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(a) Conventional AM:

The message signal is $m(t) = A_m \cos(2\pi f_m t)$
and carrier $c(t) = A_c \cos(2\pi f_c t)$

$A_m = 5$, $f_m = 5$, $f_c = 500$

and modulation index (μ) as 1.

$$A_c = \frac{A_m}{\mu} = \frac{5}{1} = 5$$

AM modulated signal is:

$$y = A_c \cdot (1 + \mu \cos(2\pi f_m t)) \cdot \cos(2\pi f_c t)$$

The amplitude of ~~Am~~ ~~bodies~~ modulated signal varies as $\cos(2\pi f_m t)$ with maximum value as $(A_c + A_m)$ and minimum value as $(A_c - A_m)$.

Upon demodulation we get ~~the~~ back ~~the~~ ~~mess~~ message signal which is same as the ~~am~~ message signal.
For demodulation, modulated signal is multiplied with $\cos(2\pi f_c t)$ and passed with low pass filter of order 2.

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The frequency domain plots shows that we have impulse at (f_m+f_c), (f_m-f_c), ; (f_c-f_m), $-(f_m+f_c)$ and also at $\pm f_c$. which can clearly be seen from the plot.

Also, from the frequency domain plot of demodulated signal we have impulses at $\pm f_m$.
This shows that modulation and demodulation was done successfully.

(b) DSB-SC

Message signal is $m(t) = A_m \sin(2\pi f_m t)$

Carrier $c(t) = A_c \cos(2\pi f_c t)$

With $A_m = \frac{1}{2}$, $A_c = 1$, $f_m = 5$, $f_c = 520$;

DSB-SC modulated signal is:

$$y = A_m A_c \cos(2\pi f_c t) \sin(2\pi f_m t)$$

The amplitude of DSB-SC modulated signal varies between $\pm A_m A_c$ which can be seen from the plot.

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Demodulation is done by multiplying the modulated signal by $\cos(2\pi f_c t)$ and passing it through a low pass filter centred at f_c and we get back the message signal which we can verify from plots.

$$V_{DSB}(f) = \frac{A}{2}\left[M(f-f_c) + M(f+f_c)\right]$$

From the plot it is clearly seen that message plot is shifted by $\pm f_c$.
And we can verify it through frequency domain plot of demodulated signal.
Hence, modulation and demodulation was done successfully.

(c) SSB-SC

Message signal $m(t) = A_m \cos(2\pi f_m t)$
$c(t) = A_c \cos(2\pi f_c t)$

$A_m = \frac{1}{5}$, $A_c = 1$, $f_m = 5$, $f_c = 250$

Modulated signal is

$$y(t) = \frac{A_m A_c}{2}\cos\left[2\pi(f_c + f_m)t\right]$$

(Upper band)

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$y(t) = \frac{A_m A_c}{2} \cos[2\pi (f_c - f_m) t]$

(Lower sideband)

From the plot it is clear that amplitude of SSB-SC modulated waveform varies with $\pm \frac{A_m A_c}{2}$ and this can be confirmed from plot.

Demodulation is done in a similar manner as $\pm \frac{A_m A_c^2}{4}$ and its amplitude varies as $\pm \frac{A_m A_c^2}{4}$.

From the frequency domain plot of SSB SC modulated signal, the impulse are centred at $\pm f_c$ and also the frequency of demodulated signal confirms this.

∴ Modulation and demodulation is successful.

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