q1.

ans.

If, before multiplication with a carrier, there is addition of a DC component to the message signal, then the modulation scheme is referred as amplitude modulation (AM). The objective of the DC component is to allow the modulated carrier to be demodulated at the receiver with the help of a means other than synchronous detection. For output that is envelope detector, the coupling should be set for AC. (So, there is completion of the envelope detection , there is no need of DC component.)

q2.

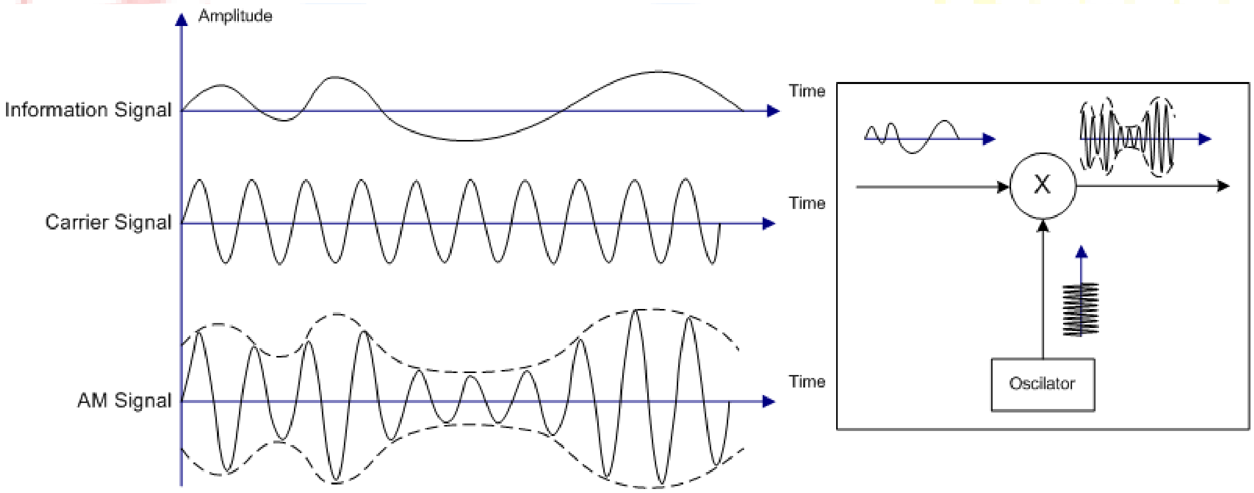
ans>

It is significant that a key characteristic of an AM signal is seen by you- shape of its envelopes are the same as the message (But there is inversion of the lower envelop).

Q3.

Ans>

Within sample, there is presence of three type of sine waves. The two sine waves have a frequency of 100khz, 49 khz and 51 khz.



Q4.

Ans. The multiplier module has been provided with a sine wave message signal and this sine wave signal appears at the message module.

Q5. Ans.

200mV of signal modulate A 1V amplitude carrier. It‘s amplitude varies from .8V to 1.2V. In case of there is an increase of signal to 300mV, there will be variation of amplitude from 0.7V to 1.3V. In case, there is an increase in carrier amplitude up to 2V, then variation in amplitude will be from 2.3 to 1.7 0.6 is the difference between valley of 1.7 and peak of 2.3. 2 is the average. Hence, modulation depth is

(1/2) of difference between valley and peak divided by average *100%. Here, it is (0.3/2}*100% = 15%. 100% is the maximum permissible. In amplitude modulation the carrier wave amplitude is varied is varied linearly with the modulating wave (the base band signal) creating what is called the envelope signal. Shape of the envelope is same as the base band signal if:
1. The highest frequency components fm of the message signal m (t) must be less then the carrier frequency fc i.e. fc >> fm
2. Unity should be more then the modulation index. If it is other wise, then there is over modulation of the carrier wave.

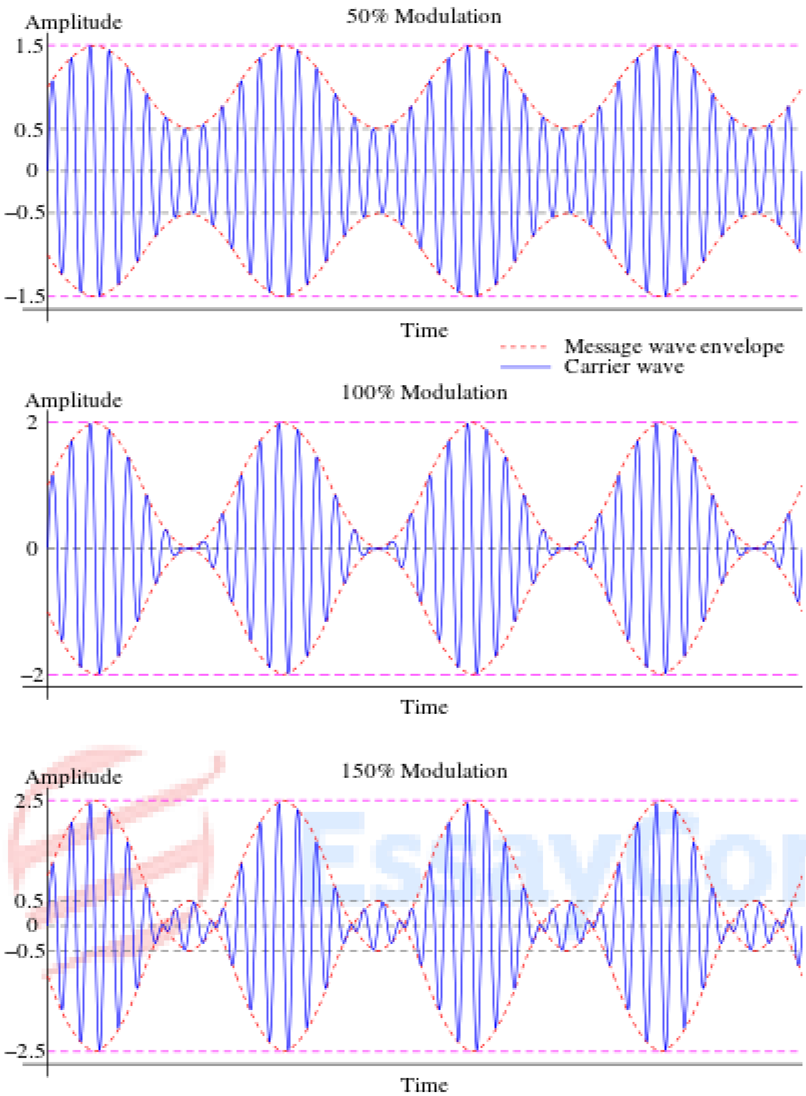
Once we don't have the envelope, or the envelope doesn't resemble the original baseband signal, the detection of the AM signal to restore the modulating wave m(t) can't be done with a simple envelope detector (a diode followed by a low pass filter- RC circuit). Detection may be done, however, using other AM types of the suppressed carrier types.

Q6.

Ans. From the envelope itself, the modulation index can be estimated which will be shown on the oscilloscope. As there is an increase in the amplitude of the message signal, in the envelop there is an appearance of extra lobes. Over modulation is indicated by these lobes. As there is decrease of the amplitude of the message signal that is below 100% modulation, measurements of the minimum and the maximum envelope amplitude provides the modulation index.

This modulation index is estimated with the help of this difference: m = 2/ 10[(carrier dB - sideband dB)/20]

The problem with am over modulation is that it causes distortion from the receiver point of view. For the transmitter, the problem is that some of the energy is now outside the frequency band in the output, and may even affect and hamper with other stations or other services.



Q7.

Ans.

Modulation index is the peak change in the RF amplitude from its unmodulated value.

For an AM modulation index of 0.5, the modulation causes the signal to multiply by a factor of 0.5 and even decrease to 0.5 of its original level.

Amplitude modulation depth

A complementary figure to modulation index is also used for amplitude modulation signals. Known as the modulation depth, it is typically the modulation index expressed as a percentage.

Thus a modulation index of 0.5 would be expressed as a modulation depth of 50%, etc.

However often the two terms and figures are used interchangeably and figures for a modulation index of 50% are often seen where the index is 0.5.

Graph:

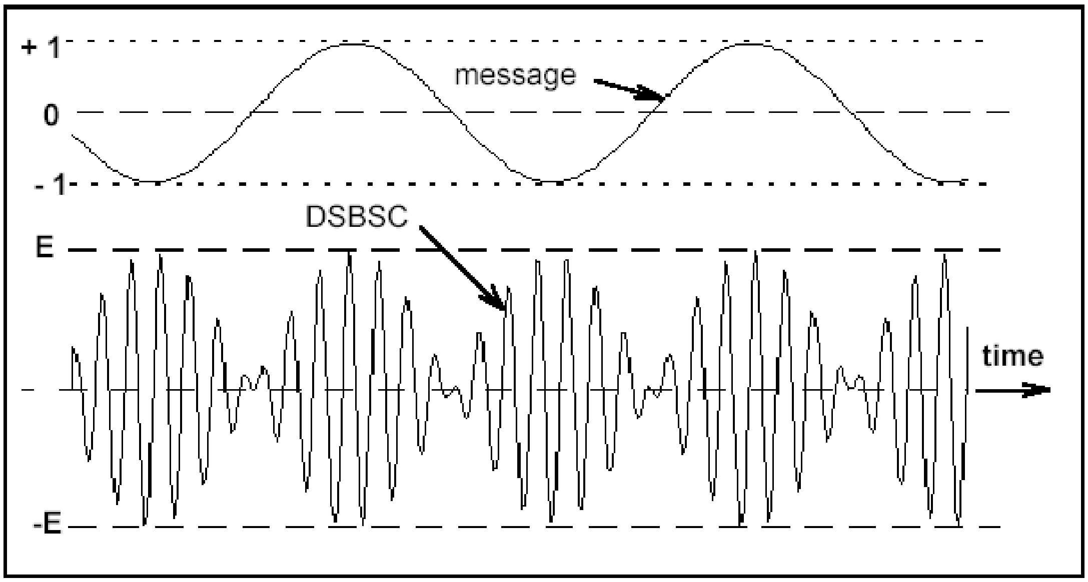


Figure 2: eqn.(1) - a DSBSC - seen in the time domain

Q8. Ans

Although the message and the carrier are periodic waveforms (sinusoids), the DSBSC itself need

not necessarily be periodic.

Q9. Ans.

The upper side band , lower sideband and carrier frequency are present in the DSB am modulation.

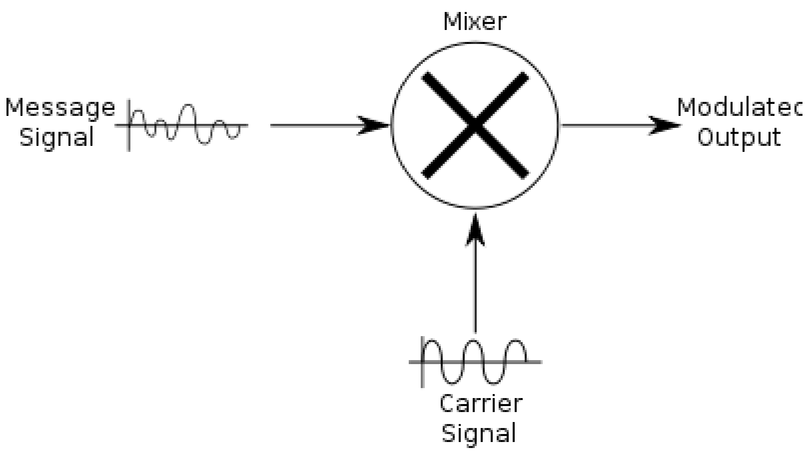
Q10. Ans.

Considering the DSB-SC modulation, unlike in AM, the wave carrier is not a transmitted one; therefore, much of the power is distributed between the sidebands. This implies an increase of the cover in DSB-SC, compared to AM, for the same power used in the message.

Q11. Ans

DSB-SC is generated by a mixer

$$\underbrace{V_m \cos(\omega_m t)}_{\text{Message}} \times \underbrace{V_c \cos(\omega_c t)}_{\text{Carrier}} = \underbrace{\frac{V_m V_c}{2}\left[\cos((\omega_m + \omega_c)t) + \cos((\omega_m - \omega_c)t)\right]}_{\text{Modulated Signal}}$$



Am modulation:

Consider a carrier wave (sine wave) of frequency f_c and amplitude A given by:

$$c(t) = A \cdot \sin(2\pi f_c t).$$

$$m(t) = M \cdot \cos(2\pi f_m t + \phi),$$

where M is the amplitude of the modulation. We shall insist that $M<1$ so that $(1+m(t))$ is always positive. If $M>1$ then over modulation occurs and reconstruction of message signal from the transmitted signal would lead in loss of original signal. Amplitude modulation results when the carrier $c(t)$ is multiplied by the positive quantity $(1+m(t))$:

$$\begin{aligned} y(t) &= [1 + m(t)] \cdot c(t) \\ &= [1 + M \cdot \cos(2\pi f_m t + \phi)] \cdot A \cdot \sin(2\pi f_c t) \end{aligned}$$

In this simple case M is identical to the modulation index, discussed below. With $M=0.5$ the amplitude modulated signal $y(t)$ thus corresponds to the top graph (labelled "50% Modulation") in Figure 4.

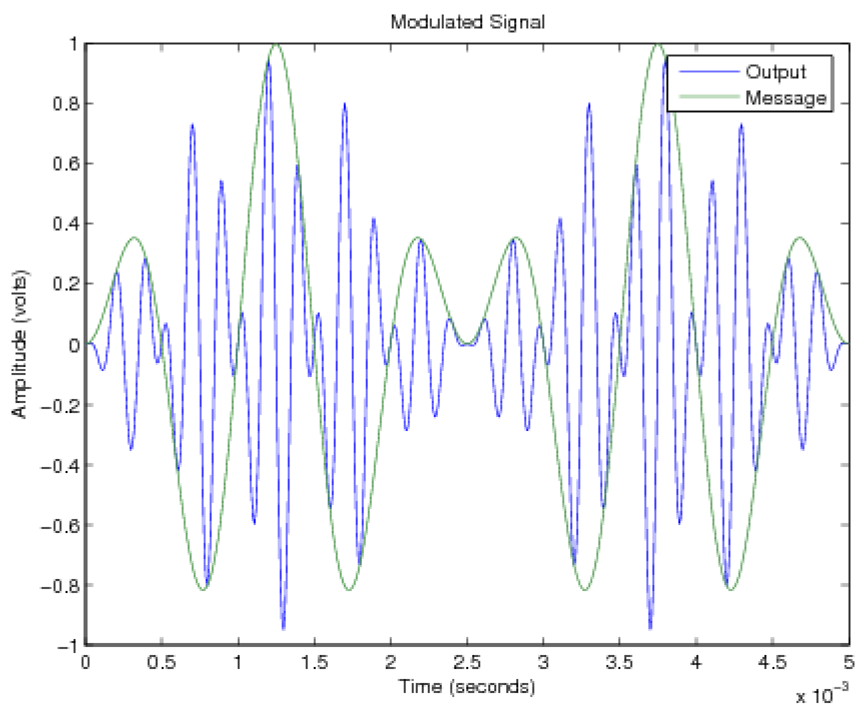
Y(t) is sum of three components and is given as
y
$$y(t) = A \cdot \sin(2\pi f_c t) + \frac{AM}{2}\left[\sin(2\pi(f_c + f_m)t + \phi) + \sin(2\pi(f_c - f_m)t - \phi)\right].$$

Therefore, the modulated signal comprises three components: the carrier wave *c(t)* which is unchanged, and two pure sine waves (known as sidebands) with frequencies slightly above and below the carrier frequency f_c.

Q12.>

Ans

Q is independent of the message signal amplitude and P is dependent on the message signal amplitude and varies linearly with it.



Q13.

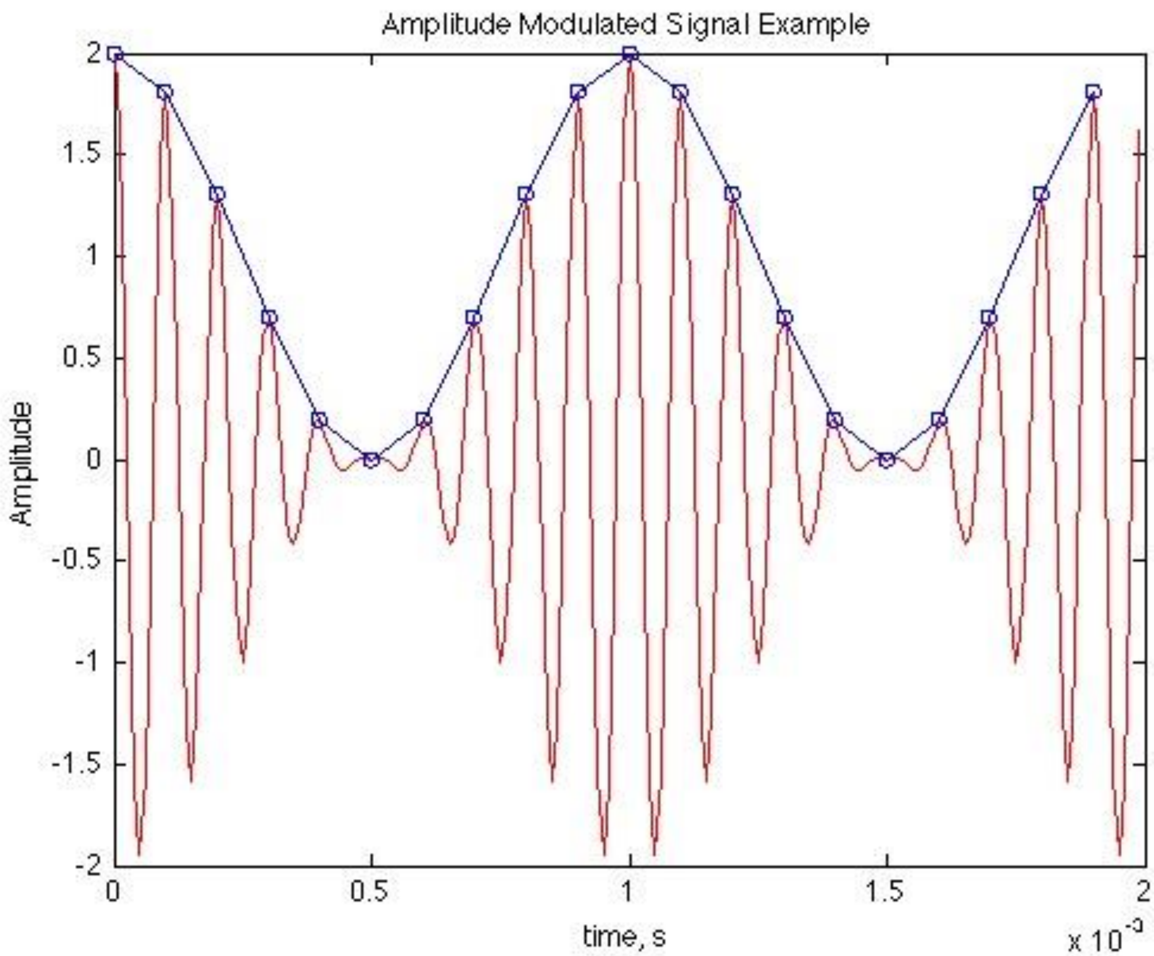
Ans

This type of distortion is called delta modulation. If we reduce the sampling interval 'Ts' in DPCM to an considerable amount and we sample a band limited signal at a rate much faster than the Nyquist sampling rate, the adjacent samples will have higher correlation .The difference in sample-to-sample amplitude will be very less. So, one should devise of only 1-bit quantization of the difference signal.

Q14.

Ans>

Envelope of the modulated signal does not have the same shape as m(t), to recover the message signal we use An envelope detector . We can demodulate any DSB signals by using an asynchronous detector. The equation of the demodulated signal is an inverted one and is given as –m(t).



Q15.

Ans>

The amplitude is generally not affected that much but it changes by half factor in demodulated wave.

Q16.

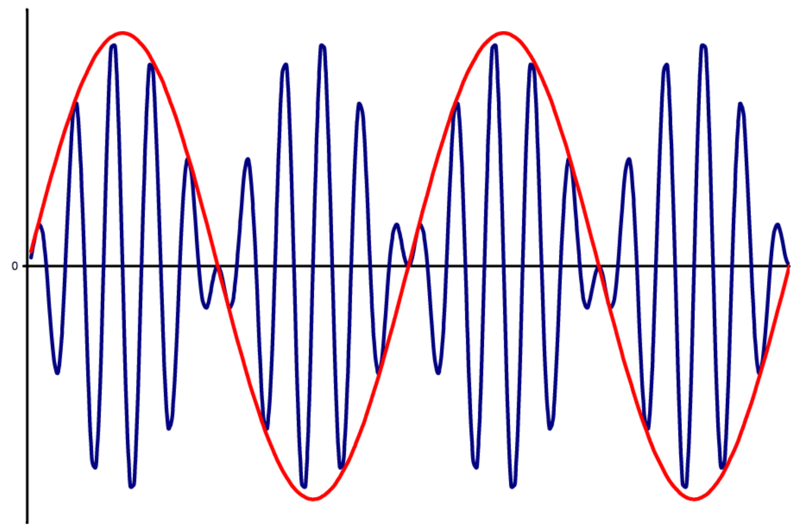
Ans>

The particular distortion is due to the nonlinearity of the detector and not because of any problem with the modulation process.
There will be a phase detection loop available in a synchronous detector, which is used to always synchronize the system to the carrier phase, so that there is least need to solve this problem as the problem doesn't arise.

Q17.

Ans

There are six waves in the multiplier output. The frequencies are 100khz,99 khz, 101khz ,103khz , 102khz,98 khz.



Q18.

Ans>

The product detector computes the product of the modulated signal and a local oscillator instead of changing the envelope of the signal into a waveform of decoded nature like an envelope detector, therefore is called product detector. A product detector is a just mixer which mixes frequencies.

Q19.

Ans>

The Buffer module allows the message signal's amplitude to be changeable and adjustable.

Q20.

Ans

The analysis has been performed so as to describe the output in terms of harmonic components of the input. The fundamental, or first harmonic, is the required term, and all other higher harmonic terms are undesired. The desired and undesired harmonic terms can be compared and correlated to describe the amount of harmonic distortion.

Before the distortion sets in, the BUFFER #2 varies the amplitude of both traces, so they stay superimposed on each other at low input amplitudes. Then we adjust the gain of BUFFER #2 till the signal in the output indicates the onset of moderate distortion; this means that its shape is different from the input waveform. It can be found by viewing the display on the oscilloscope. The measurable amount of distortion is given by a ratio of about 5:6 for the distorted and undistorted peak-to-peak amplitudes.

Q21 ans.

When the phase error φ is a constant then the modulated signal (v (t)) is proportional to m(t) (0 v t α m t)
• The amplitude of the demodulated signal as observed (when φ = 0 , v(t) is maximum ⇒ cosφ = 1 and has a minimum of zero when cos 0. 2 = ± ⇒ φ = π . v (t) A m (t) = c φ is the phase error message . There is attenuation in the detector output to be attenuated by a factor equal to cosφ caused by phase error φ in the local oscillator. The time till the phase error φ is constant, the output of the detector gives an undistorted output of the actual signal m(t).

Q22 ans.

The circuitry must be provided at the receiver to keep up with the local oscillator in perfect frequency and phase synchronism with the carrier wave used for generating the DSB-SC modulated wave in the transmitter. The price paid for suppressing the carrier wave to reduce loss in transmitter power and it results by increase in receiver complexity.

Q23.

Ans. At the output of VCO there are infinite number of sine waves with f(c) + n*f(m) and fc- n.f(m).

Q24.

Ans

As the phase changes so this type of modulation is phase modulation. It is usually equivalent to the frequency modulation

When we use a sine function in the above equation, the real function used is cosine function to modulate the frequency and it is the derivative of the sine function.

The resulting FM waveform has very high harmonic components so it can be exploited for any music synthesis. It is Becuase of the very complex harmonics generated by FM

Q25.

Ans

The upper frequency produces the peak because the LPF deals in lower frequencies and blocks upper frequencies.

Q26

Ans

Yes they have the same frequency as they are the output of the harmonics form.

Q27

Ans

Let the information transmitted (i.e., the baseband signal) be $x_m(t)$ and the sinusoidal carrier wave be represented by $x_c(t) = A_c \cos(2\pi f_c t)$, where f_c is the base frequency of the carrier wave, and A_c is the amplitude of the carrier wave. The modulator joins the carrier with the baseband data signal to obtain the transmitted signal:

$$y(t) = A_c \cos\left(2\pi \int_0^t f(\tau) d\tau\right)$$

$$= A_c \cos\left(2\pi \int_0^t \left[f_c + f_\Delta x_m(\tau)\right] d\tau\right)$$

$$= A_c \cos\left(2\pi f_c t + 2\pi f_\Delta \int_0^t x_m(\tau) d\tau\right)$$

$f(\tau)$ is the *instantaneous frequency* of the oscillator and f_Δ is the *frequency deviation*, , assumption $x_m(t)$ is limited to the range ±1.

Most of the energy of the signal is contained within $f_c \pm f_\Delta$, and thus after the Fourier analysis it can be shown that a wide range of frequencies is required to represent an FM signal. The frequency spectrum of an actual FM signal has various components which extend infinitely; although their amplitude decreases we often neglect the higher-order components in practical design problems.

Q28. Ans

As we talk louder the distortion increases and hence the VCO output becomes distorted due to interference.

Q29.

ans

The fundamental blocks are integrator, pulse generator and limiter. The function of limiter is to produce square wave of the input FM wave. The pulse generator forms pulses at the positive going edges and negative going edges of the limiter output. The Integrator functions the averaging over the time interval of T and hence reproduces the original message signal. Thus message signal contains only one frequency which is the original frequency.

Q30.

Ans>

The phase comparator output is first filtered using the LPF and its current is amplified with help of source follower. The output of the source follower is then matching the original message signal.

Q31/ ans

The dc component is same as that of message signal.

q32.

The zcd output a waveform of square wave varying from +v(sat) to -v(sat.)

q33.

Both signal mark and space changes.

q34.

The dc component of the zcd output is rejected and is equal to constant.

q35.

If the wave is a sine wave then the output of a baseband LPF is a sine wave with noise and eliminating all other frequencies except the carrier frequency.

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