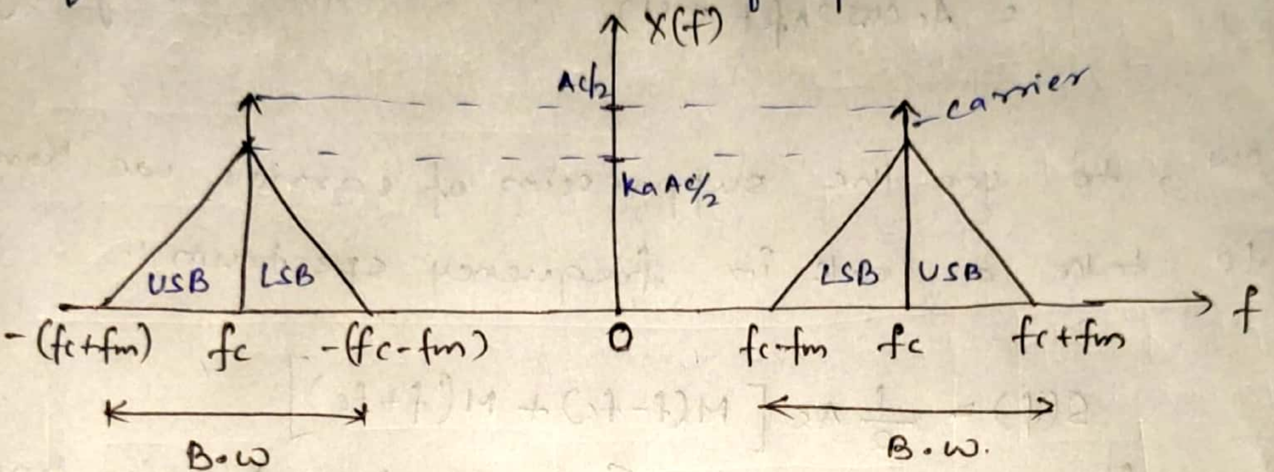
Standard amplitude modulation can also be termed as DSB-FC (Double sideband - full carrier)

As for standard AM we have ~~fol~~ spectrum as :-



Here we have two side bands & one carrier.

The main disadvantages of this technique are:

1. Power wastage take place.
2. AM needs larger bandwidth
3. AM wave gets affected due to noise.

These can be explained as:-

— The carrier signal in the DSB-FC system does not convey any information. The information is contained in two sidebands only.

→ Now, to overcome this drawback of power wastage, we may suppress the carrier component from the modulated wave, resulting in double sideband - suppressed carrier (DSB-SC) modulation.

Advantages of AM:-

1. Primary advantage is that demodulation is simple.
2. It is used for long distance communication.
3. Since AM Receiver is simple & cheaper, it is preferred in broadcasting (point to multi-point)

DSB-SC modulation :-

For, time domain expression :-

$$s(t) = c(t)\, m(t)$$
$$= A_c \cos 2\pi f_c t \; m(t)$$

where, $c(t)$ = carrier signal
$m(t)$ = message signal

Now, to see the suppression of carrier we have to take a look in frequency spectrum :-

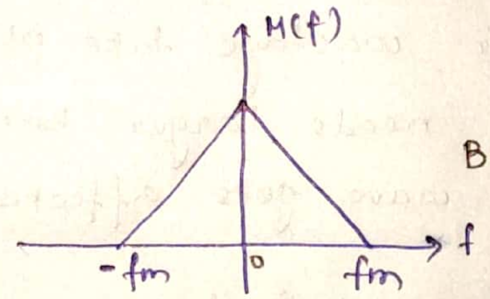
$$S(f) = \frac{1}{2} A_c \left[M(f-f_c) + M(f+f_c) \right]$$

or $S_{DSB}(f)$

[by taking Fourier transform of $s(t)$]

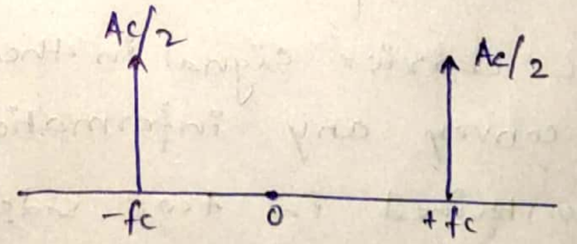
* frequency spectrum:-

$m(t) \longleftrightarrow$



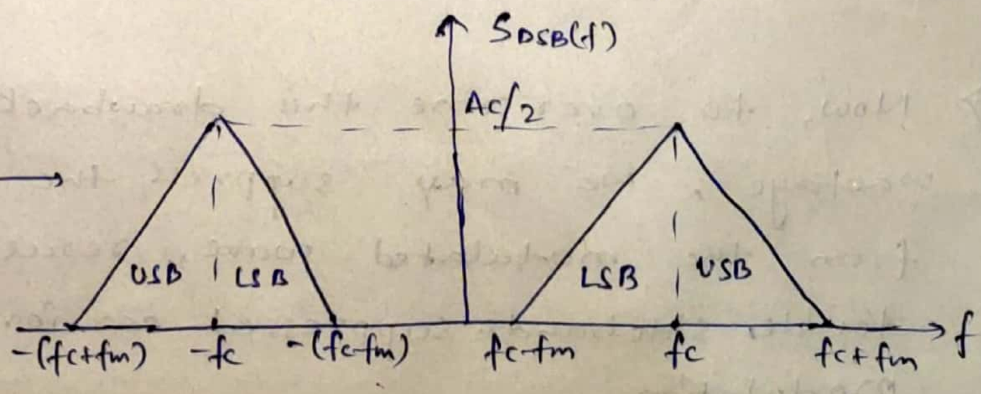
$BW = f_m - 0$
$= f_m$

$c(t) \longleftrightarrow$



$S_{DSB}(t) \longleftrightarrow$

or $s(t)$



$BW = (f_c + f_m) - (f_c - f_m) = 2 f_m$
$= 2 \times$ message signal BW

Single-tone DSB-SC:

Assume $m(t) = A_m \cos 2\pi f_m t$, $c(t) = A_c \cos 2\pi f_c t$

$$S_{DSB}(t) = A\,c(t)\,m(t)$$

$$= A_c \cos 2\pi f_c t \; A_m \cos 2\pi f_m t$$

$$= \underbrace{\frac{A_c A_m}{2}}_{\text{peak value}} \overset{\uparrow USB}{\cos 2\pi (f_c + f_m)t} + \frac{A_c A_m}{2} \overset{\uparrow LSB}{\cos 2\pi (f_c - f_m)t}$$

$\left[\text{using } \cos A \cos B = \frac{1}{2}\cos(A+B) + \frac{1}{2}\cos(A-B)\right]$

Total power of DSB-SC:-

$$P_t = P_{LSB} + P_{USB}.$$

$\cancel{P_{USB} =} \; \frac{A_c A_m}{2}$ $\quad P_{USB} = \left(\frac{\text{peak value}}{\sqrt{2}}\right)^2 / R$

$$= \frac{V_{rms}^2}{R}$$

$$\therefore \; P_{USB} = \left(\frac{A_c A_m}{2\sqrt{2}}\right)^2 \times \frac{1}{R} = \frac{A_c^2 A_m^2}{8R}.$$

$$P_{LSB} = \left(\frac{A_c A_m}{2\sqrt{2}}\right)^2 \times \frac{1}{R} = \frac{A_c^2 A_m^2}{8R}$$

$$P_t = \text{Total power} = \frac{A_c^2 A_m^2}{8R} + \frac{A_c^2 A_m^2}{8R} = \frac{A_c^2 A_m^2}{4R}$$

$$\therefore \; \boxed{P_t = \frac{A_c^2 A_m^2}{4R}}$$

Scanned by CamScanner

Modulation efficiency (η) :-

$$\eta = \frac{P_{side\,band}}{P_{total}}$$

$$= \frac{P_{SB}}{P_t} = \frac{P_{LSB} + P_{USB}}{P_t}$$

Here, in DSB-SC, $P_t = P_{LSB} + P_{USB}$.

$$\therefore \eta = 1 \text{ or } 100\%$$

Multitone DSB-SC :-

let $m(t) = A_{m_1} \cos 2\pi f_{m_1} t + A_{m_2} \cos 2\pi f_{m_2} t$

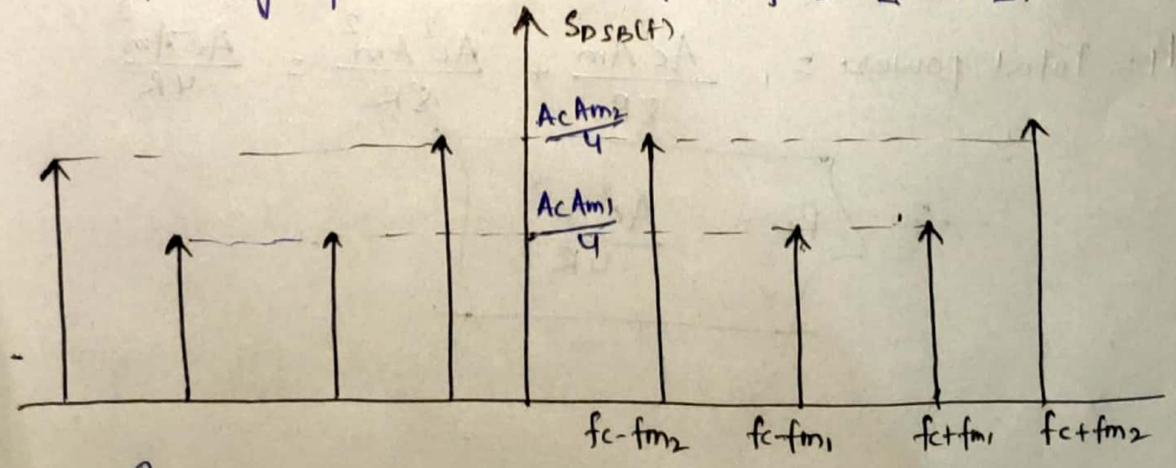
$S_{DSB}(t) = A_c \cos 2\pi f_c t \cdot m(t)$

$$= A_c \cos 2\pi f_c t \left[A_{m_1} \cos 2\pi f_{m_1} t + A_{m_2} \cos 2\pi f_{m_2} t \right]$$

$$= \frac{A_c A_{m_1}}{2} \cos 2\pi \underbrace{(f_c + f_{m_1})}_{USB1} t + \frac{A_c A_{m_1}}{2} \cos 2\pi \underbrace{(f_c - f_{m_1})t}_{LSB1}$$

$$+ \frac{A_c A_{m_2}}{2} \cos 2\pi \underbrace{(f_c + f_{m_2})t}_{USB2} + \frac{A_c A_{m_2}}{2} \cos 2\pi \underbrace{(f_c - f_{m_2})t}_{LSB1}$$

For plotting spectrum, let $f_{m_2} > f_{m_1}$ & $A_{m_2} > A_{m_1}$



$BW = ?$

Total power of multitone-DSB:-

$$P_t = P_{SB} = P_{USB} + P_{LSB}$$

$$P_{LSB_1} = \left(\frac{A_c A_{m1}}{2\sqrt{2}}\right)^2 \times \frac{1}{R} = \frac{A_c^2 A_{m1}^2}{8R}$$

$$P_{USB_1} = \frac{A_c^2 A_{m1}^2}{8R}$$

~~Simitto~~ Similarly, $P_{LSB_2} = P_{USB_2} = \frac{A_c^2 A_{m2}^2}{8R}$

$$\therefore P_t = P_{LSB_1} + P_{USB_1} + P_{LSB_2} + P_{USB_2}$$

$$= \frac{A_c^2 A_{m1}^2}{4R} + \frac{A_c^2 A_{m2}^2}{4R}$$

$$\boxed{P_t = \frac{A_c^2}{4R}\left[A_{m1}^2 + A_{m2}^2\right]}$$

Assignment :-

1. For a DSB-SC modulated signal $S_{DSB}(t) = c(t)\,m(t)$ with $c(t) = 20\sqrt{2}\cos 2\pi\times10^{5}t$ and $m(t) = 2\sqrt{2}\cos 2\pi\times10^{3}t$. Calculate ~~the~~ total power and modulation efficiency.

2. For the above DSB-SC modulated signal

$S_{DSB}(t) = c(t)\,m(t)$,

Draw the frequency ~~spectr~~ spectrum.
And also calculate the bandwidth of the spectrum.