# AUDIO ANALYSIS AND OPERATIONS (VOICE SIGNAL ANALYSIS)

TABLE OF

# CONTENTS



# INTRODUCTION

Throughout the world, communication is a key component. For common people, talking over phone, sending voice messages is just a touch of a button but for us telecommunication Engineers, the reality is very different. We know that how communication actually works. Here we introduce the concept of modulation. Modulation is the process of passing the information on another carrier signal. There are various types of modulation but in this task, we are going to use Amplitude Modulation. AM has its sub types out which we are using the following two:

- Amplitude Modulation Double Side Band Large Carrier (also known as Full Carrier)
- Amplitude Modulation Double Side Band Suppressed Carrier (AM-DSBSC)

# CONCEPTS USED

For the developement of the code we have used some major concepts which are as followed:

- MODULATION
- AMPLITUDE MODULATION
- DEMODULATION
- AUDIO FILTERS

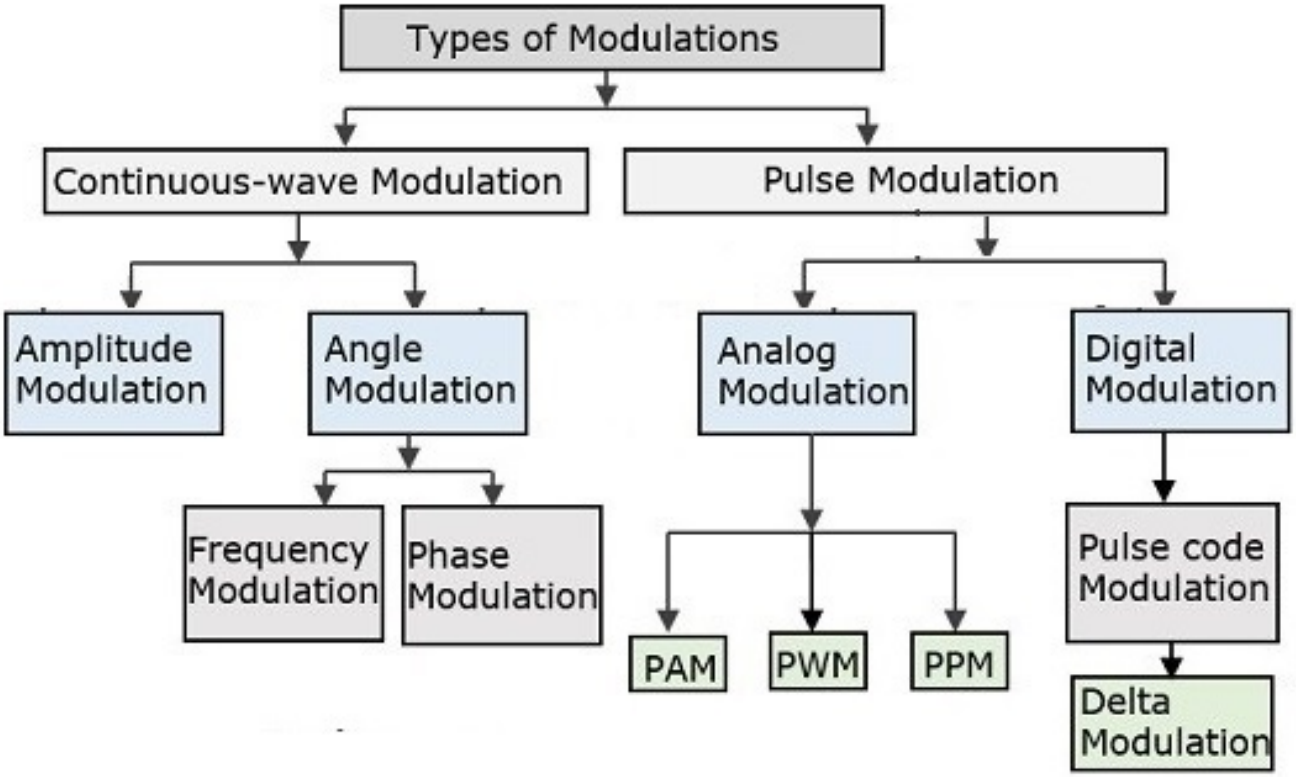
# MODULATION:

For a signal to be transmitted to a distance, without the effect of any external interferences or noise addition and without getting faded away, it has to undergo a process called as Modulation. It improves the strength of the signal without disturbing the parameters of the original signal.

# NEED FOR MODULATION:

Baseband signals are incompatible for direct transmission. For such a signal, to travel longer distances, its strength has to be increased by modulating with a high frequency carrier wave, which doesn't affect the parameters of the modulating signal.

# TYPES OF MODUATION:



# ADVANTAGES OF MODULATION:

The antenna used for transmission, had to be very large, if modulation was not introduced. The range of communication gets limited as the wave cannot travel a distance without getting distorted.

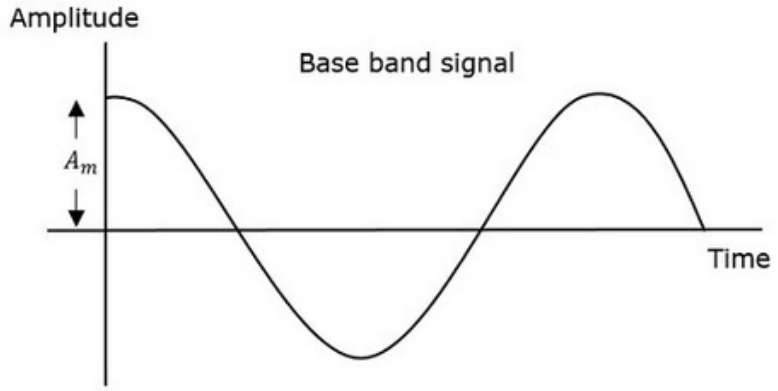
Following are some of the advantages for implementing modulation in the communication systems.

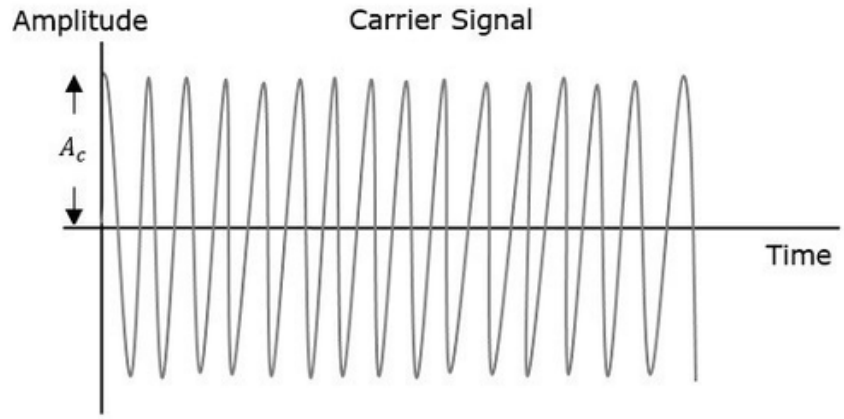
- Reduction of antenna size
- No signal mixing
- Increased communication range
- Multiplexing of signals
- Possibility of bandwidth adjustments
- Improved reception quality

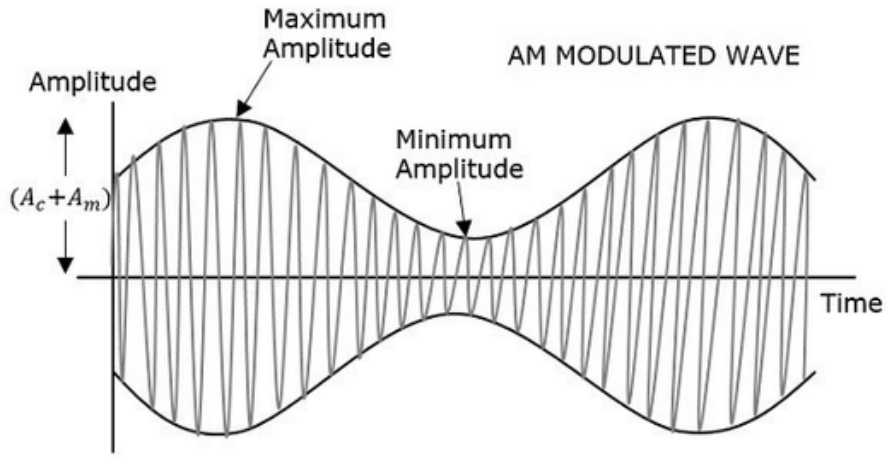
# AMPLITUDE MODULATION:

In continuous-wave modulation, a high frequency sine wave is used as a carrier wave. This is further divided into amplitude and angle modulation.

If the amplitude of the high frequency carrier wave is varied in accordance with the instantaneous amplitude of the modulating signal, then such a technique is called as Amplitude Modulation.


Amplitude
Base band signal
$A_m$
Time

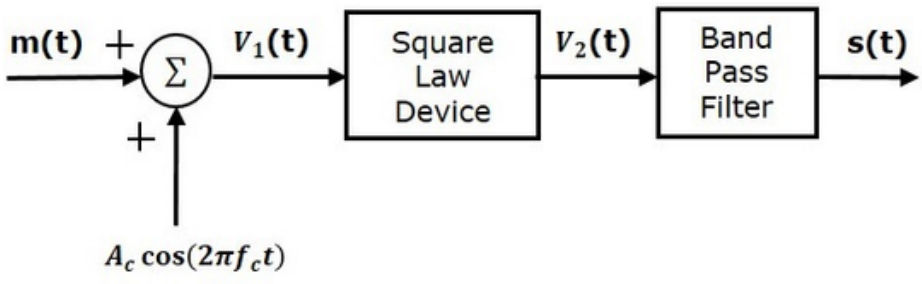

Amplitude
Carrier Signal
$A_c$
Time


Maximum
Amplitude
AM MODULATED WAVE
Amplitude
Minimum
Amplitude
$(A_c+A_m)$
Time

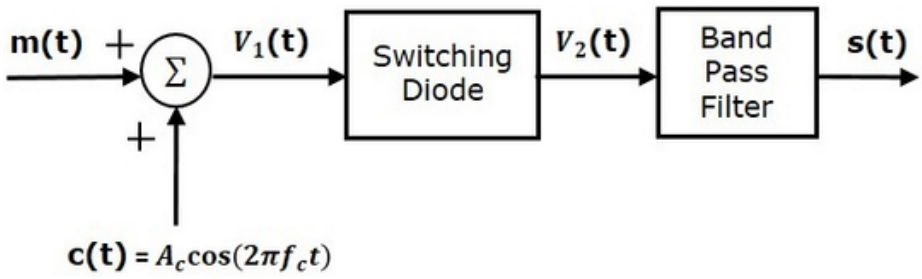
# AMPLITUDE MODULATOR:

The following two modulators generate AM wave.

Square law modulator
Switching modulator




SQUARE LAW MODULATOR




SWITCHING MODULATOR

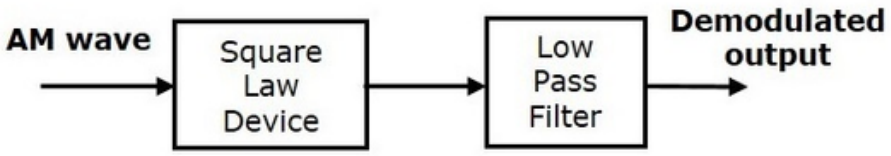
# DEMODULATION:

The process of demodulation always requires a nonlinear operation on a signal in order to estimate a baseband signal proportional to the modulation of the carrier. Based on this nonlinearity, the demodulation methods can be broadly classified as methods using rectification (non-synchronous detection) and methods using mixing with a reference oscillator signal (synchronous detection). For demodulators of the latter class, the reference signal can be either a square wave, most commonly used for analog implementations.

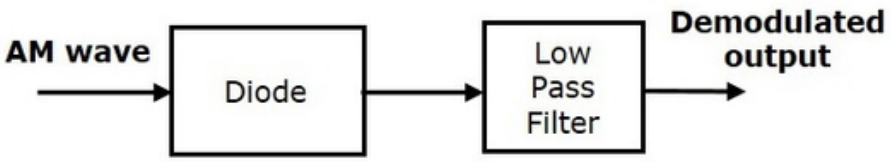
# AMPLITUDE DEMODULATION:

The following demodulators (detectors) are used for demodulating AM wave.

Square Law Demodulator
Envelope Detector




SQUARE LAW DEMODULATOR

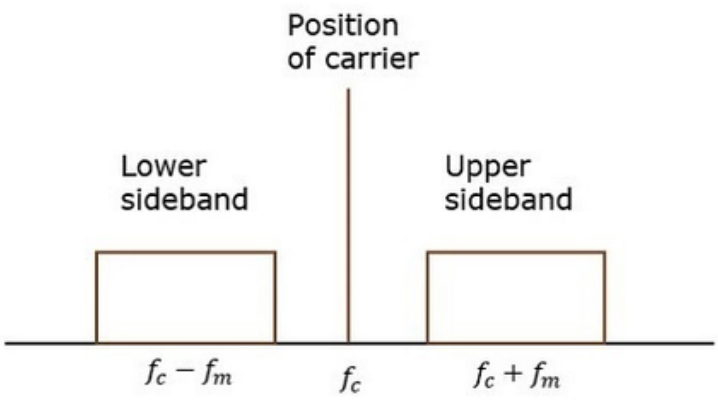



ENVELOPE DETECTOR

# DSB-SC

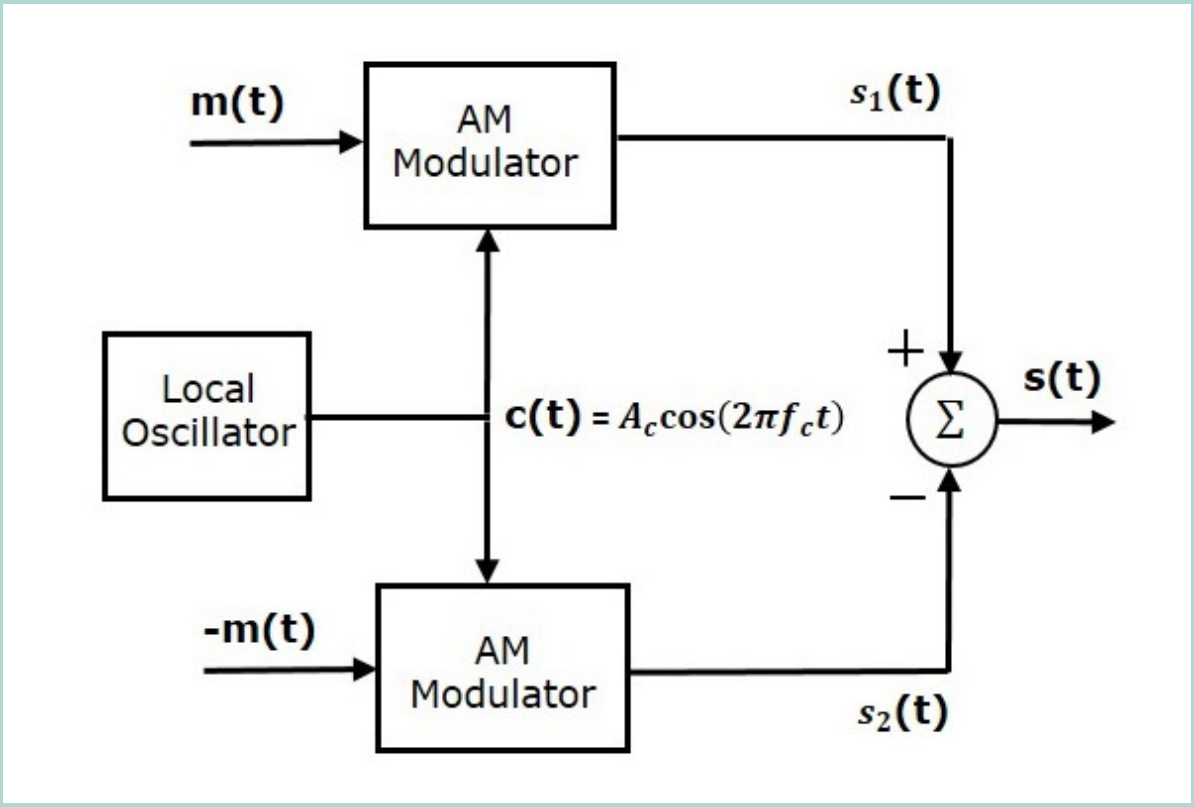
In the process of Amplitude Modulation, the modulated wave consists of the carrier wave and two sidebands. The modulated wave has the information only in the sidebands. Sideband is nothing but a band of frequencies, containing power, which are the lower and higher frequencies of the carrier frequency.

The transmission of a signal, which contains a carrier along with two sidebands can be termed as Double Sideband Full Carrier system or simply DSBFC.



The following two modulators generate DSBSC wave.

Balanced modulator
Ring modulator




BALANCED MODULATOR

# AUDIO FILTERS

An audio filter is a frequency dependent circuit, working in the audio frequency range, 0 Hz to 20 kHz. Audio filters can amplify (boost), pass or attenuate (cut) some frequency ranges. Many types of filters exist for different audio applications including hi-fi stereo systems, musical synthesizers, effects units, sound reinforcement systems, instrument amplifiers and virtual reality systems.

There are 2 types of filters namely:

- High pass filter
- Low pass filter

## Low-pass

Low-pass filters pass through frequencies below their cutoff frequencies, and progressively attenuates frequencies above the cutoff frequency. Low-pass filters are used in audio crossovers to remove high-frequency content from signals being sent to a low-frequency subwoofer system.

## High-pass

A high-pass filter does the opposite, passing high frequencies above the cutoff frequency, and progressively attenuating frequencies below the cutoff frequency. A high-pass filter can be used in an audio crossover to remove low-frequency content from a signal being sent to a tweeter.

# STEPS INVOLVED:

- Take the input from users.
- Record a voice signal
- Filter the Voice signal to remove unwanted Frequencies.
- Apply Modulation (AM-DSBSC)
- Design filter for Demodulation.
- Pass signal through Filter.
- Demodulation process (AM-DSBSC).
- Apply Low Pass Filter.
- Apply Modulation (AM-LC)
- Make envelope detector for Demodulation.
- Demodulation process (AM-LC).
- Apply Low Pass Filter.
- Plot Graphs in time domain.
- Fourier Transformation of signals for Frequency Analysis.
- Shift Frequency signals to origin.
- Plot Graphs in Frequency Domain.

# APPLICATION

The following listed are some of the applications of speech signal .

- Communication through telephones .
- Speech detection .
- Use of speech detection in smart devices like smartwatches or any other smart device like Alexa, Google home or any other AI assistant.
- Use of speech in digital cameras .
- To use the devices like Alexa or google home it requires speech to be delivered by the user .

# REFERENCES


- https://www.techtarget.com/searchnetworking/definition/modulation#:~:text=Modulation%20is%20the%20process%20of,%2C%20or%20amplitude%2C%20and%20frequency.
- https://byjus.com/jee/amplitude-modulation/
- https://www2.ece.ohio-state.edu/~anderson/Outreachfiles/AudioEqualizerPresentation.pdf
- https://www.researchgate.net/publication/344389890_Audio_signal_Processing_using_MATLAB