UNIT I

ANALOG TRANSMISSION

Digital-to-Analog Conversion

- When data from one computer is sent to another via some analog carrier, it is first converted into analog signals. Analog signals are modified to reflect digital data.

- An analog signal is characterized by its amplitude, frequency, and phase.

- There are three kinds of digital-to-analog conversions:

➢ **Amplitude Shift Keying**

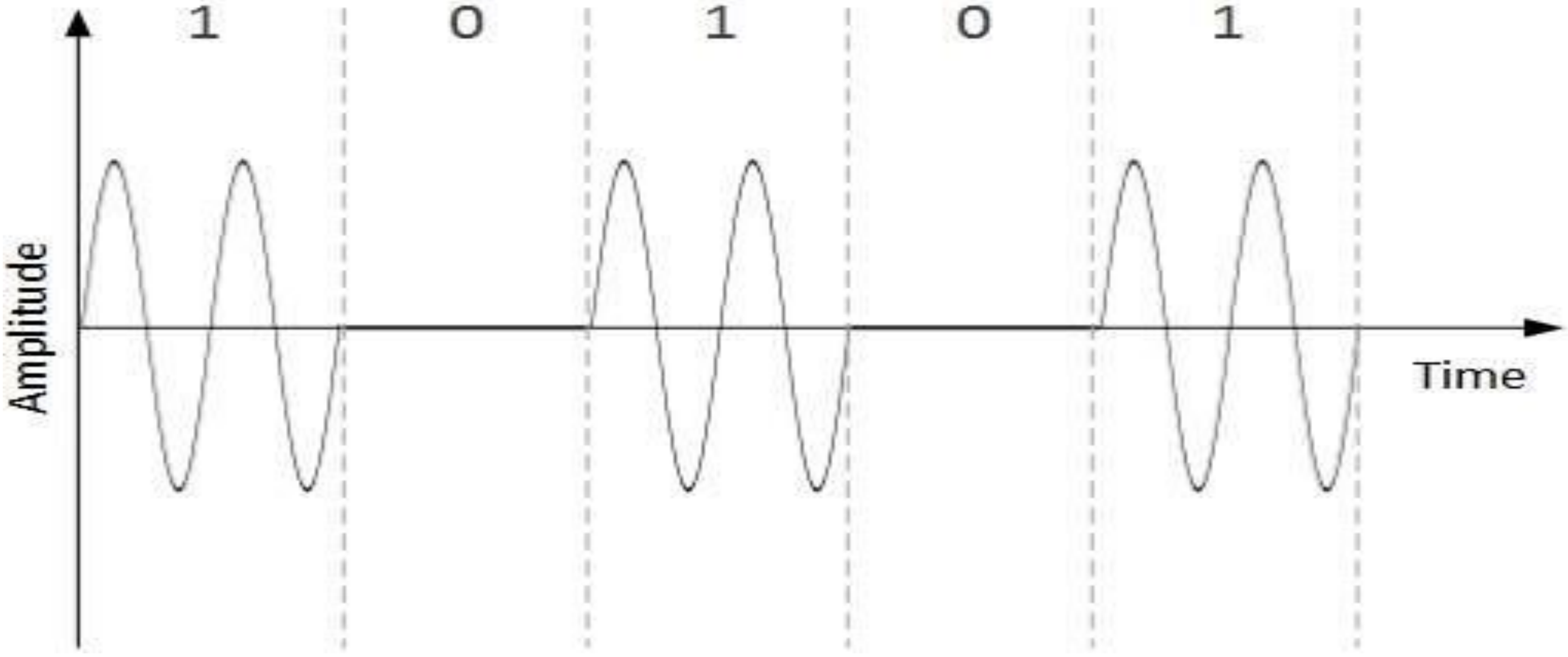
➢ **Frequency Shift Keying**

➢ **Phase Shift Keying**

Amplitude Shift Keying

- In this conversion technique, the amplitude of analog carrier signal is modified to reflect binary data.

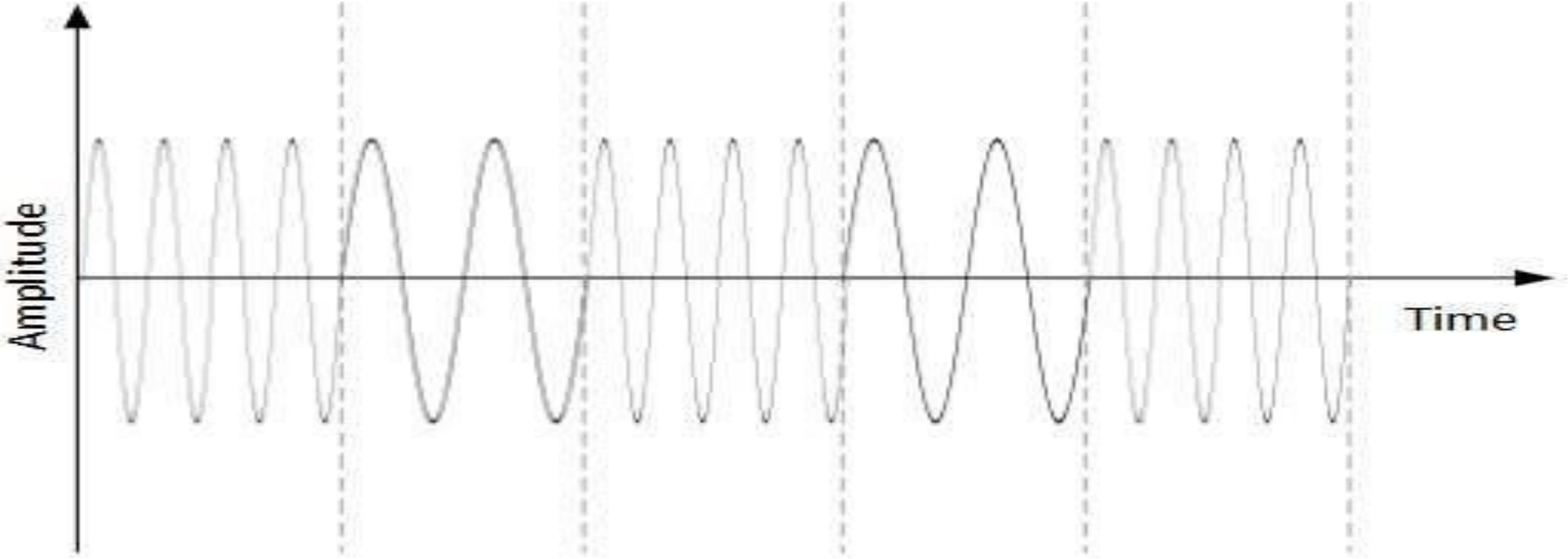
- When binary data represents digit 1, the amplitude is held; otherwise it is set to 0. Both frequency and phase remain same as in the original carrier signal.



Frequency Shift Keying

- In this conversion technique, the frequency of the analog carrier signal is modified to reflect binary data.

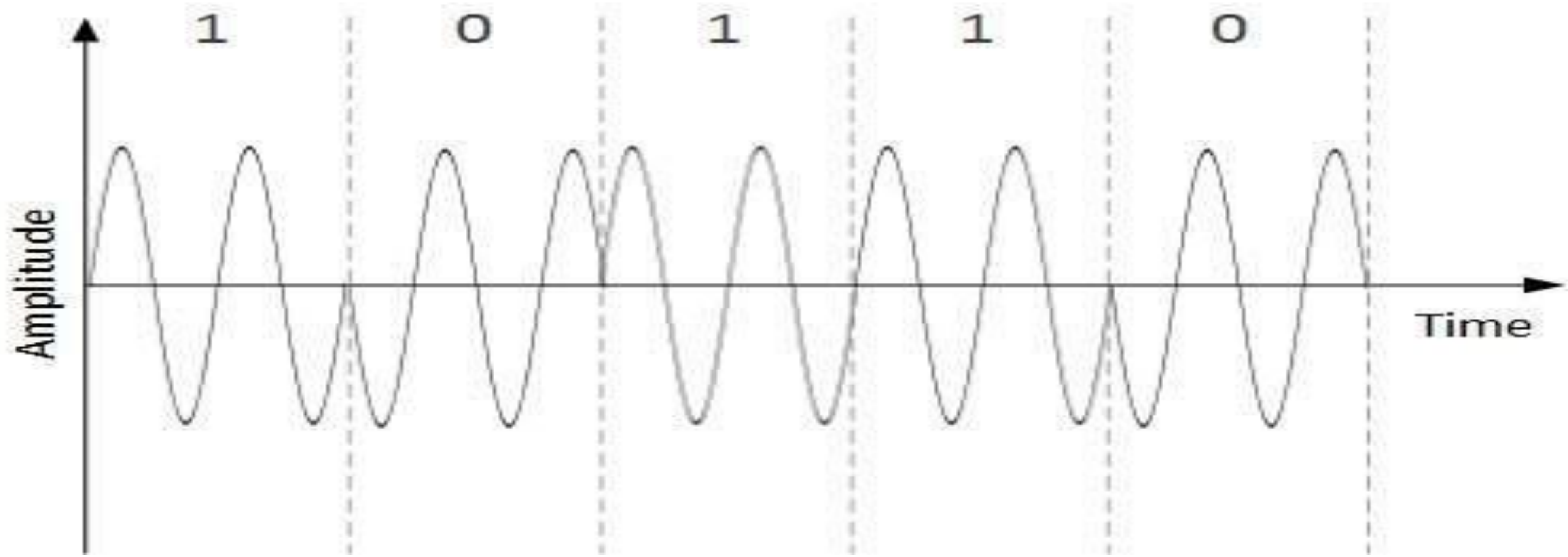
- This technique uses two frequencies, f1 and f2. One of them, for example f1, is chosen to represent binary digit 1 and the other one is used to represent binary digit 0. Both amplitude and phase of the carrier wave are kept intact.

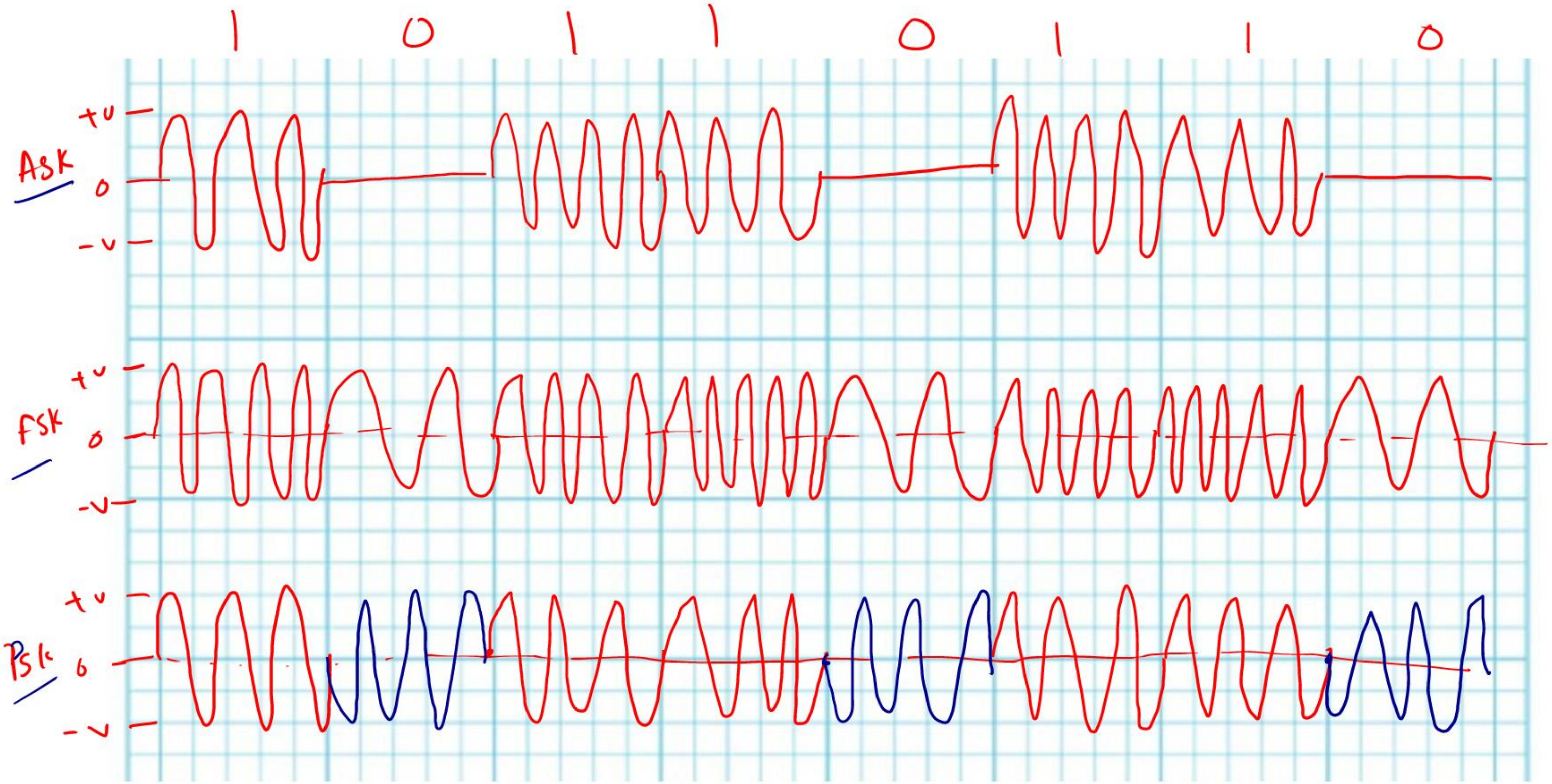


Phase Shift Keying

- In this conversion scheme, the phase of the original carrier signal is altered to reflect the binary data.

- When a new binary symbol is encountered, the phase of the signal is altered. Amplitude and frequency of the original carrier signal is kept intact.




1 0 1 1 0 1 1 0
ASK
+v
0
-v
FSK
+v
0
-v
PSK
+v
0
-v

<u>Modulation of Analog Signals</u>

What is Modulation?

- A message carrying a signal has to get transmitted over a distance and for it to establish a reliable communication, it needs to take the help of a high frequency signal which should not affect the original characteristics of the message signal.

- The characteristics of the message signal, if changed, the message contained in it also alters. Hence, it is a must to take care of the message signal. A high frequency signal can travel up to a longer distance, without getting affected by external disturbances.

- We take the help of such high frequency signal which is called as a **carrier signal** to transmit our message signal. Such a process is simply called as Modulation.

- **Modulation** is the process of changing the parameters of the carrier signal, in accordance with the instantaneous values of the modulating 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.

Signals in the Modulation Process

- The signal which contains a message to be transmitted, is called as a **message signal**.

- It is a baseband signal, which has to undergo the process of modulation, to get transmitted. Hence, it is also called as the **modulating signal**.

Carrier Signal

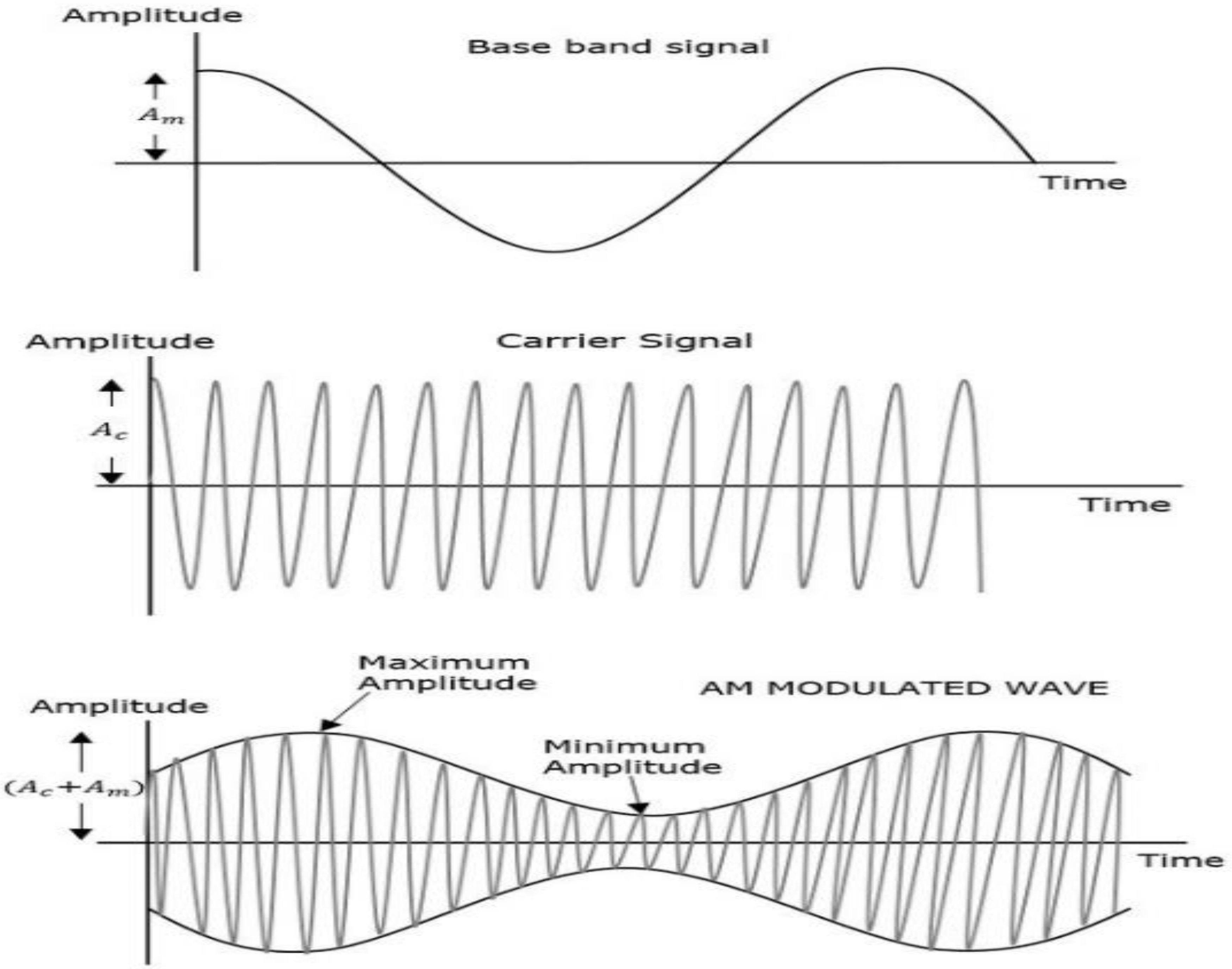
- The high frequency signal, which has a certain amplitude, frequency and phase but contains no information is called as a **carrier signal**.
- It is an empty signal and is used to carry the signal to the receiver after modulation.

Modulated Signal

- The resultant signal after the process of modulation is called as a **modulated signal**.
- This signal is a combination of modulating signal and carrier signal.

Analog to Analog conversion can be done in three ways:

- Amplitude Modulation(AM)
- Frequency Modulation(FM)
- Phase Modulation(PM)


Amplitude
Base band signal
A_m
Time
Amplitude
Carrier Signal
A_c
Time
Maximum
Amplitude
AM MODULATED WAVE
Amplitude
(A_c+A_m)
Minimum
Amplitude
Time

* AM (Mathematical Representation of AM)

Modulating signal e_m

$$\boxed{e_m = E_m \cos \omega_m t} \quad \text{——— (1)}$$

e_m = instantaneous amplitude

E_m = Peak amplitude

$\omega_m = 2\pi f_m$

f_m = frequency

Carrier Signal

$$\boxed{e_c = E_c \cos \omega_c t} \quad \text{——— (2)}$$

E_c = Peak amplitude

f_c = carrier frequency

AM can be represented as

$$e_{AM} = A\cos(2\pi f_c t) \quad \text{--- (2)}$$

$A \rightarrow$ Envelop of AM waves.

$$A = E_c + e_m$$

Substitute $e_m = E_m \cos \omega_m t$

$$A = E_c + E_m \cos \omega_m t$$

Substitute A in (2)

~~$e_{Am} = E_c + E_m$~~

$$\boxed{e_{Am} = E_c\left[1 + m\cos(2\pi f_m t)\right]\cos(2\pi f_c t)}$$

This is the time domain Representation of AM

$$e_{AM} = (E_c + E_m \cos \omega_m t)\cos(2\pi f_c t) \quad \text{— (3)}$$

$$e_{AM} = E_c\left[1 + \frac{E_m}{E_c}\cos(2\pi f_m t)\right]\cos 2\pi f_c t \quad \text{— (3)}$$

let $m = \dfrac{E_m}{E_c}$ - be the modulation index

in (3)

* Modulation Index or Modulation factor

$$\boxed{m = \frac{E_m}{E_c}}$$

when $E_m < E_c$
then have value less" of 1 & no distortion is introduced in AM

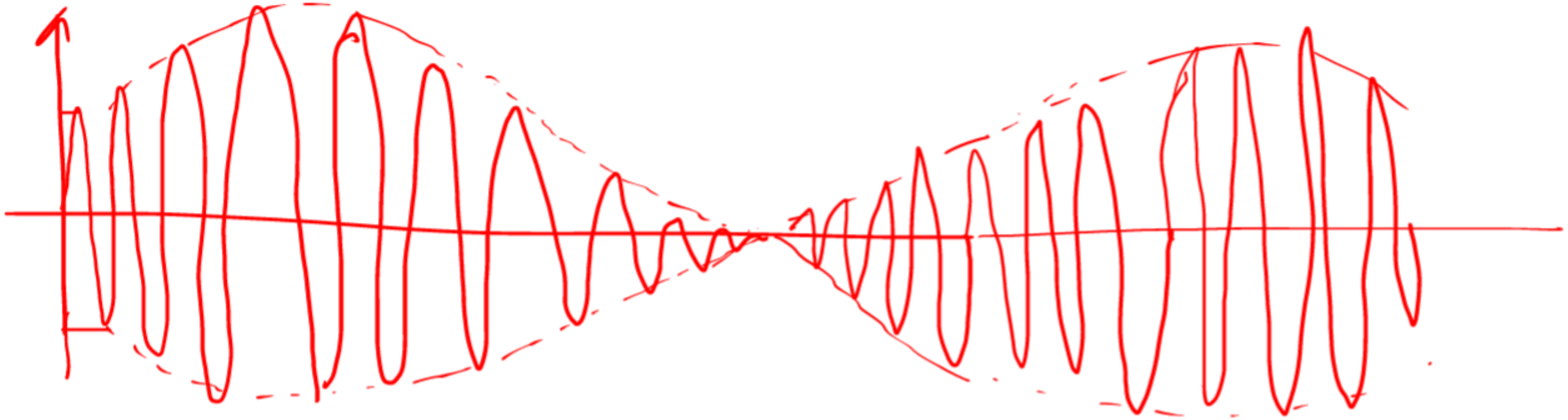
when $E_m > E_c$

$m > 1$

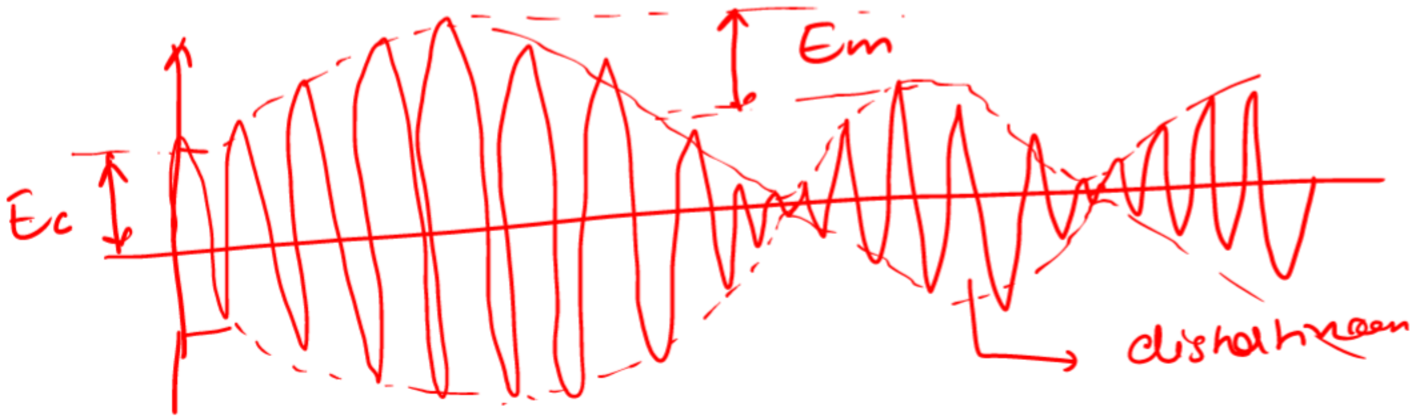
this distorted the shape of AM. which is called as over modulation

AM wave with $m = 1$ i.e 100% modulation

$E_m = E_c$



AM wave with $m > 1$ (overmodulation)



distortion due to overmodulation