Example 2.4

For an AM modulator with a carrier frequency of 150 kHz and a modulating signal frequency of 10kHz, determine the :

i) Frequency for the upper and lower sideband .

ii) Bandwidth.

Sketch the output frequency spectrum.

Solution

i) The lower and upper side band frequency

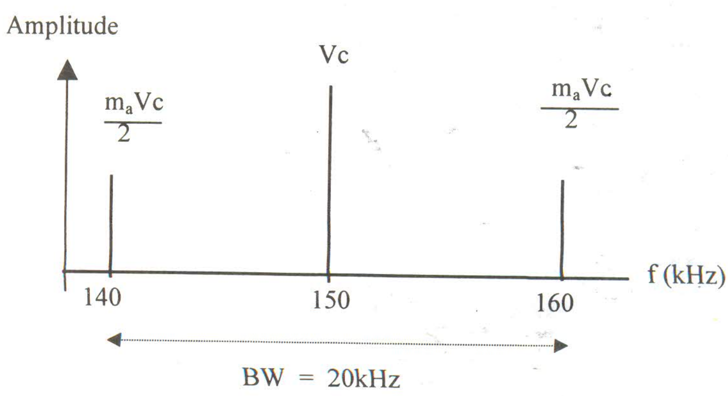
$$f_{LSB} = f_c - f_m$$
$$= 150\text{kHz} - 10\text{kHz}$$
$$= \underline{140\ \text{kHz}}$$

$$f_{USB} = f_c + f_m$$
$$= 150\text{kHz} + 10\ \text{kHz}$$
$$= \underline{160\text{kHz}}$$

ii) Bandwidth

$$BW = 2fm$$
$$= 2\,(10)\ \text{kHz}$$
$$= \underline{20\ \text{kHz}}$$

The output frequency spectrum is as shown ,



e) Power content in AM

The power in the AM signal is the total power in the carrier and the power in the sidebands,

$$P_T = \text{Carrier power} + \text{LSB power} + \text{USB power}$$

$$P_T = P_C + P_{LSB} + P_{USB}$$

Note that ,

$$V_{LSB} = V_{USB} = \frac{m_a V_c}{2} \text{ (peak value)}$$

$$= \frac{m_a V_c}{2\sqrt{2}} \text{ (r.m.s value)}$$

Therefore ,

$$P_T = V_C^2 / 2R + m_a^2 V_C^2 / 8R + m_a^2 V_C^2 / 8R$$

$$= V_c^2 / 2R + m_a^2 V_c^2 / 4R$$

$$= V_c^2 / 2R \, (1 + m_a^2 / 2)$$

where $V_c^2 / 2R = P_c$, giving,

$$\boxed{\therefore \quad P_T = P_C (1 + m_a^2 / 2)} \qquad (2.11)$$

So, the total power in the AM wave depends on the carrier power and modulation index.

Example 2.5

For an AM wave with a peak unmodulated carrier voltage $V_c = 20$ V, a load resistance $R_L = 20\ \Omega$ and a modulation index, $m_a = 0.2$, determine ;

a) Power contained in the carrier and the upper and lower sidebands.

b) Total sideband power

c) Total power of the modulated wave

Solution ;

a) The carrier power is:

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

$$= \frac{20^2}{2(20)}$$

$$= \underline{10W}$$

The upper and lower sideband power is ;

$$P_{USB} = P_{LSB} = \frac{m_a^2 V_c^2}{8R} = \frac{m_a^2 \; P_c}{4}$$

$$= \frac{(0.2)^2 (10)}{4}$$

$$= \underline{0.1W}$$

b) Total sideband power,

$$P_{SB} = m_a^2 P_c / 2$$

$$= (0.2)^2 (10) / 2$$

$$= \underline{0.2 \text{ W}}$$

or, $P_{SB} = P_{USB} + P_{LSB}$

$$= 0.1 + 0.1$$

$$= \underline{0.2 \text{ W}}$$

c) The total power in the modulated wave ,

$$P_T = P_c [1 + m_a^2 / 2]$$

$$= 10 [1 + (0.2)^2 / 2]$$

$$= \underline{10.2 \text{ W}}$$

or, $P_T = P_c + P_{SB}$

$$= 10 + 0.2$$

$$= \underline{10.2 \text{ W}}$$