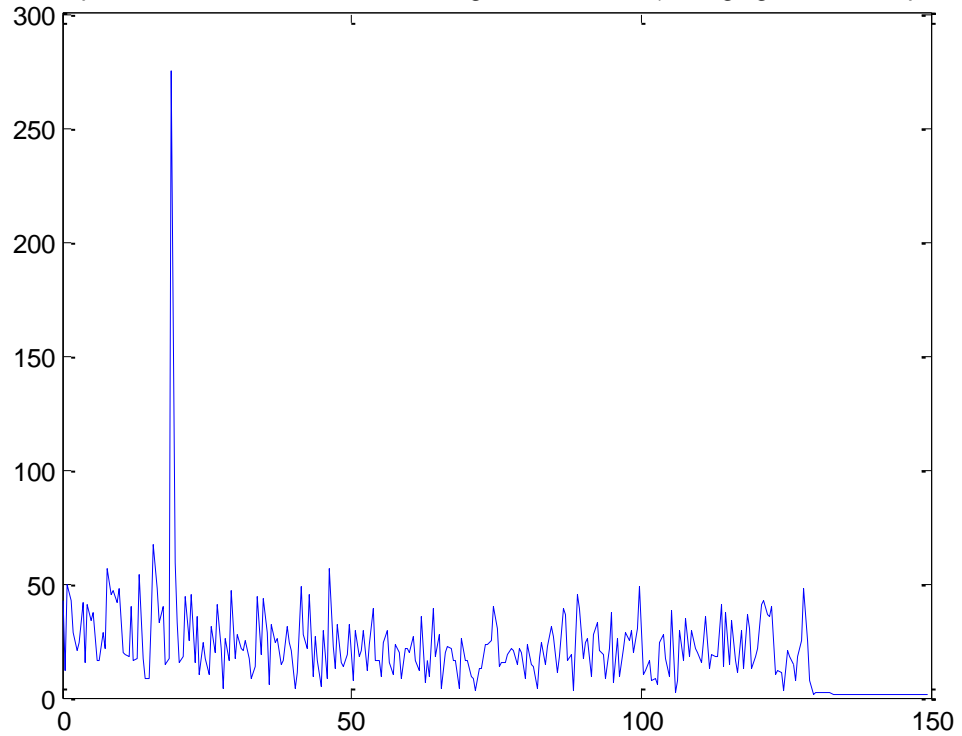
Lower SSB

Sampling rate = 300 sample per second

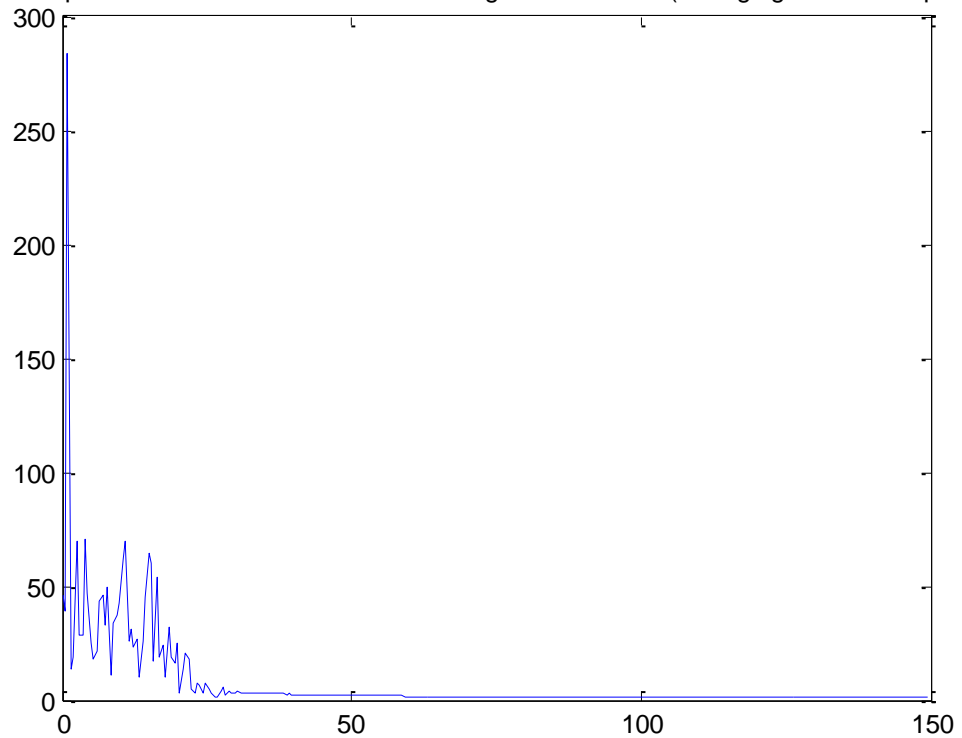
Carrier frequency = 20 Hz

Without Noise:

Third Spectrum of the SSB Modulated Signal With Noise(Changing Carrier Frequency)



Third Spectrum of the SSB Demodulated Signal With Noise(Changing Carrier Frequency)



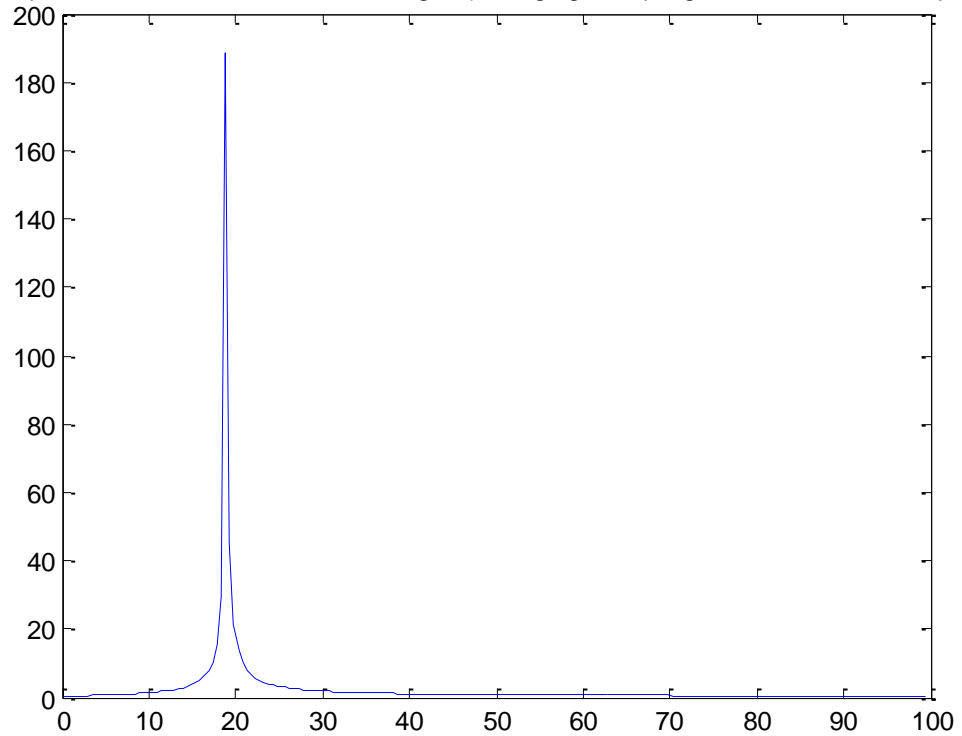
Lower SSB

Sampling rate = 200 sample per second

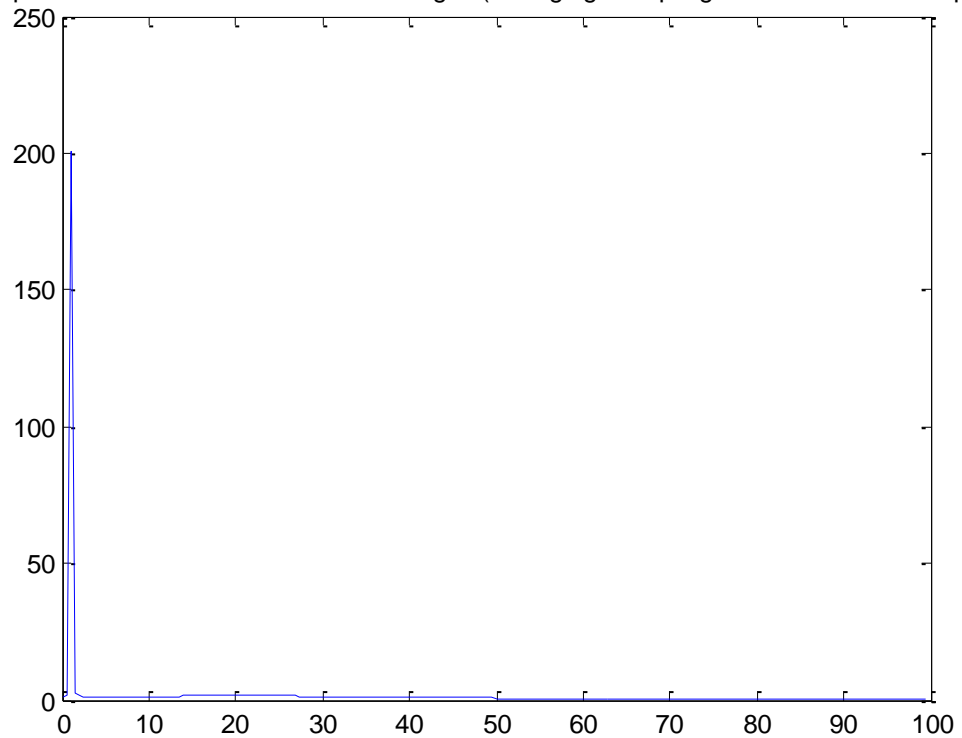
Carrier frequency = 20 Hz

Without Noise:

4th Spectrum of the SSB Modulated Signal(Changing Sampling rate and Carrier Frequency)



4th Spectrum of the SSB Demodulated Signal(Changing Sampling rate and Carrier Frequency)



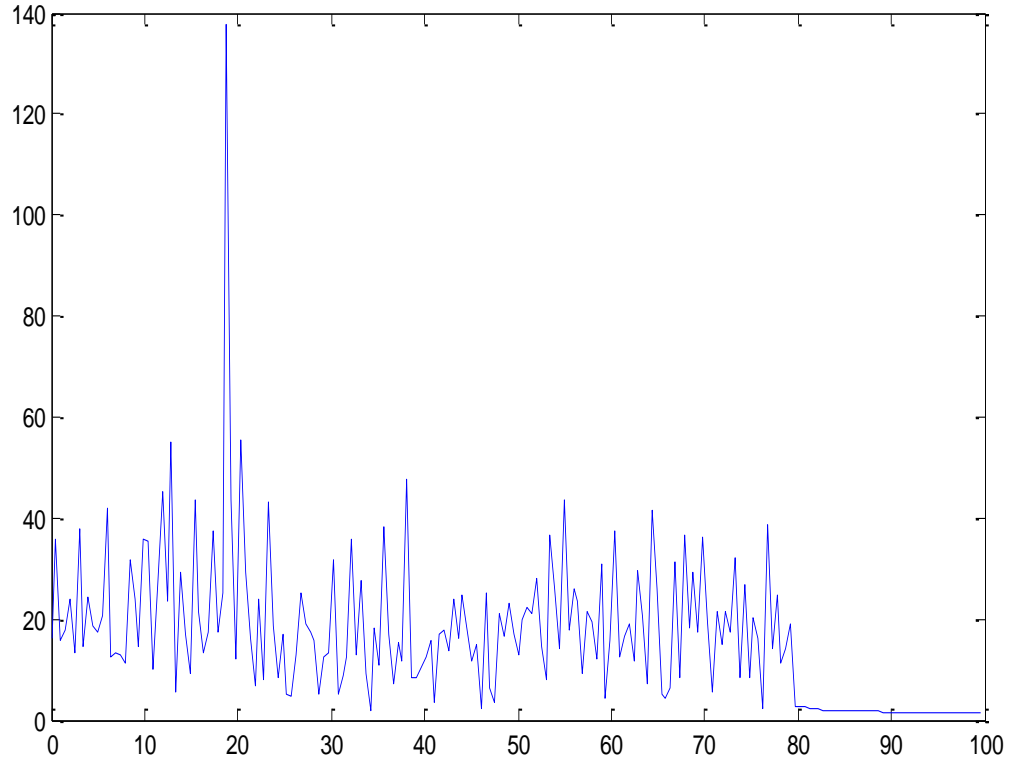
Lower SSB

Sampling rate = 200 sample per second

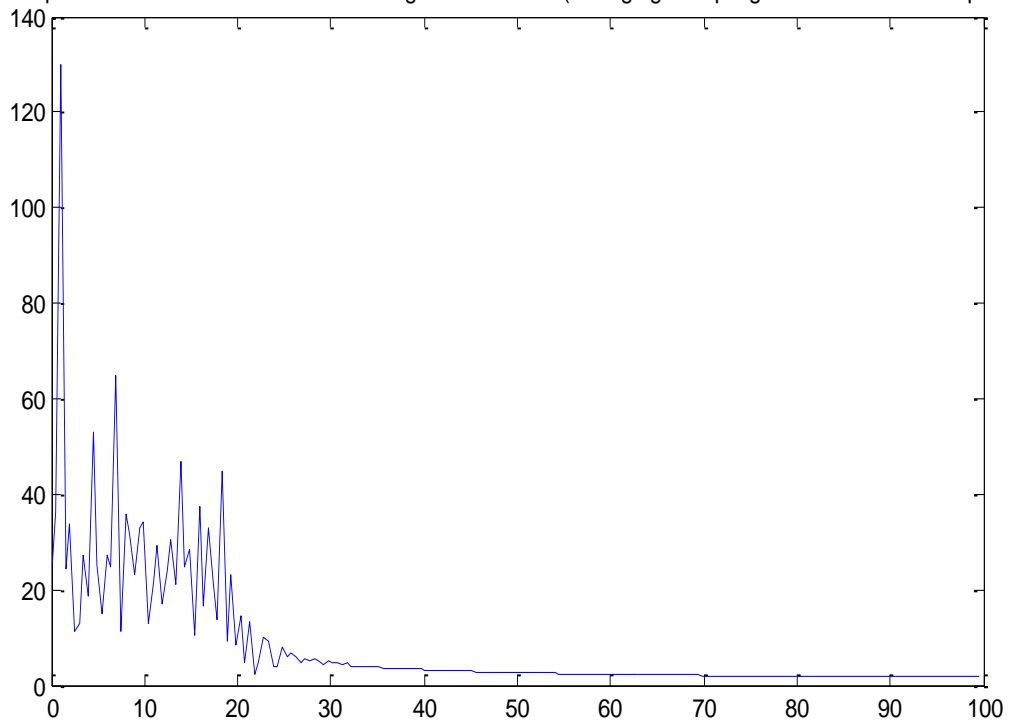
Carrier frequency = 20 Hz

Without Noise:

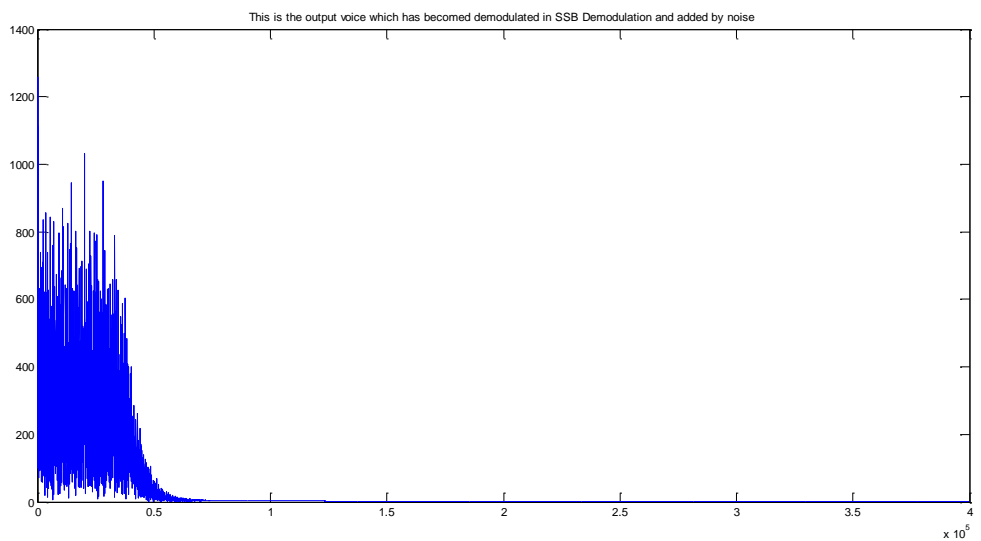
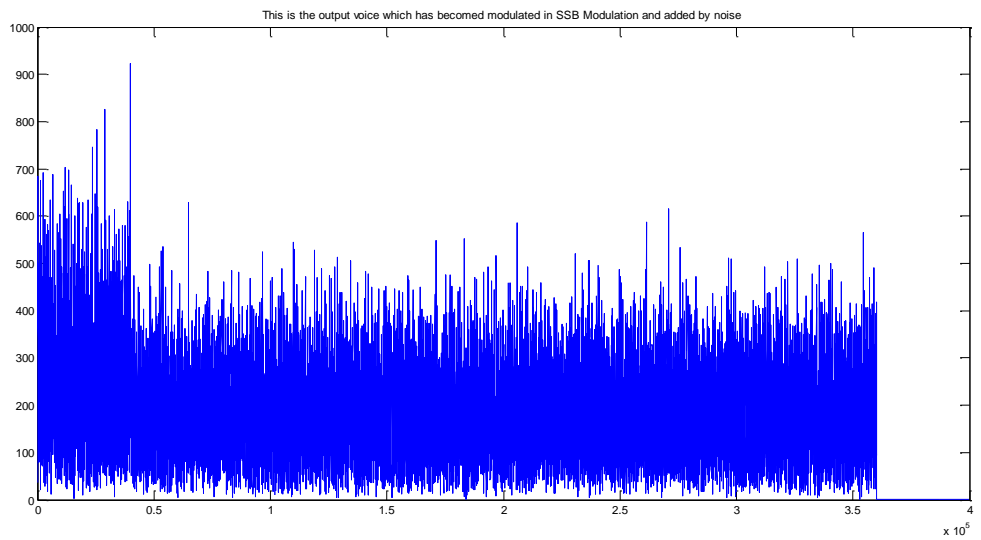
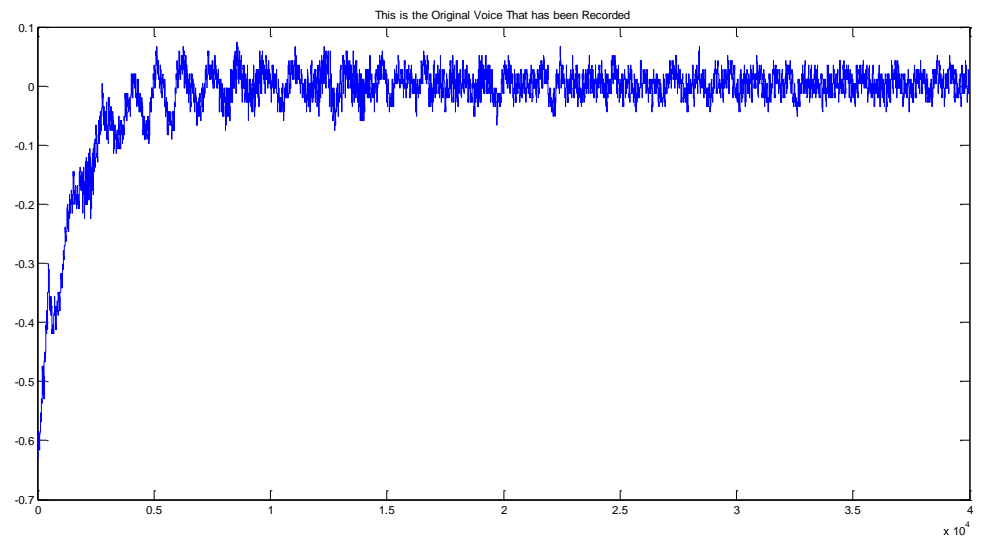
4th Spectrum of the SSB Modulated Signal With Noise(Changing Sampling rate and Carrier Frequency)



4th Spectrum of the SSB Demodulated Signal With Noise(Changing Sampling rate and Carrier Frequency)



Recorded Voice with Noise and $f_c = 40KHz$ and $f_s = 800KHz$
This is the original signal (message signal that we want to send it)

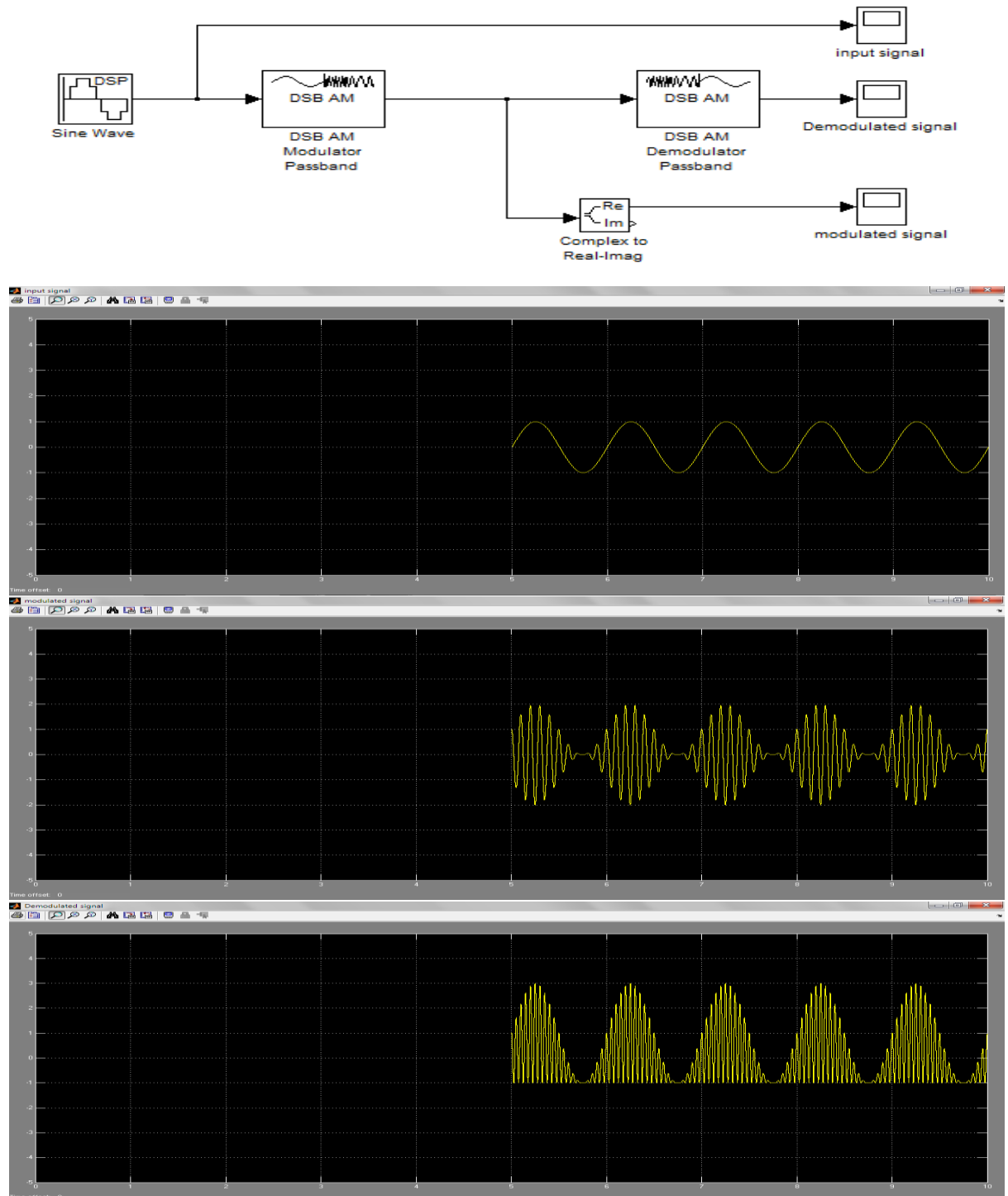


Second Part:

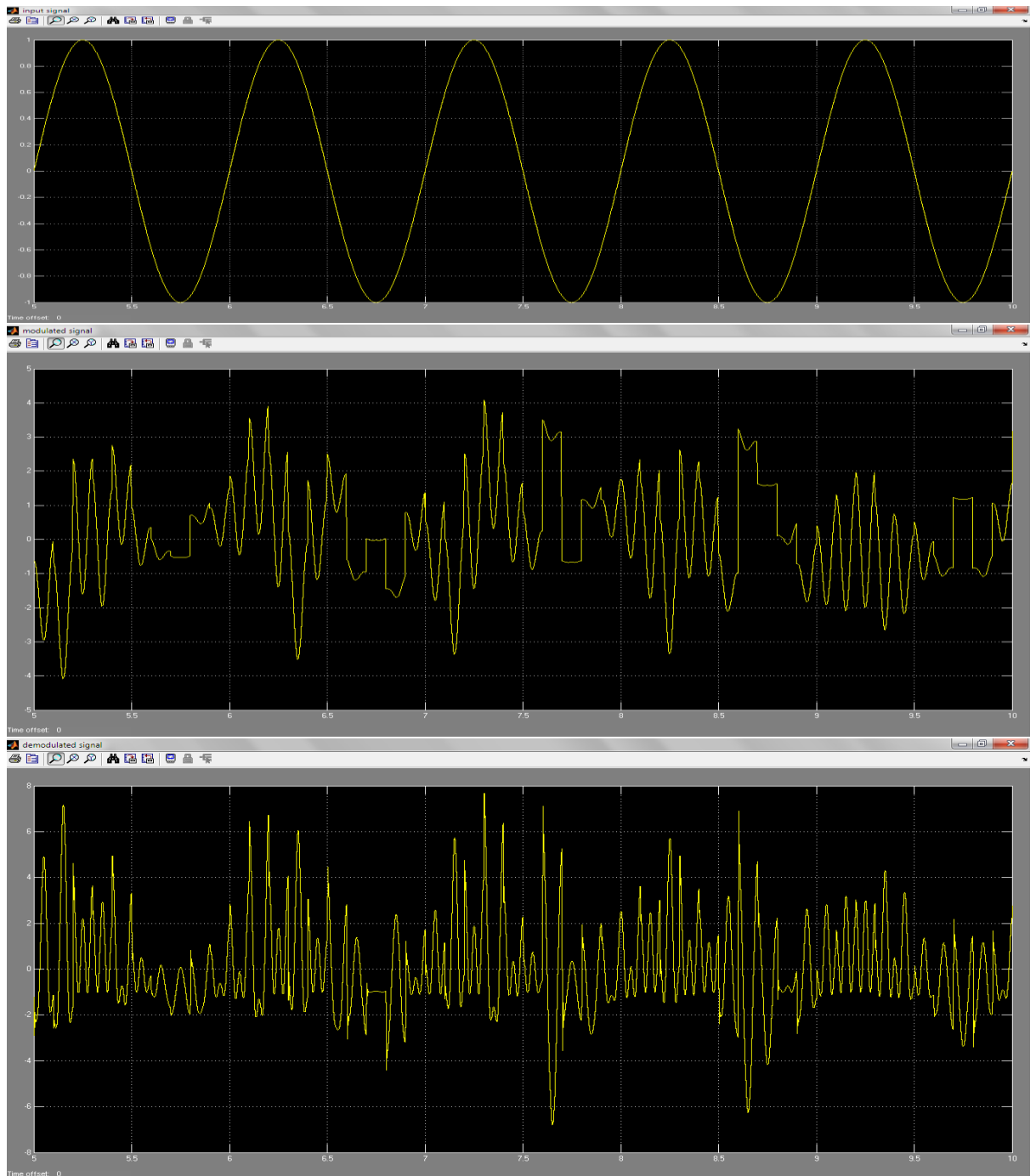
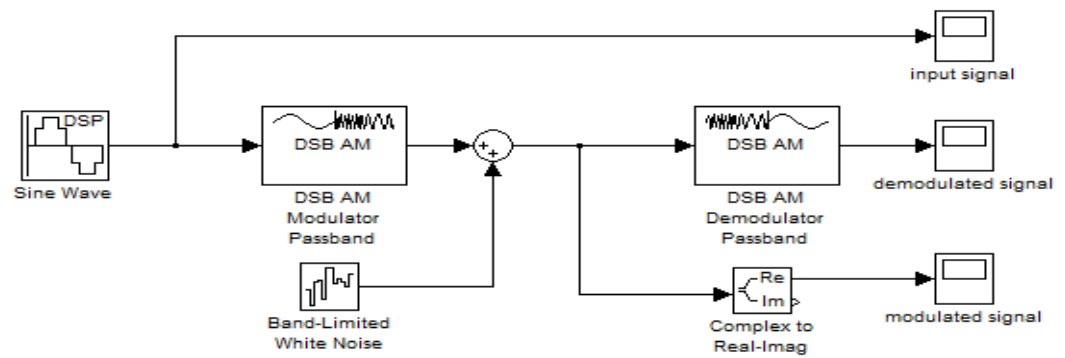
Simulink

Our initial waveform is sinusoidal waveform with 1 Hz frequency and our carrier frequency is 10 Hz

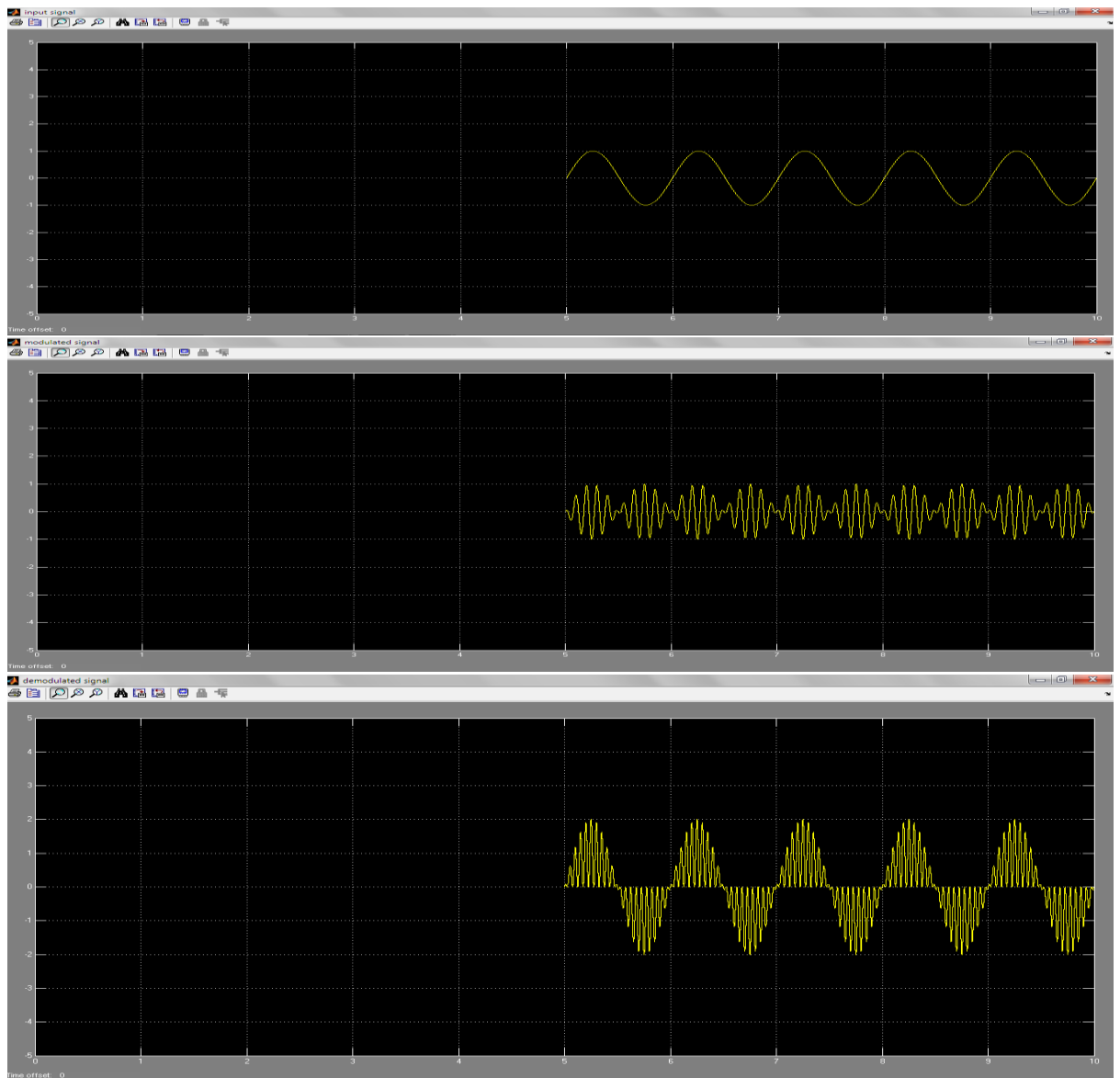
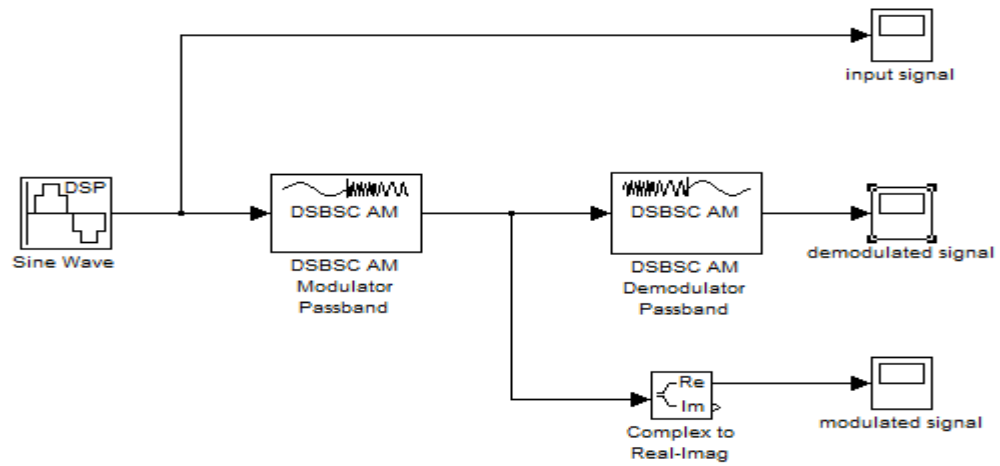
DSB AM Modulators and Demodulators (Without Noise):



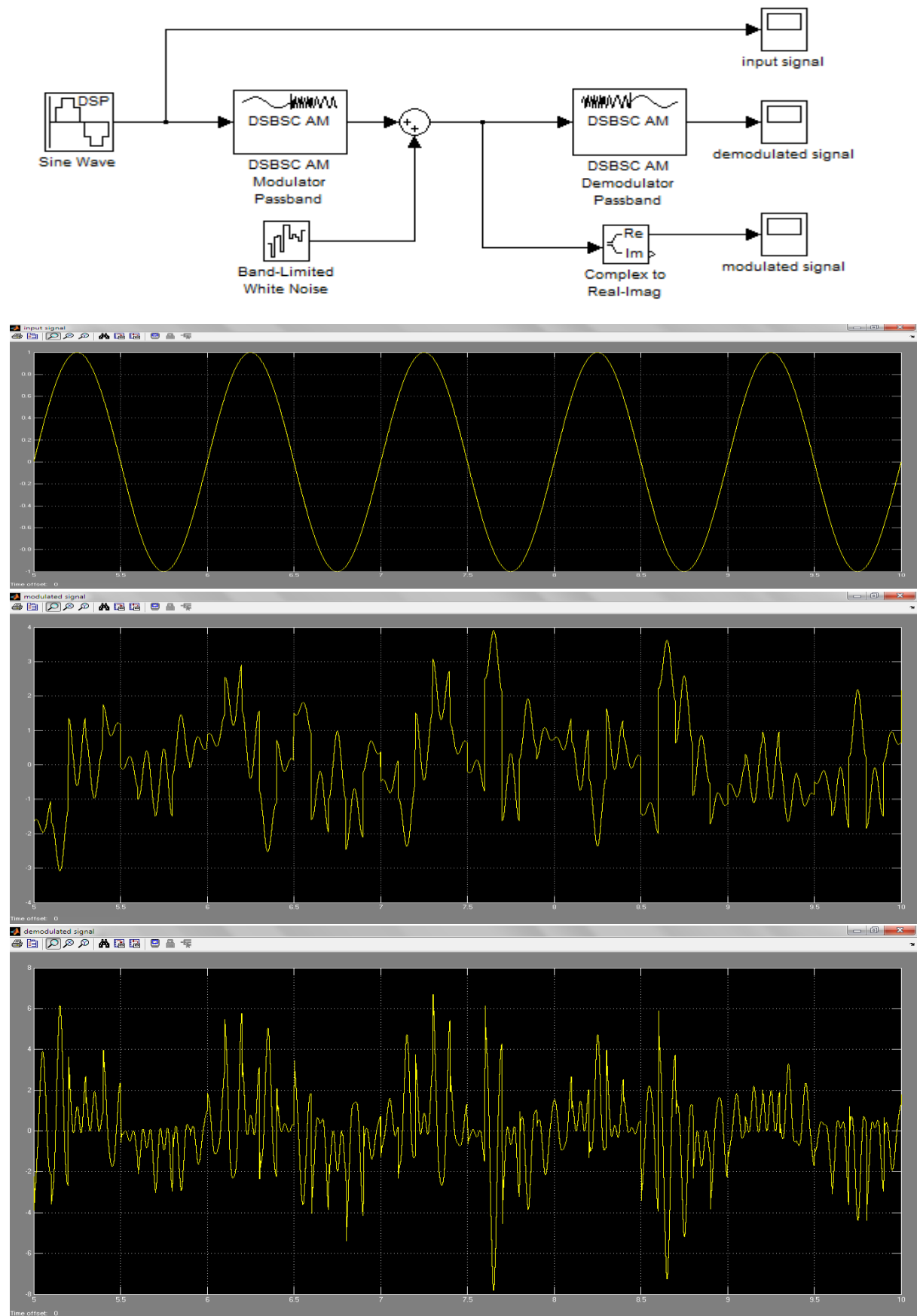
DSB AM Modulators and Demodulators (With Noise):



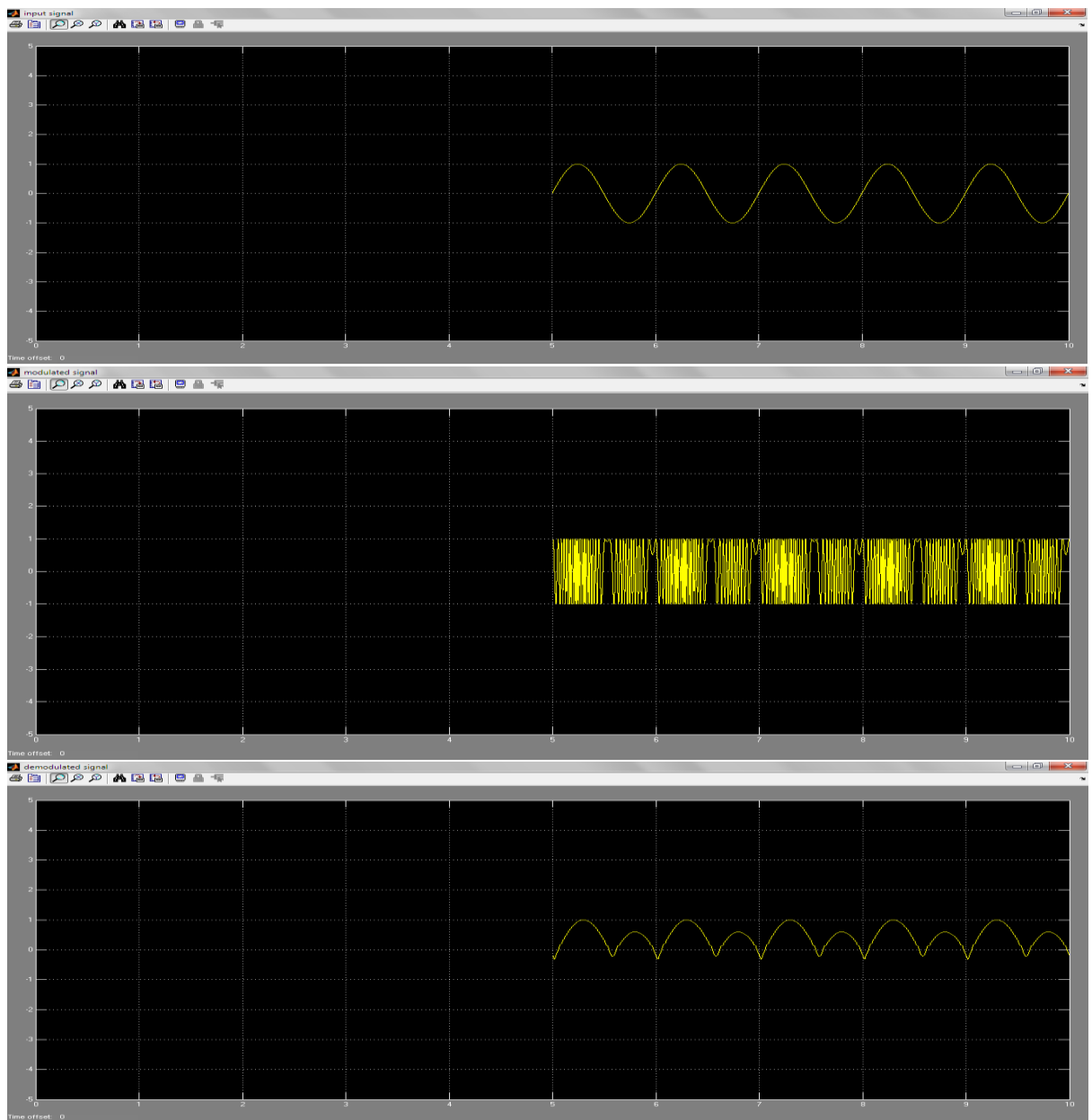
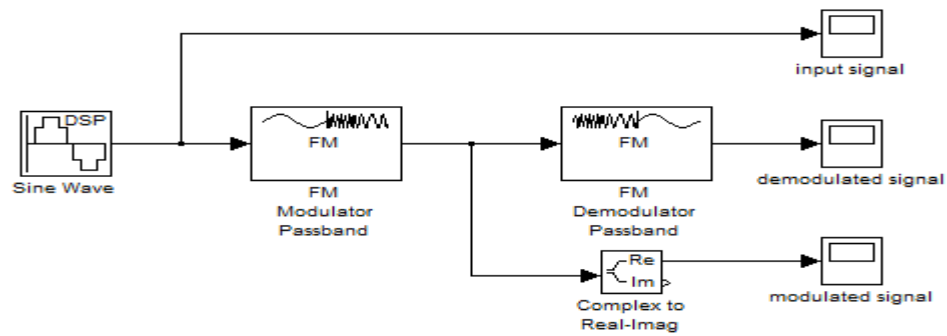
DSBSC AM Modulator and Demodulator (Without Noise):



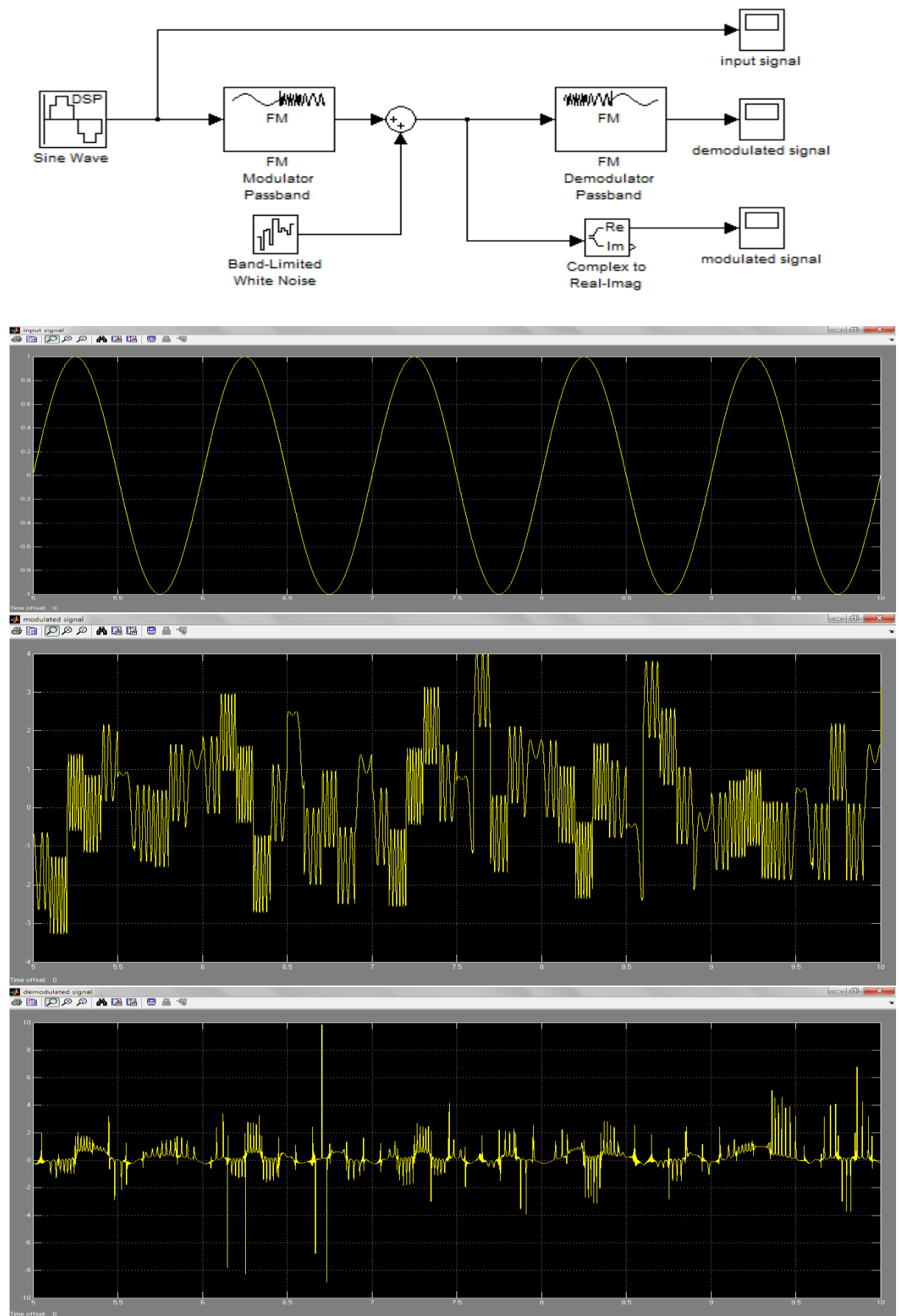
DSBSC AM Modulator and Demodulator (With Noise):



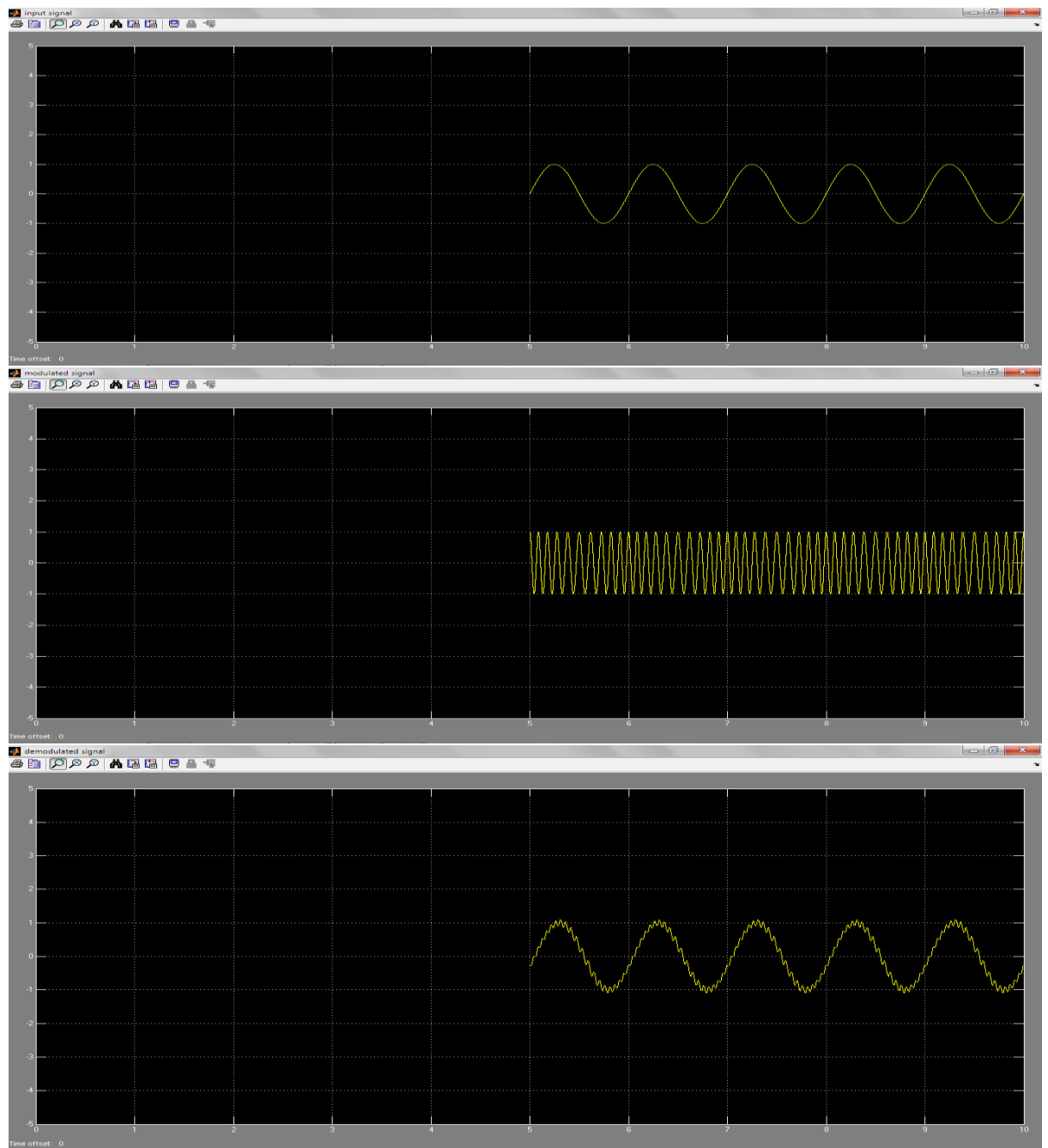
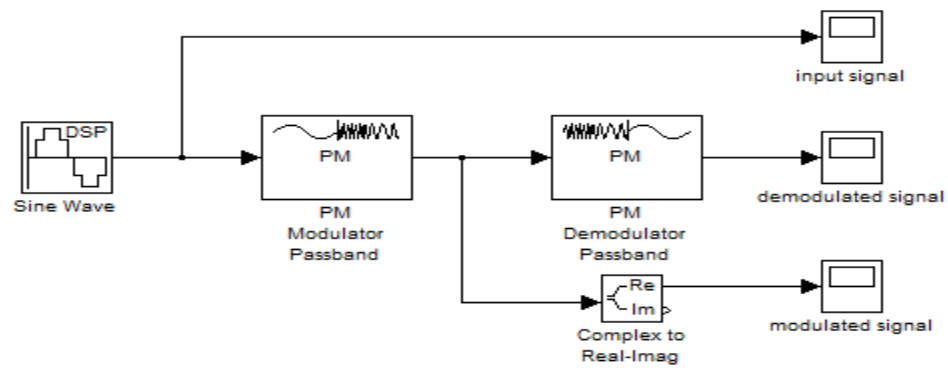
FM Modulator and Demodulator (Without Noise):



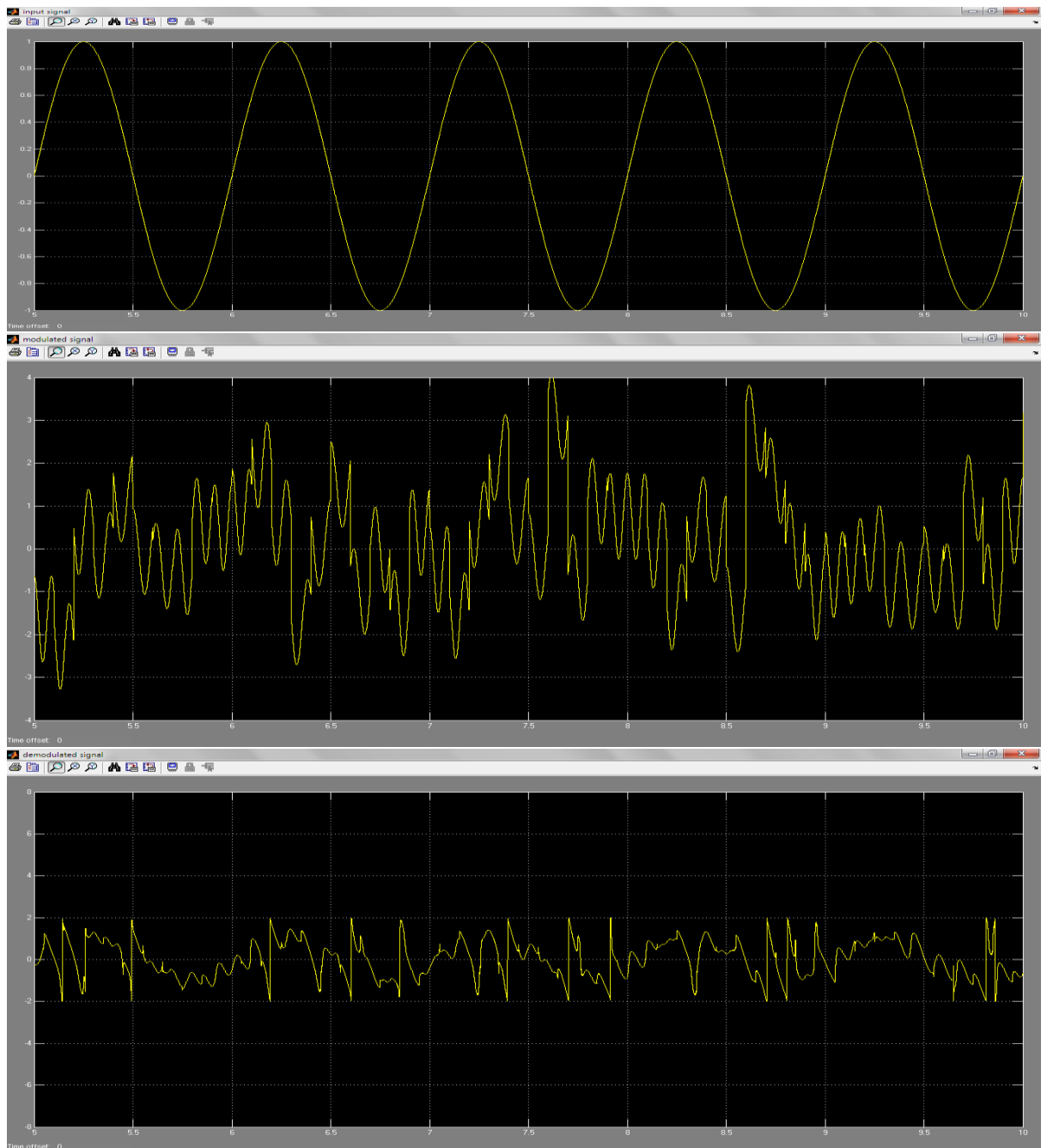
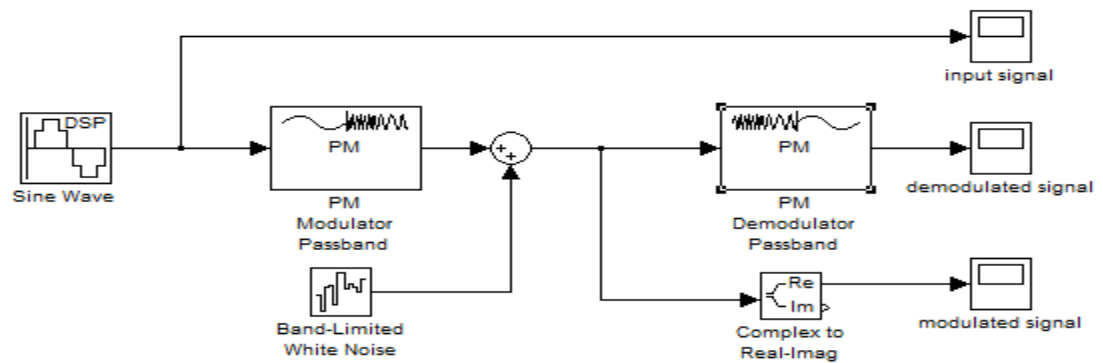
FM Modulator and Demodulator (With Noise):



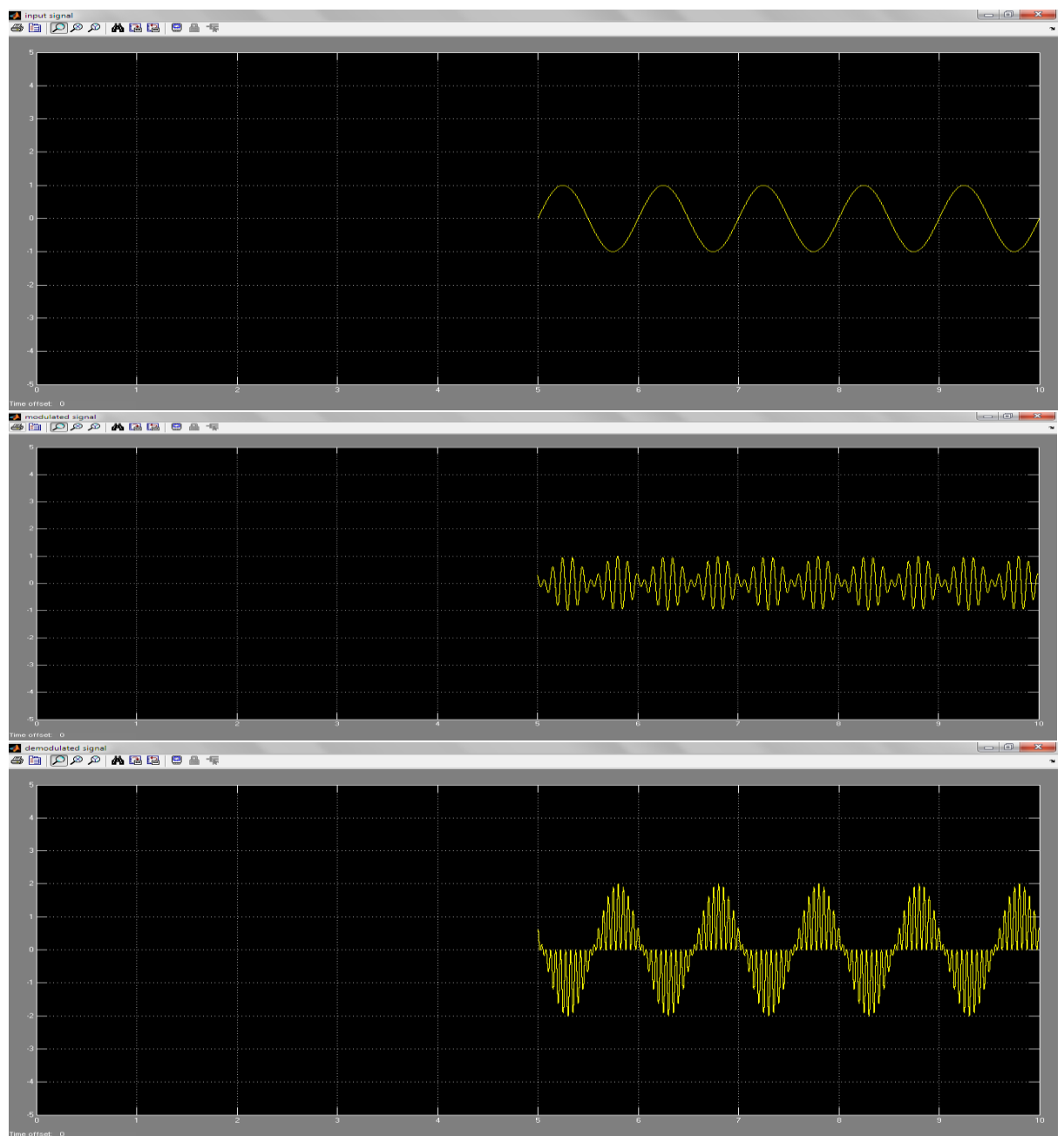
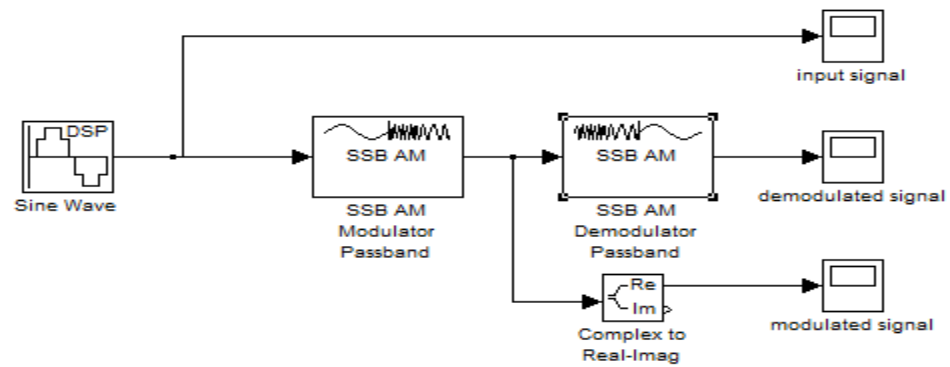
PM Modulator and Demodulator (Without Noise):



PM Modulator and Demodulator (With Noise):



SSB AM Modulator and Demodulator (Without Noise):



SSB AM Modulator and Demodulator (With Noise):

