Q:-> For a broadcast superheterodyne AM receiver having no RF amplifier, the loaded Quality factor 'Q' of the antenna coupling circuit is 100. Now if the Intermediate frequency is 455 KHz, then determine the following:

(i) the image frequency and its rejection ratio at an incoming frequency of 1000 kHz

(ii) the image frequency and its rejection ratio at an incoming frequency of 25 MHz.

Solution:- IF = 455 KHz, Q = 100

(i) $f_s = 1000\,kHz$.

image frequency $f_i = f_s + 2f_{IF}$

$$f_i = 1000\,KHz + 2 \times 455$$
$$= (1000 + 910)\,kHz$$
$$f_i = 1910\,kHz.$$

rejection ratio $\alpha = \sqrt{1+Q^2\rho^2}$

$$\rho = \frac{f_i}{f_s} - \frac{f_s}{f_i} = \frac{1910}{1000} - \frac{1000}{1910}$$
$$= 1.910 - .524 = 1.386$$

$\alpha = \sqrt{1+(100)^2 \times (1.386)^2}$ or $\alpha = \sqrt{1+(138.6)^2}$

$\boxed{\alpha = 138.6}$. Ans

(ii) $f_s = 25$ MHz.

$f_i = f_s + 2f_{IF} = 25 + 2 \times .455$

$f_i = 25.91$ MHz.

$\rho = \frac{f_i}{f_s} - \frac{f_s}{f_i} = \frac{25.91}{25} - \frac{25}{25.91}$

$= 1.0364 - .9649 = .0715$

then rejection ratio

$\alpha = \sqrt{1+Q^2\rho^2}$

$= \sqrt{1+(100)^2(.0715)^2}$

$\alpha = \sqrt{1+(7.15)^2} = 7.15$

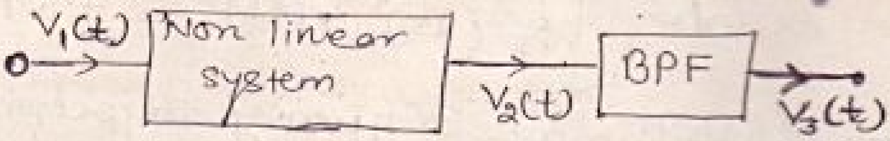
715
715
31.1225

Q:→ In a superheterodyne receiver having no RF amplifier, the loaded Q of the antenna coupling circuit (at the input of the mixer) is 90. If the IF is 455 kHz, calculate the following.

(i) the image frequency and image frequency rejection ratio at 950 kHz

(ii) the image frequency and its rejection ratio at 10 MHz.

Q:→ Derive an expression for the signal $V_3(t)$ in figure (a) for $V_1(t) = 10\cos(2000\pi t) + 4\sin(200\pi t)$. Assume that $V_2(t) = V_1(t) + .1\, V_1^2(t)$ and that the BPF is unity gain filter with passband from 800 Hz to 1200 Hz.



__Solution__ :- Output at Non linear system

$$V_2(t) = V_1(t) + .1\, V_1^2(t)$$

or

$$V_2(t) = [10\cos(2000\pi t) + 4\sin(200\pi t)] + .1[10\cos(2000\pi t) + 4\sin(200\pi t)]^2$$

$$= 10\cos(2000\pi t) + 4\sin(200\pi t) + .1[100\cos^2(2000\pi t) + 16\sin^2(200\pi t) + 80\cos(2000\pi t)\sin(200\pi t)]$$

$$= 10\cos(2000\pi t) + 4\sin(200\pi t) + .1[50 + 50\cos(4000\pi t) + 8 - 8\cos(400\pi t) + 40\sin(2200\pi t) + 40\sin(1800\pi t)]$$

$$\xrightarrow[800-1200]{BPF} 10\cos(2000\pi t) + 4\sin(2200)\pi t + 4\sin(1800)\pi t.$$

In a superheterdyne receiver the incoming RF signal frequency is combined with the local oscillator signal frequency through a mixer and is converted into a signal of lower fixed frequency. This lower fixed frequency is known as Intermediate frequency [IF]. However, the Intermediate frequency signal contains the same modulation as the original signal. This intermediate frequency signal is now amplified and demodulated to produce the original signal.

advantages of superheterodyne

(i) NO variation in bandwidth.
(ii) High selectivity and senstivity.
(iii) High adjacent channel rejection.

Intermediate frequencies used for different communication systems:-

(i) AM broadcast [540 KHz - 1650 KHz]

IF: 455 kHz.

(ii) FM broadcast [88 MHz - 108 MHz]

IF: 10.7 MHz

(iii) Television receivers in the

VHF band [54 MHz to 223 MHz]

IF: 26 MHz - 46 MHz.

UHF band [470 MHz to 940 MHz]

IF: 36 MHz - 46 MHz.

(iv) Microwave and Radar receivers

(1 GHz to 10 GHz)

IF: 30 MHz, 60 MHz, 70 MHz.