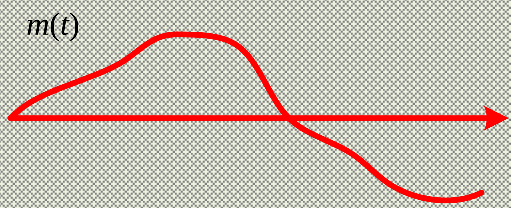
Amplitude Modulation

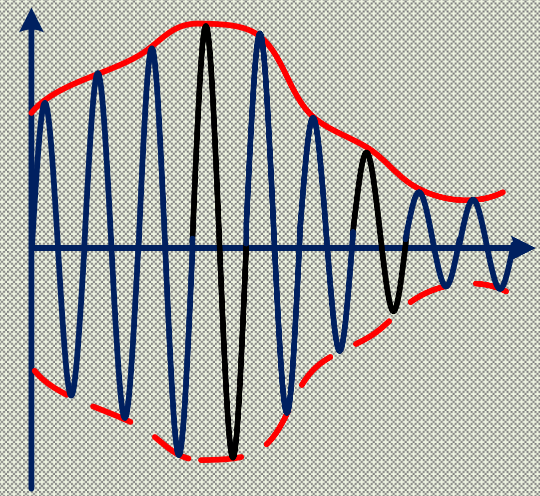
Lecture - 1

The modulating Signal



The Carrier Signal

The AM signal



By:
Dr. Akhilesh Kumar Gupta

Modulation

- **Modulating Signal:** **Message Signal** **or** **Baseband Signal** **or** **Information carrying Signal**
- **Carrier signal:** **High frequency signal** whose property varies according to message signal.

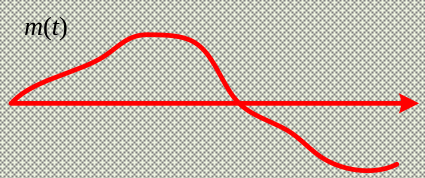
Modulati **a carrier signal** **(a high-frequen** **ntaneous value of the baseba**

Modulat ng the modulating signal and carrier si

Amplitude Modulation

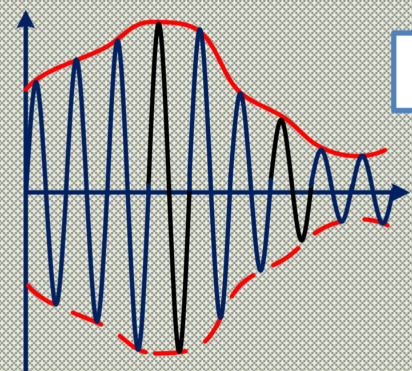
As the name indicates the term **"Amplitude"**, in this approach, the amplitude of the carrier signal is varied in accordance with the instantaneous value of modulating signal.

जैसा कि नाम **"आयाम"** शब्द को इंगित करता है, इस दृष्टिकोण में, वाहक सिग्नल का आयाम, मॉड्यूलेटिंग सिग्नल के तात्कालिक मान के अनुसार बदलता है ।



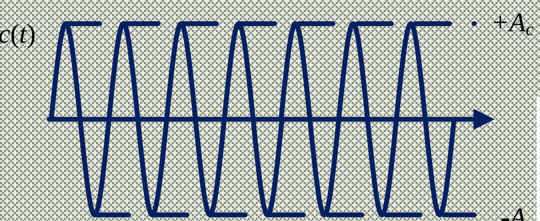
The Modulating Signal

$$m(t) = A_m \cos(\omega_m t)$$



The Modulated Signal

$$\phi_{AM}(t) = \left(A_c + m(t)\right)\cos(\omega_c t)$$



The Carrier Signal

$$c(t) = A_c \cos(\omega_c t)$$

$$\begin{aligned}\phi_{AM}(t) &= \left(A_c + A_m \cos\omega_m t\right)\cos\omega_c t \\ &= A_c\left(1 + \frac{A_m}{A_c}\cos\omega_m t\right)\cos\omega_c t \\ &= A_c\left(1 + m_a \cos\omega_m t\right)\cos\omega_c t\end{aligned}$$

Amplitude Modulation

Modulation Index - The ratio between the amplitudes of the modulating signal and carrier, expressed by the equation:

$$m_a = \frac{\left|m(t)\right|_{\max}}{A_c}$$

Modulation index is also known **as depth of modulation, degree of modulation** and **modulation factor.**

Bandwidth- The bandwidth of AM wave is twice the bandwidth of the baseband signal.

$$BW = 2\omega_m$$

Power content in AM signal

The power of any signal is the mean square value of that signal.

किसी सिग्नल की पॉवर उस सिग्नल का औसत वर्ग मान होती है ।

The AM signal :
$$\phi_{\mathrm{AM}}(t) = \underbrace{A_c \cos \omega_c t}_{\text{Carrier part}} + \underbrace{m(t)\cos \omega_c t}_{\text{Message part}}$$

Carrier Power:
$$P_c = \overline{\left[A_c \cos \omega_c t\right]^2} = \frac{A_c^2}{2}$$

Sidebands Power:
$$P_s = \overline{\left[m(t)\cos \omega_c t\right]^2} = \frac{\overline{[m(t)]^2}}{2}$$

Therefore, total AM power is given by
$$P_T = P_c + P_s$$

$$P_T = \frac{1}{2}\left[A_c^2 + \overline{m^2(t)}\right]$$

Power content and Transmission Efficiency of AM signal

The power of any signal is the mean square value of that signal.

किसी सिग्नल की पॉवर उस सिग्नल का औसत वर्ग मान होती है ।

The AM signal :

$$\begin{aligned}\phi_{AM}(t) &= \left(A_c + A_m \cos\omega_m t\right)\cos\omega_c t\\ &= A_c\left(1+\frac{A_m}{A_c}\cos\omega_m t\right)\cos\omega_c t\\ &= A_c\left(1+m_a\cos\omega_m t\right)\cos\omega_c t\\ &= A_c\cos\omega_c t + m_a A_c\cos\omega_m t\cos\omega_c t\end{aligned}$$

Therefore, total

AM power is given by

$$P_T = \frac{1}{2}A_c^2 + \frac{1}{4}m_a^2A_c^2 \Rightarrow \frac{1}{2}A_c^2\left[1+\frac{m_a^2}{2}\right]$$

$$\Rightarrow P_c\left[1+\frac{m_a^2}{2}\right]$$

For 100 percent modulation $m_a = 1$

$$(\eta)_{AM} = \frac{1}{[2+1]}\times 100 = 33.3\%$$

$$(\eta)_{AM} = \frac{P_s}{P_T}\times 100 = \frac{P_c\dfrac{m_a^2}{2}}{P_c\left[1+\dfrac{m_a^2}{2}\right]}\times 100$$

$$(\eta)_{AM} = \frac{m_a^2}{\left[2+m_a^2\right]}\times 100$$