Nalanda Open University
B.Sc. Part-III

Course-Physics
Paper-VIII

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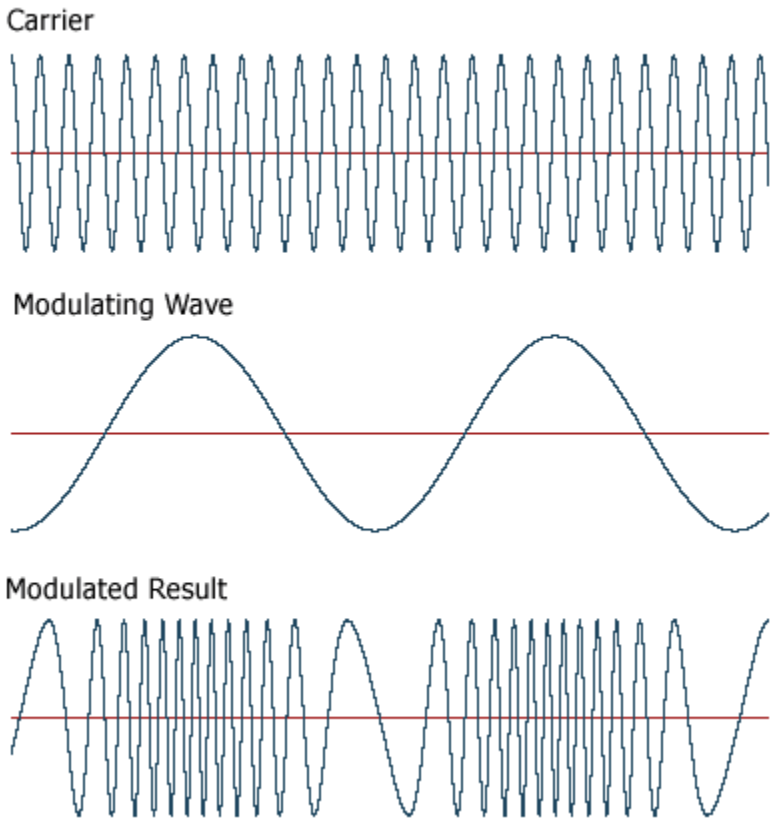
Topic:- Principle of frequency modulation:-The frequency of the carrier signal is varied proportional to the Amplitude of the input modulating signal. The input is a single tone sine wave.The carrier and the FM wave form also shown in the following figure:



The range of frequency of speech or music is 20Hz to 20,000 Hz. This range of frequency is called Audio Frequency (A.F.). The wave of frequency less than 16000 Hz can not be transmitted to long distance directly. Thus, in order to carry the A.F. waves; Radio Frequency (R.F) waves are used. The superposition of A.F. waves over the R.F waves is known as modulation.

Modulating voltage is the signal while the voltage undergoing the alteration is the carrier wave. The carrier voltage at any time is represented by:

$$e_c = E_c \text{ Cos } (W_c t + \Theta),$$

where, E_c = Amplitude of the carrier voltage
W_c = Frequency of the carrier voltage
Θ = Phase angle of the carrier voltage

If the frequency W_c is varied in accordance with the modulating wave, while E_c and Θ remain constant, the process is known as **frequency modulation.**

The frequency of a carrier (f_c) will increase as the amplitude of modulating (input) signal increases. The carrier frequency will be maximum (f_c max.) when the input signal is at its peak. The carrier deviates maximum from its normal value and the frequency of a carrier will decrease as the amplitude of the modulating input signal decreases. The carrier frequency will be minimum (f_c min) when the input signal is at its lowest.

The carrier deviates minimum from its normal value. The frequency of the carrier will be at its normal value (free running) f_c when the input signal value is 0 V. There is no deviation in the carrier.

Frequency deviation:- The amount of change in the carrier frequency produced, by the amplitude of the input modulating signal is called frequency deviation. The carrier frequency swings between f_{max} and f_{min} as the input varies in its amplitude. The difference between f_{max} and f_c is known as frequency deviation.

$$f\,d = f_{max} - f_c$$

Similarly, the difference between f_c and f_{min} also is known as frequency deviation.

$f\,d = f_c - f_{min}$. It is denoted by Δf.

Therefore, $\Delta f = f_{max} - f_c = f_c - f_{min}$

Therefore, $fd = f_{max} - f_c = f_c - f_{min}$

Frequency Modulation Equation and modulation index of FM:-

The FM equation include the following

$$V = A \text{ Sin } [wct + (\Delta f/fm) \text{ sin } wmt]$$

or, $V = A \sin [wct + mf \sin wmt]$

where, A=Amplitude of the FM signal. Δf = Frequency Deviation

mf = modulation index of FM;
$mf = \Delta f/fm$
$wm = 2\pi fm$ $wc = 2\pi fc$

Therefore, the modulation index of frequency modulation is defined as the ratio of the frequency deviation of the carrier to the frequency of the modulating signal.
The applications of frequency modulation include in FM radio broadcasting, radar, seismic prospecting, telemetry, observing infants for seizure through EEG, music synthesis, two-way radio systems, magnetic tape, recording systems, video broadcast system, etc.