Amplitude Modulation - 2

$x_m(t) = A_m \cos \omega_m(t)$ $\quad \omega_m = 2\pi f_m$

$x_c(t) = A_c \cos \omega_c(t)$ $\quad \omega_c = 2\pi f_c$

$x_{AM}(t) = A_c \cos\omega_c t \left(1 + m \cos \omega_m t\right)$

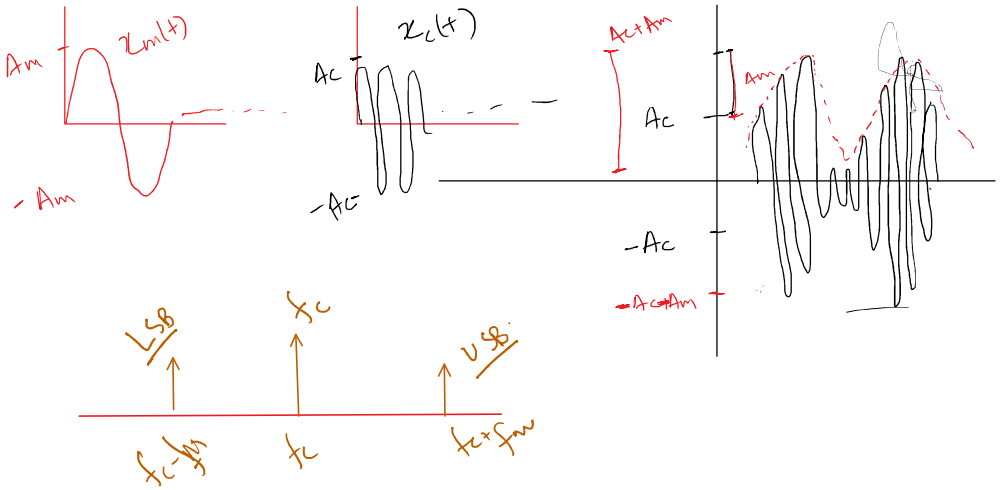
m = modulation Index.
% modulation

$x_{AM}(t) = A_c \cos\omega_c t + \frac{A_c \cdot m}{2} \cos\omega_c t \cos\omega_m t \times 2$ $\quad \frac{A_m}{A_c}$

$= A_c \cos\omega_c t + \frac{A_c \cdot m}{2}(2\cos\omega_c t \cos\omega_m t)$

$= A_c \cos\omega_c t + \frac{A_c \cdot M}{2}\left(\cos(\omega_c + \omega_m)t + \cos(\omega_m - \omega_m)t\right)$

$0 \le m \le 1$ → 100% $\quad m > 1$ → over Mod



EXAMPLES

Draw AM waveform for less than 100%, 100% and greater than 100% modulation.

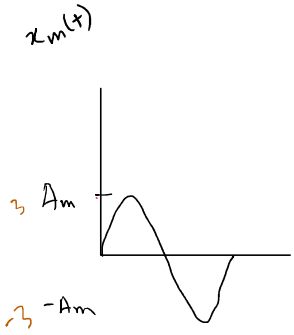
i) $m < 1$
ii) $m = 1$
iii) $m > 1$

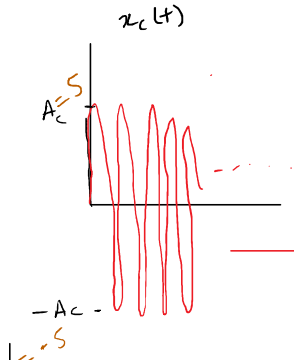
$m = \frac{A_m}{A_c}$

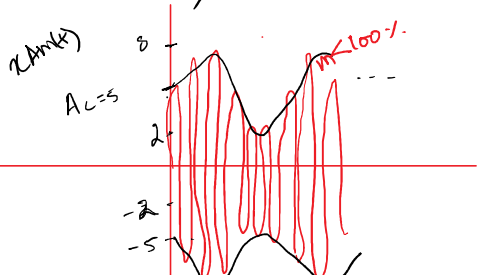
$m < 1 \Rightarrow A_c > A_m$

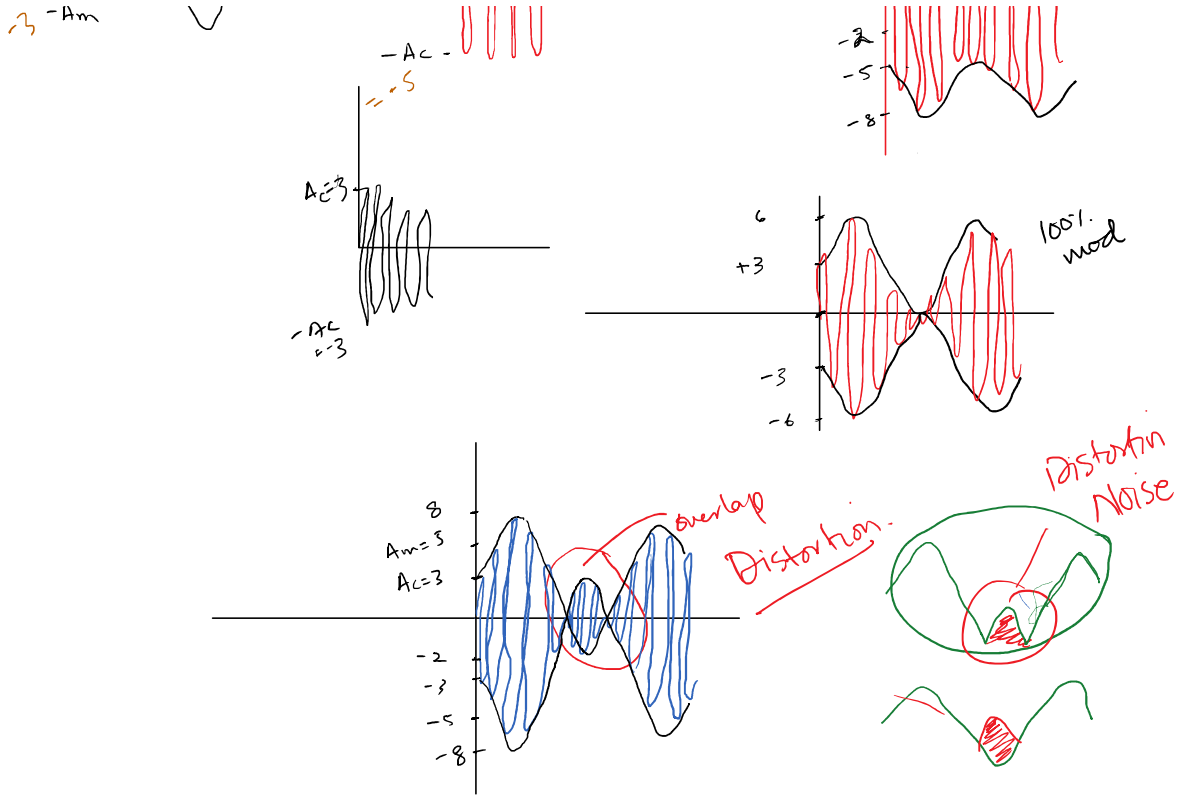
$m = 1 \Rightarrow A_c = A_m$

$m > 1 \Rightarrow A_c < A_m$









Example

$x_c(t) \Rightarrow A_c = 10V \quad f_c = 30KHz$

$x_m(t) \Rightarrow A_m = 3V \quad f_m = 1kHz$ $\boxed{R=50\Omega}$

i) Equations
ii) Plot
iii) m=?
iv) Spectrum

i) (a) $x_m(t) = 3\cos 2\pi 1\times10^3 t$

$x_m(t) = 3\cos 2\pi\times10^3 t$

(b) $x_c(t) = 10\cos 2\pi\, 3\times10^4 t$

(c) $x_{Am}(t) = A_c\left(1+\frac{A_m}{A_c}\cos 2\pi f_m t\right)\cos 2\pi f_c t$

$= 10\left(1+\frac{3}{10}\cos 2\pi\times10^3 t\right)\cos 2\pi\times30\times10^3 t$

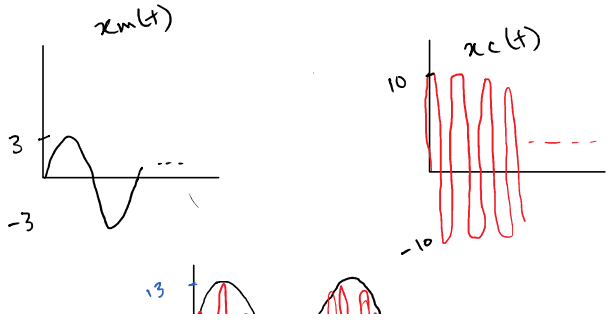
$\boxed{x_{Am} = 10\left(1+0.3\cos 2\times10^3\pi t\right)\cos 60\times10^3\pi t}$

$\rightarrow m = 0.3$

% mod = 30%

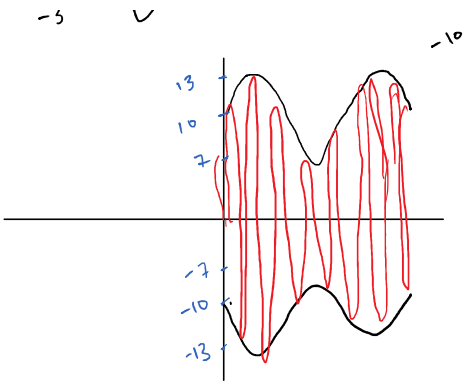
$P_c = \frac{V_c^2}{2R}$

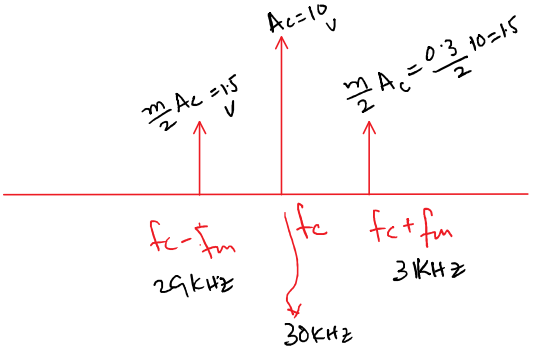
ii) Plot



$A_c = 10_V$

$0.3\,\frac{10}{15}$





Single Tone AM ⟶ $x_m(t)$ has one frequency

Multiple Tone AM. ⟶ $x_m(t)$ has multiple frequencies

$x_m(t) = A_m \cos \omega_m t$ Single Tone

$x_m(t) = A_{m_1} \cos \omega_{m_1} t + A_{m_2} \cos \omega_{m_2} t$