**DESIGN AND ANALYSIS OF AMPLITUDE AND FREQUENCY
MODULATION USING MATLAB SIMULINK**

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ABSTRACT

In day to day life for communication, message signals need to be transmitted over a wide range without any mixing or interference of another signal. So, Modulation is a process in which the message signal is mixed up with high frequency signal i.e. carrier signal so that it can be used for communication over a long distance. Modulation process is then classified depending on various parameters and

requirements as Amplitude Modulation, Frequency Modulation and Phase Modulation. This paper gives an idea about the types of Modulation Process and brief description about the Amplitude and frequency modulation Modulation technique using Simulink, GUI and Spectrum analyzer .It also explains about working, block diagram, spectrum and variation of waveforms by changing different parameter. Simulink tool is used for designing model for Amplitude modulation. Basically it is software developed by mathworks in MATLAB which gives the advantage of building block diagrams, analyzing dynamic systems and simulating them. Analyzing the response of the amplitude modulation is somewhat tedious, so GUI makes it easier to analyze by varying different parameters. Spectrum analyzer gives output in form of the band of frequency. Using spectrum analyzer, the magnitude of an input signal versus frequency within the full frequency range of the instrument can be measured.

KEYWORDS: *Frequency modulation, MATLAB, SIMULINK, GUI, spectrum analyzer.*

INTRODUCTION

Modulation is the process in which high frequency carrier signal is varied in accordance with message signal which is having low frequency.

This message signal is also called as a modulating signal this modulating signal is also known as base band signal.

The output signal obtained after the modulation is called as the modulated signal. The carrier signal is always greater than the modulating or message or baseband signal.

Amplitude modulation (AM) is obtained if amplitude of the carrier signal is varied in accordance with the modulating signal.

This is all about modulation and its classification. Among all these types of modulation, Amplitude modulation is introduced in detail in this paper.

Simulink is a software which is used for building, simulating and evaluate different systems. it contains various diagramming tools and has a library consisting different functional blocks like adder, differentiator, integrator, gain etc.

Need of Modulation

1. Increases the range of communication: As the message signal is having low frequency, noise signals get easily mixed up with message signal. So message signal or modulating signal gets highly attenuated and cannot travel over a longer distance.

2. Avoid mixing of signal: Since in communication channel noise signal is present. so when message signal gets transmitted through communication channel noise signal gets mixed up. therefore due to amplitude modulation, mixing of signal is avoided.

3. Improve quality of reception: Since due to amplitude modulation, signal can travel over longer distance without distortion. so at receiver when original signal is obtained due to demodulation, quality of received signal will be good.

First part contains brief description about what is amplitude modulation its need, block diagram, waveforms. Second part contains how we can use Simulink model for evaluating amplitude modulation technique, its designing and study of variation in output for different values of modulation index.

Since this paper contains Simulink model on the amplitude modulation, so description about modulation is mentioned below.

Amplitude Modulation

The process in which amplitude of the carrier signal is varied in accordance to the modulating signal is called the amplitude modulation. The carrier voltage and the modulating voltage, v_c and v_m , respectively, be represented by.

$$v_c = V_c \sin \omega_c t$$

$$v_m = V_m \sin \omega_m t.$$

In amplitude modulation, the high frequency carrier signal is used. This high frequency carrier signal is having greater strength as compared to the modulating signal. Thus in amplitude modulation, carrier signal changes as per the instantaneous value of the modulating signal, so that the output obtained after the amplitude modulation can be used for the communication purpose.

Note that Amplitude modulation does not affect the phase of the modulating signal and carrier signal.

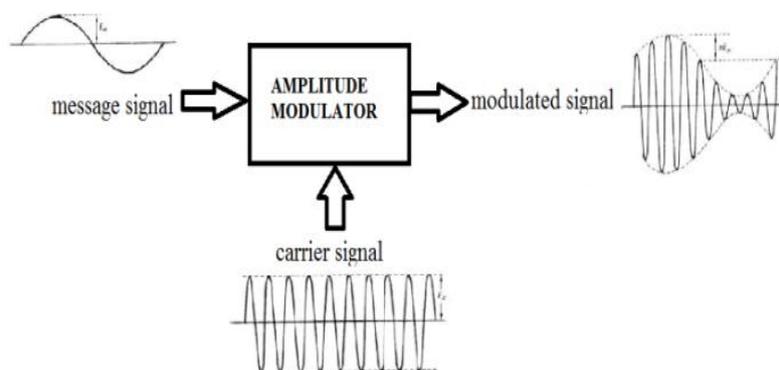


Figure 1: Block Diagram of Amplitude Modulation.

Frequency Modulation

When the frequency of a carrier signal is varied keeping amplitude and phase constant according to the modulated signal then the desired signal obtained is frequency modulated signal.

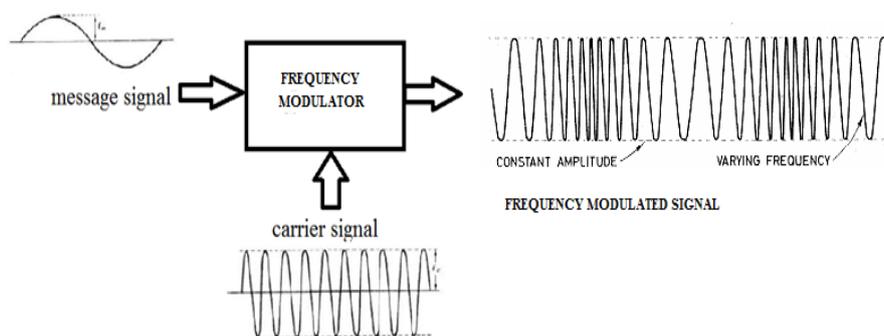


Figure 2: Block Diagram of Frequency Modulation.

Let the message signal will be given by

$$v_m = V_m \sin(\omega_m t + \phi_m)$$

$$v_c = V_c \sin(\omega_c t + \phi_c)$$

Where, v_c = instantaneous value (of voltage and current)

V_c = (maximum) amplitude

ω_c = angular velocity, radians per second (rad/s)

ϕ_c = phase angle, rad.

If any one of these parameters is varied in accordance with another signal, normally of a lower frequency, then the second signal is called the modulating, and the first is said to be modulated by the second. If the frequency of the carrier ω_c is made to vary, frequency modulated wave is obtained. It is assumed that the modulating signal is sinusoidal. This signal has two important parameters which must be represented by the modulation process without distortion, specifically, its amplitude and frequency.

GUI

Graphical User Interfaces in Matlab is very simple. A good place to begin learning about GUI development on the Matlab platform is to first understand how Matlab manages graphical objects. This platform makes an excellent choice for developing interactive interfaces as the previous versions of Matlab had a noticeably clumsier and less mature feel when it came to developing GUI's. Developing GUI's on Matlab is a breeze I would recommend a migration to Matlab as it is a more stable and a more mature platform where many of the bugs, especially in Matlab's ability to handle graphical objects have been addressed.

The main difference between Matlab and the other softwares is the following. Matlab uses Java while the others used C++.

Basically if you see that knowledge of neither platform is necessary to use matlab properly.

Simulation of Amplitude modulation and Frequency modulation using MATLAB Simulink

Using MATLAB Simulink is easy for anyone as the interface designed is very easy to understand. One just need to drag the blocks they need for the desired output from the inbuilt library given.

After placing the blocks on the correct place join them with the arrows and check the output. One can also change the parameters of any block as per requirements by just simply double clicking on it.

Blocks used	Specifications
Sine Block	It is used for the message and the carrier signal.
Gain	It multiplies the input given to it with a constant value.
Product	The output of this block gives a multiplied signal of two incoming signals.
Sum	It is used to add or subtract the inputs given to it.
Display/Scope	This block is used to see the results generated during the simulation.

Simulink Model

Given below is the Simulink model for Amplitude and Frequency Modulation and Demodulation.

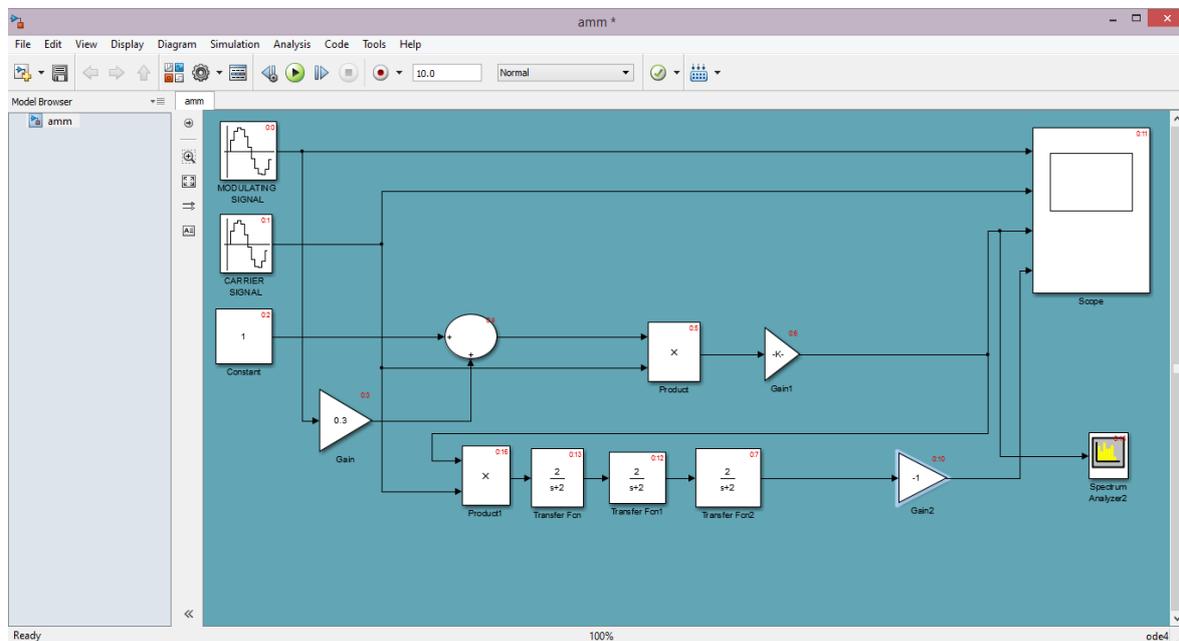


Fig 3: Simulink model of amplitude Modulation and Demodulation using scope and spectrum analyzer,

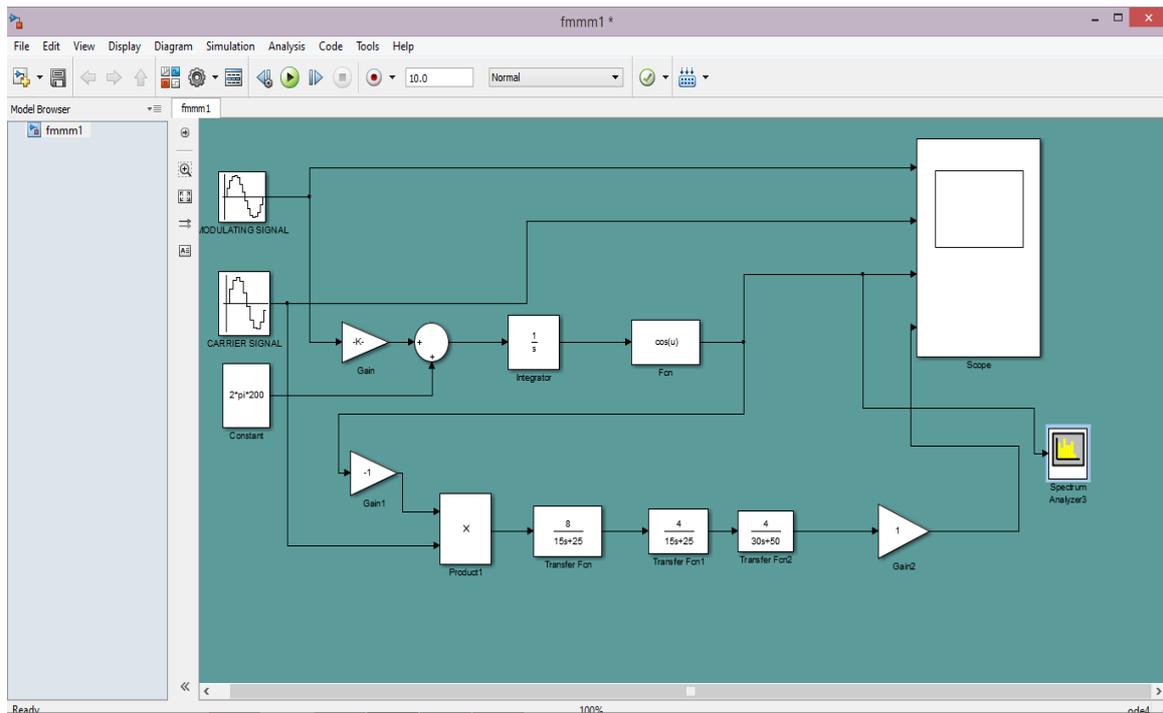


Fig 4: Simulink model of frequency Modulation and Demodulation using scope and spectrum analyzer.

RESULT

Following is the result of the above Simulink model.

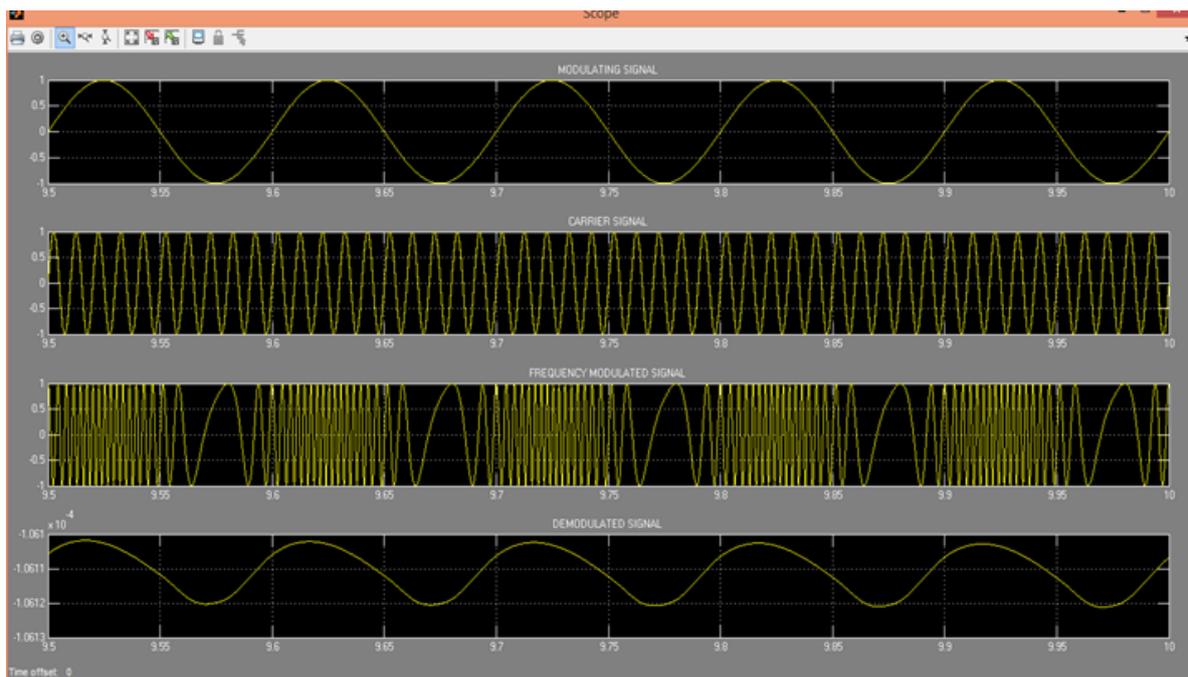


Fig 5: scope output for frequency modulation & demodulation.

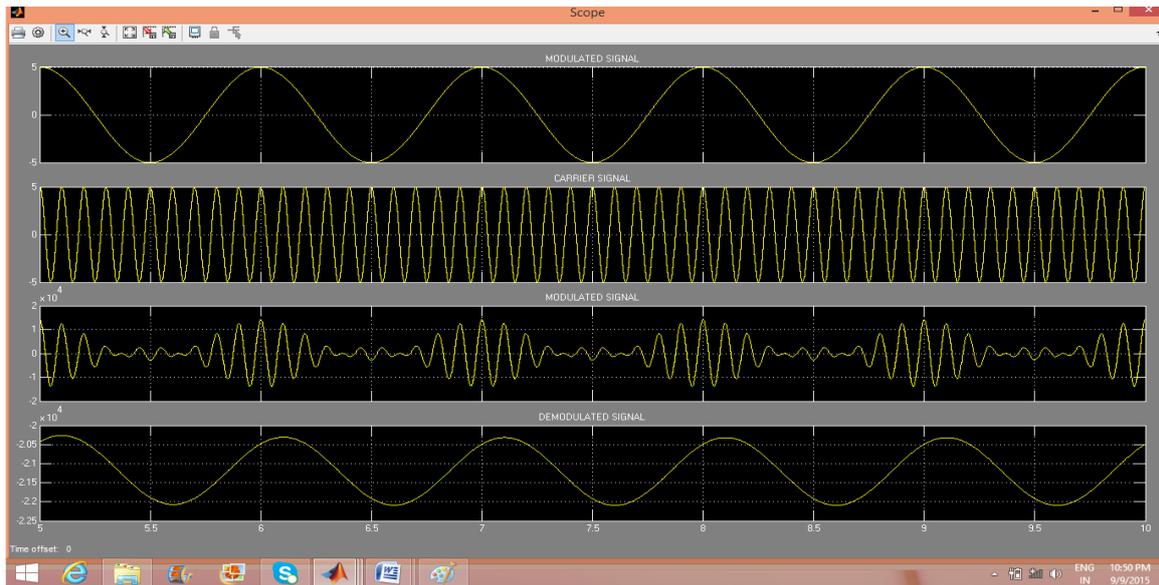


Fig 6: scope output for amplitude modulation & demodulation.

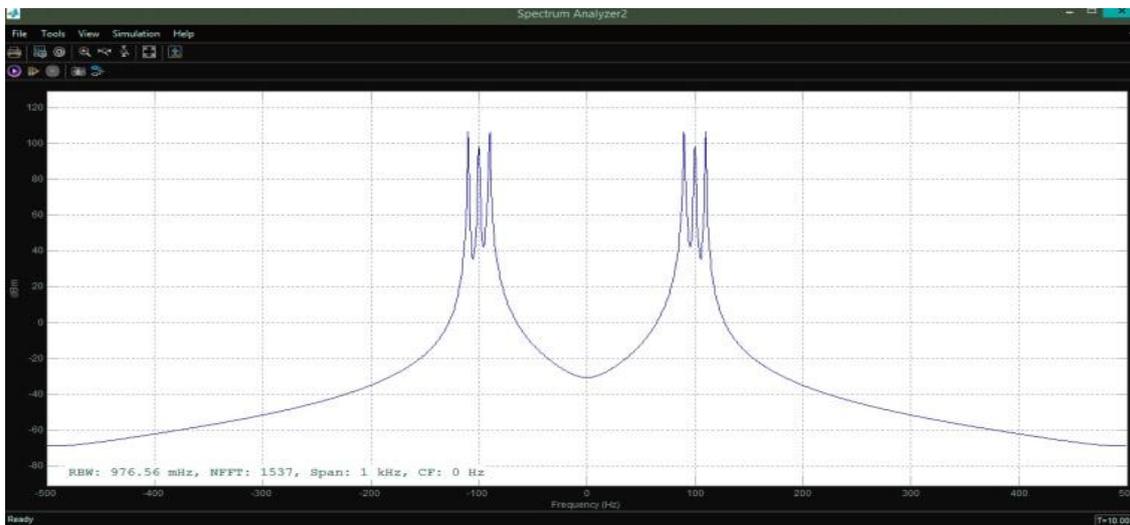


Fig 8: spectrum analyzer output for amplitude modulation.

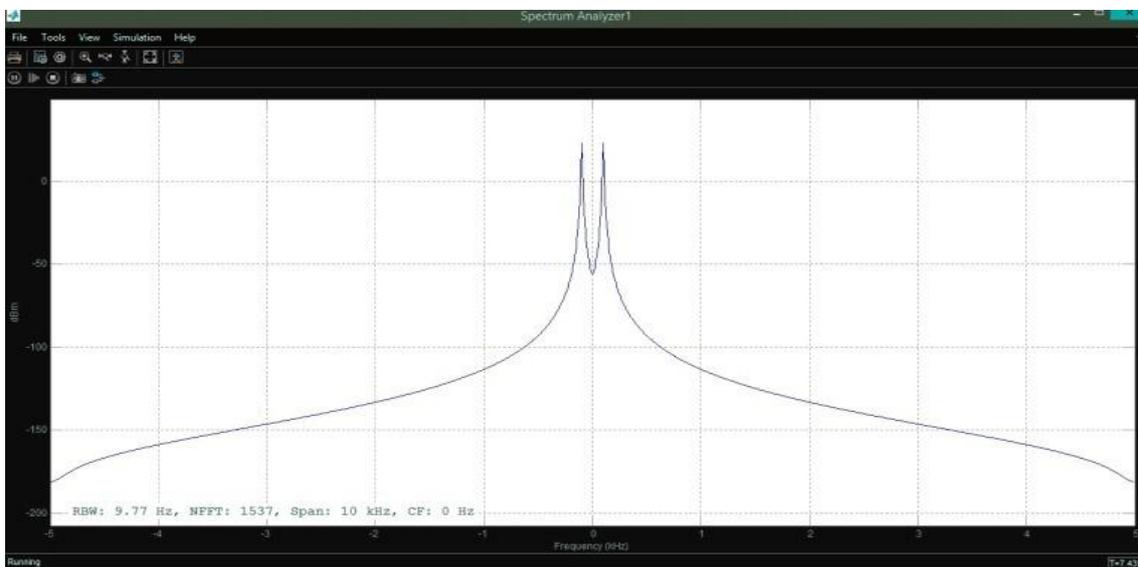


Fig 9: spectrum analyzer output for frequency modulation.

Above graph contains modulating wave, carrier wave, modulated wave and demodulated wave.

- The first waveform is of modulating wave.
- The second waveform is of carrier wave with high frequency.
- The third waveform is of Modulated wave.
- The fourth waveform is Demodulated wave.

AMPLITUDE AND FREQUENCY MODULATION USING GUI.

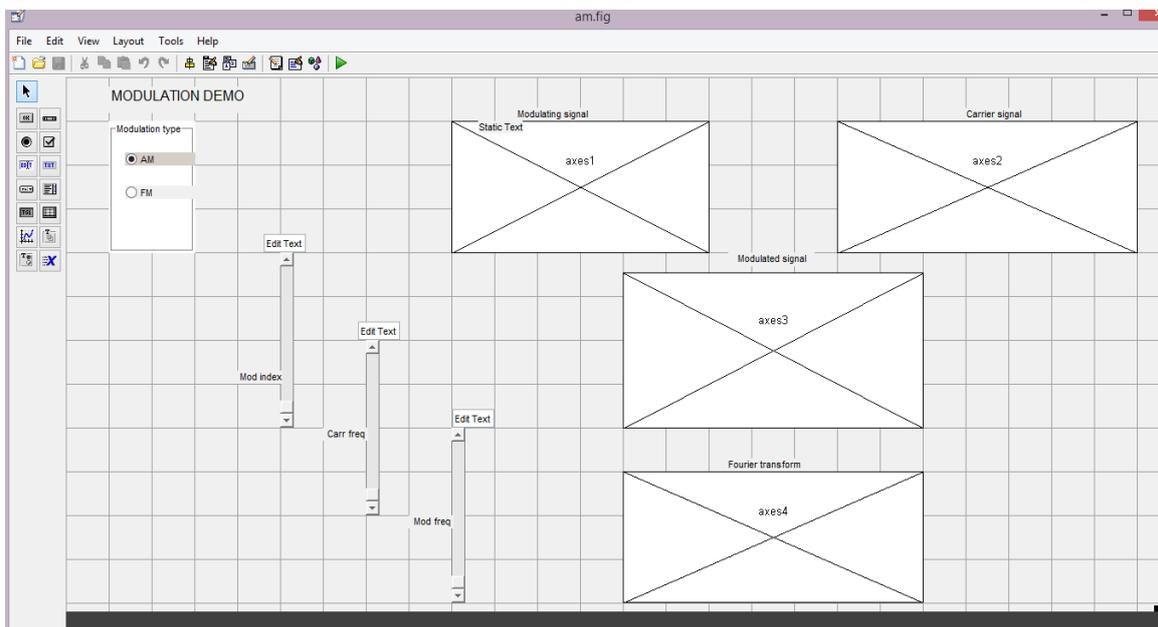


Fig 10: implementing AM and FM on GUI.

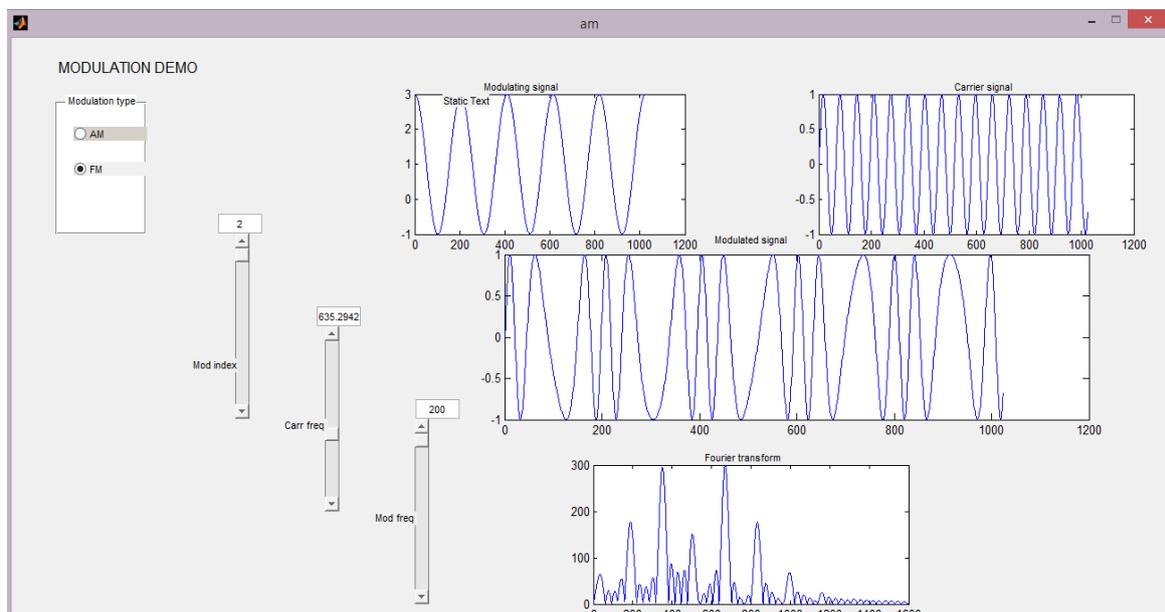


Fig 11: GUI output for frequency modulation.

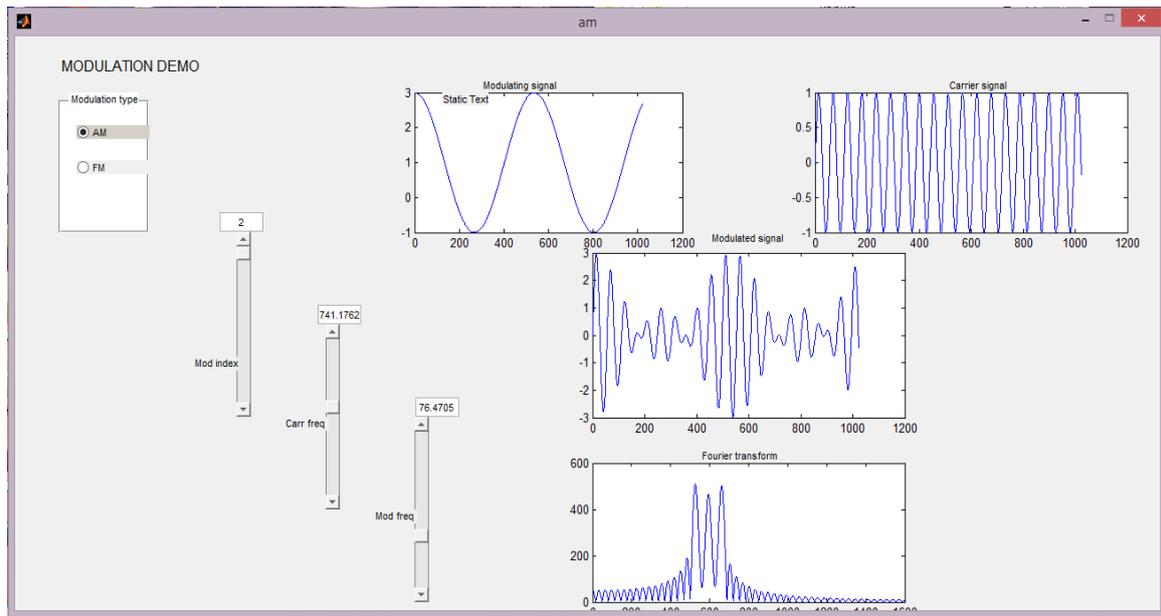


Fig 12: GUI output for amplitude modulation.

GUI TOOLS USED	SPECIFICATIONS
Radio button	These are used as check boxes to select a particular function.
Slider	It is used to choose a specific numeric value.
Axes	It is used to display graphical representation.
Edit text	It is used to display the text given by the user.

CONCLUSION

Thus we have studied the Amplitude and Frequency Modulation and Demodulation using various functional blocks in simulink. Also we analyzed output waveforms of Amplitude and Frequency modulation and Demodulation.

In this we have done spectral analysis of both AM & FM by using spectrum analyzer. GUI makes the working of AM & FM easy to understand for students by observing simply the variation in the waveforms by varying different parameters.

FUTURE SCOPE

The future scope of this paper is that as we have analyzed the amplitude and frequency modulation in simulink, spectrum and GUI. so, the variation in the waveforms and signals can be observed by varying different parameters like modulating frequency, carrier frequency and modulation index.

So it can help in implementing these modulations and also to study the modulation to get the complete knowledge about it and performing various operations so that it can be used for various applications like slope detector, sound mixing and for the broadcasting purpose too as described below.

Broadcasting: Nowadays everywhere digital signal transmission is more preferred over analog signal transmission. Still even today there are few applications which use analogue. Amplitude modulation is still widely used for broadcasting on long, medium and short bands. AM is easy to demodulate and hence the radio receivers able to modulate and demodulate are cheaper and simple to produce.

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