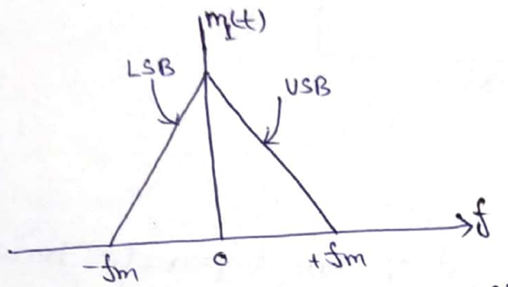
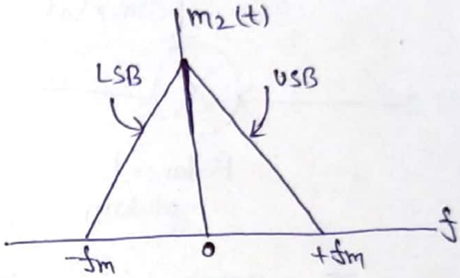
Quadrature-Amplitude Modulation (QAM):⇒

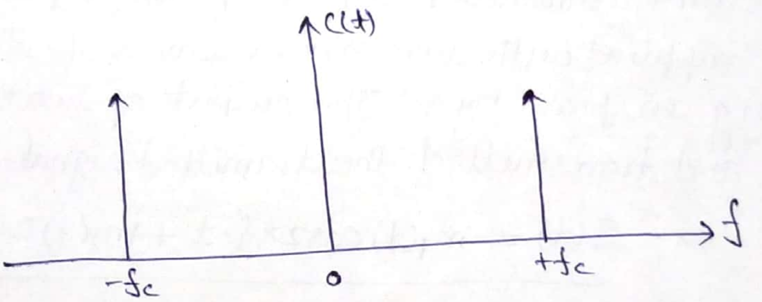
(Quadrature-Carrier Multiplexing)/(Bandwidth utilization sheme)

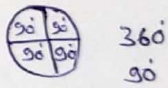
This modulation scheme enables two DSB-SC modulated signals to occupy the same transmission bandwidth and therefore it allows for the seperation of the two message signals at the receiver output. It is therefore known as a bandwidth-conversion scheme.

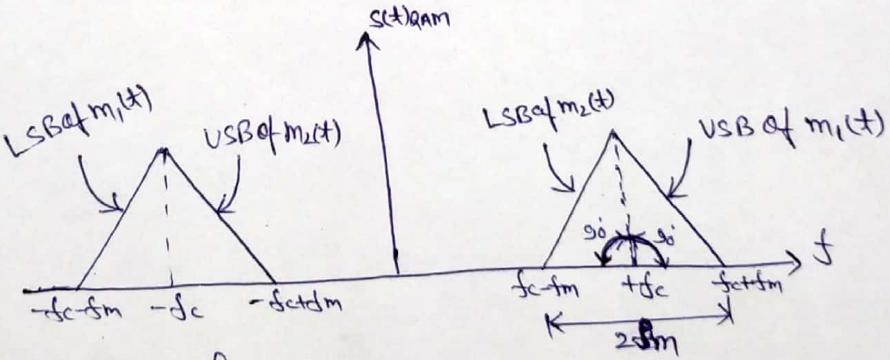
Spectrum:-











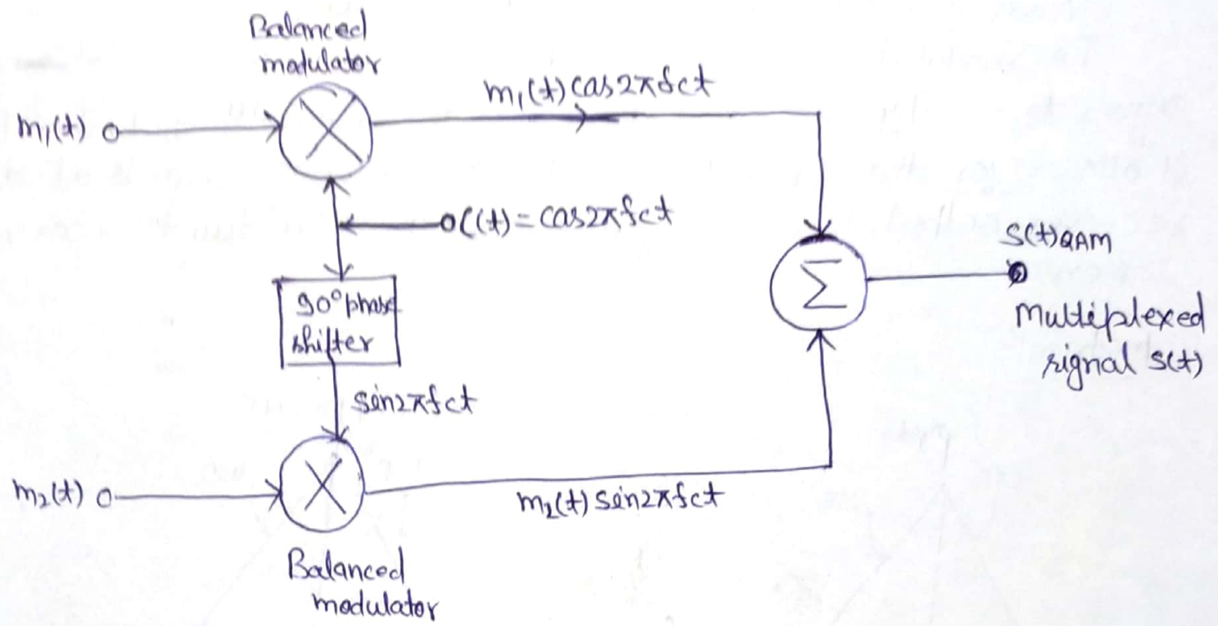
The output of QAM scheme,

$$S(t)_{QAM} = m_1(t)\cos 2\pi f_c t + m_2(t)\sin 2\pi f_c t$$

where, $m_1(t)$ and $m_2(t)$ are two different message signals applied to the balanced modulators. ~~Both $m_1(t)$ and $m_2(t)$~~ Which are supplied with two carrier waves of the same frequency but differing in phase by $(-\pi/2)$.

Both $m_1(t)$ and $m_2(t)$ are band limited in the interval $-f_m \leq f \leq f_m$, then S(t) will occupy a bandwidth of $2f_m$. This bandwidth $2f_m$ is centered at the carrier frequency f_c, where, f_m is the bandwidth of $m_1(t)$ and $m_2(t)$.

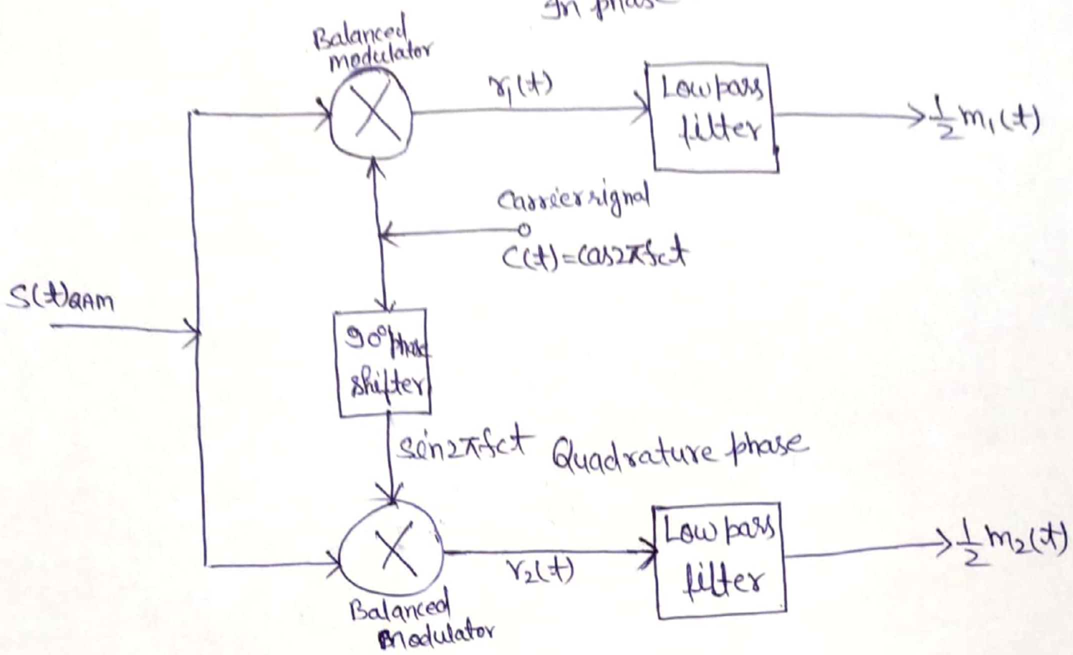
Generation of QAM signal :⇒



The QAM transmitter consist of two separate balanced modulator which are supplied with two carrier waves of the same frequency but differing in phase by 90°. The output of two B.M. are added in the adder and transmitted. The tramitted signal is

$$S(t) = m_1(t)\cos 2\pi f_c t + m_2(t)\sin 2\pi f_c t$$

Demodulation of QAM-signal :→



The QAM-signal applied simultaneously two seperate cohrent detector that are supplied with two local carriers of the same frequency, but differing in phase by 90°. the output of both detector detect $m_1(t)$ and $m_2(t)$.

⇒ the output of first detector

$$r_1(t) = [m_1(t)\cos 2\pi f_c t + m_2(t)\sin 2\pi f_c t]\cos 2\pi f_c t$$

$$= [m_1(t)\cos w_c t + m_2(t)\sin w_c t]\cos w_c t$$

$$= m_1(t)\cos^2 w_c t + m_2(t)\sin w_c t \cos w_c t$$

$$= \frac{1}{2}[m_1(t) + m_1(t)\cos 2w_c t + m_2(t)\sin 2w_c t]$$

$2\cos^2 w_c t = [1 + \cos 2w_c t]$

$2\sin w_c t \cos w_c t = \sin 2w_c t$

$2\sin^2 w_c t = [1 - \cos 2w_c t]$

hence the output of in phase channel is

$$\tilde{r}_1(t) = \frac{1}{2} m_1(t)$$

⇒ and output of second detector

$$r_2(t) = [m_1(t)\cos 2\pi f_c t + m_2(t)\sin 2\pi f_c t]\sin 2\pi f_c t$$

$$= [m_1(t)\cos w_c t + m_2(t)\sin w_c t]\sin w_c t$$

$$= m_1(t)\cos w_c t \sin w_c t + m_2(t)\sin^2 w_c t$$

$$= \frac{1}{2}[m_1(t)\sin 2w_c t + m_2(t) - m_2(t)\cos 2w_c t]$$

hence the output of Quadrature channel

$$\tilde{r}_2(t) = \frac{1}{2} m_2(t)$$

* For satisfactory operation of the coherent detector, it is essential to maintain coherent phase and frequency relationship b/w the oscillators used in QAM transmitter and receiver.

* The QAM finds application in colour television.