K.L.N. COLLEGE OF INFORMATION TECHNOLOGY
POTTAPALAYAM, SIVAGANGAI DISTRICT – 630 612

Subject Code/Subject Name : CS6403/ANALOG AND DIGITAL COMMUNICATION)

PART – A   5 × 2 = 10 Marks

Answer all the questions

1. Why we need Modulation? **[K1]**

In order to carry the low frequency message signal to a longer distance, the high frequency carrier signal is combined with it.
a) Reduction in antenna height b) Long distance communication c) Ease of radiation
d) Multiplexing e) Improve the quality of reception f) Avoid mixing up of other signals

2. Define Noise Figure and Noise Factor. **[K1]**

Noise figure (NF) and **noise factor** (F) are measures of degradation of the signal-to-**noise** ratio (SNR), caused by components in a radio-frequency (RF) signal chain. It is a number by which the performance of an amplifier or a radio receiver can be specified, with lower values indicating better performance.

3. Explain Percent Modulation. **[K2]**

m=Em/Ec
It s defined as the percentage change in the amplitude of the output wave whn the carrier is acted on by a modulating signal.
M=(Em/Ec)*100

4. What is meant by Carson Rule? **[K1]**

Carson's rule states that the bandwidth required to transmit an angle modulated wave as twice the sum of the peak frequency deviation and the highest modulating ignal frequency. Mathematically carson's rule is B=2(f +fm) Hz.

5.List out the methods to suppress the single side bands. **[K1]**

Single side band transmission methods, **Filter method**, **Phase shift Method**. ... This is the filter method of SSB suppression for the transmission. The phase shifting action causes one side band to be canceled out.

PART – B   1 × 15 = 15 Marks

6. (a) i) Define Noise, Explain the classification of Noise. **(8)** **[K1]**

"In common use, the word noise means any unwanted sound". Unwanted signal are called noise.
Classification of Noise:
There are several way to classify Noise, but conveniently Noise is classified as
1) External Noise
2) Internal Noise

External Noise:

External noise is defined as the type of Noise which is general externally due to communication system. External Noise are analysed qualitatively. Now, External Noise may be classified as

a) Atmospheric Noise :

Atmospheric Noise is also known as static noise which is the natural source of disturbance caused by lightning, discharge in thunderstorm and the natural disturbances occurring in the nature.

b) Industrial Noise :
Sources of Industrial noise are auto-mobiles, aircraft, ignition of electric motors and switching gear. The main cause of Industrial noise is High voltage wires. These noises is generally produced by the discharge present in the operations.

c) Extraterrestrial Noise :
Extraterrestrial Noise exist on the basis of their originating source. They are subdivided into
i) Solar Noise
ii) Cosmic Noise

Internal Noise:
Internal Noise are the type of Noise which are generated internally or within the Communication System or in the receiver. They may be treated qualitatively and can also be reduced or minimized by the proper designing of the system. Internal Noises are classified as

1) Shot Noise :
These Noise are generally arises in the active devices due to the random behaviour of Charge particles or carries. In case of electron tube, shot Noise is produces due to the random emission of electron form cathodes.

2) Partition Noise :
When a circuit is to divide in between two or more paths then the noise generated is known as Partition noise. The reason for the generation is random fluctuation in the division.

3) Low- Frequency Noise :
They are also known as FLICKER NOISE. These type of noise are generally observed at a frequency range below few kHz. Power spectral density of these noise increases with the decrease in frequency. That why the name is given Low- Frequency Noise.

4) High- Frequency Noise :
These noises are also known TRANSIT- TIME Noise. They are observed in the semi-conductor devices when the transit time of a charge carrier while crossing a junction is compared with the time period of that signal.

5) Thermal Noise : Thermal Noise are random and often referred as White Noise or Johnson Noise. Thermal noise are generally observed in the resistor or the sensitive resistive components of a complex impedance due to the random and rapid movement of molecules or atoms or electrons.

ii) Compare AM, FM, PM. **(7) [K2]**

s.no	AM	FM	PM
1.	Amplitude Modulation is defined as changing the amplitude of the carrier signal with respect to the instantaneous change in message signal.	Frequency Modulation is defined as changing the frequency of the carrier signal with respect to the instantaneous change in message signal.	Phase Modulation is defined as changing the phase of the carrier signal with respect to the instantaneous change in message signal.
2.	It has only three terms carrier,LSB and USB hence bandwith is finite	It has infinite sideband.hence bandwith is infinite.	It has only two sideband like,hence Bandwith is finite.
3.	Modulation index should be within 1	Modulation index is high	Modulation index is low
4.	Noise Interference is more.	Noise Interference is less compared than AM.	Noise Interference is less.

(OR)

(b) i)Define Modulation, Derive the necessary mathematical expression . (8) [K1]

Modulation is defined as changing the characteristics of the carrier signal with respect to the instantaneous change in message signal.
Essentially an amplitude modulated wave consists of a radio frequency carrier - a sine wave at one frequency, typically in the radio frequency portion of the spectrum. A modulating wave, which in theory could be another sine wave, typically at a lower audio frequency is superimposed upon the carrier.

Amplitude modulation theory & equations:

It is possible to look at the theory of the generation of an amplitude modulated signal in four steps:

1. Carrier signal
2. Modulating signal
3. Overall modulated signal for a single tone
4. Expansion to cover a typical audio signal

These steps will be covered in greater details below:

1. Carrier signal equations

Looking at the theory, it is possible to describe the carrier in terms of a sine wave as follows:

$$\mathbf{C\,(t) = C \sin(\omega c + \varphi)}$$

Where:

carrier frequency in Hertz is equal to $\omega c / 2\pi$
C is the carrier amplitude
φ is the phase of the signal at the start of the reference time

Both C and φ can be omitted to simplify the equation by changing C to "1" and φ to "0".

2. Modulating signal equations

The modulating waveform can either be a single tone. This can be represented by a cosine waveform, or the modulating waveform could be a wide variety of frequencies - these can be represented by a series of cosine waveforms added together in a linear fashion.

For the initial look at how the signal is formed, it is easiest to look at the equation for a simple single tone waveform and then expand the concept to cover the more normal case. Take a single tone waveform:

$$\mathbf{m\,(t) = M \sin(\omega m + \varphi)}$$

Where:

modulating signal frequency in Hertz is equal to $\omega m / 2\pi$
M is the carrier amplitude
φ is the phase of the signal at the start of the reference time

Both C and φ can be omitted to simplify the equation by changing C to "1" and φ to "0".It is worth noting that normally the modulating signal frequency is well below that of the carrier frequency.

3. Overall modulated signal for a single tone

The equation for the overall modulated signal is obtained by multiplying the carrier and the modulating signal together.

$$y(t) = [A + m(t)] \cdot c(t)$$

The constant A is required as it represents the amplitude of the waveform.

Substituting in the individual relationships for the carrier and modulating signal, the overall signal becomes:

$$y(t) = [A + M \cos(\omega m\, t + \varphi] \cdot \sin(\omega c\, t)$$

The trigonometry can then be expanded out to give an equation that includes the components of the signal:

$$y(t) = [A + M \cos(\omega m\, t + \varphi] \cdot \sin(\omega c\, t)$$

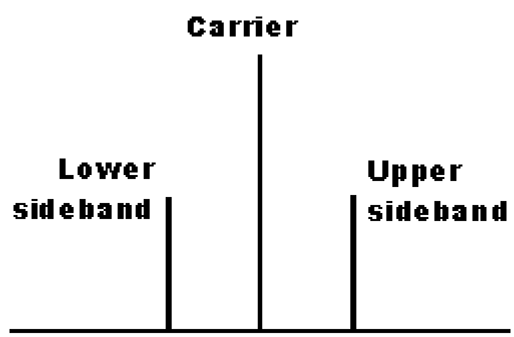
This can be expanded out using the standard trigonometric rules:

$$y(t) = A \cdot \sin(\omega c\, t) + M/2\, [\sin((\omega c + \omega m)\, t + \varphi) + M/2\, [\sin((\omega c - \omega m)\, t - \varphi)$$

In this theory, three terms can be seen which represent the carrier, and upper and lower sidebands:

Carrier: $A \cdot \sin(\omega c\, t)$
Upper sideband: $M/2\, [\sin((\omega c + \omega m)\, t + \varphi)$
Lower sideband: $M/2\, [\sin((\omega c - \omega m)\, t - \varphi)$

Note also that the sidebands are separated from the carrier by a frequency equal to that of the tone.

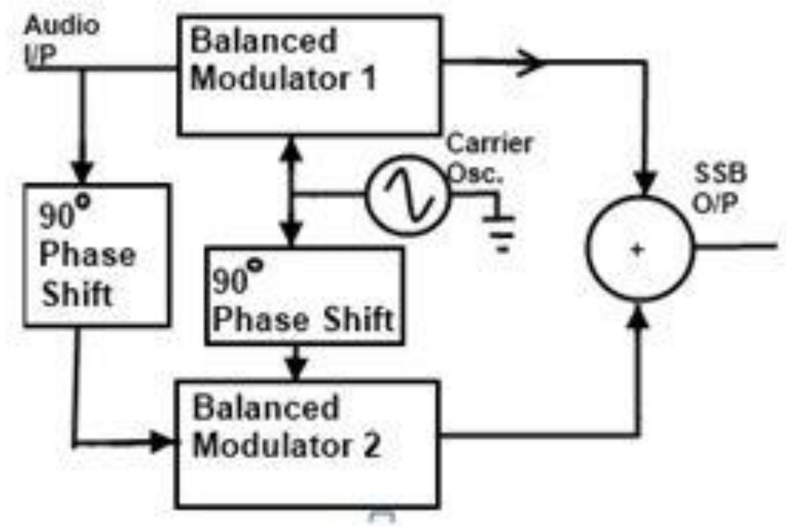


Sidebands on an amplitude modulated carrier when modulated with a single tone

It can be seen that for a case where there is 100% modulation, i.e. M = 1, and where the carrier is not suppressed, i.e. A = 1, then the sidebands have half the value of the carrier, i.e. a quarter of the power each.

ii)Explain the Phase shift method in SSB with neat Diagram. (7) [K2]

The phase shift method of SSB generation uses two balanced modulators and 90° phase shiftier but avoids the requirement for filters. The audio is shifted a total of 90° either by a pair of ± 45° phase shiftier or a single 90° phase shifter. A simplified block diagram of phase-shift method of SSB generation is as shown in Figure.



The RF carrier f1 is shifted 90° before it is applied to the modulators. Each modulator output is the expected upper and lower sideband. The upper sideband lead the carrier by 90°, but the lower sidebands are leading and lagging the carrier by 90°. The net result is two lower sidebands out of phase and cancelling each other. The upper sidebands are in phase and add, resulting in upper sideband output from the adder

- The carrier signal is $V_c \sin 2\pi f_c t$ the modulating signal is $V_m \sin 2\pi f_m t$. Balanced modulator produces the product of these two signals.

$$(V_m \sin 2\pi f_m t)(V_c \sin 2\pi f_c t)$$

- Applying a trigonometric identity.

$$(V_m \sin 2\pi f_m t)(V_c \sin 2\pi f_c t) = 1/2[\cos(2\pi f_c - 2\pi f_m)t - \cos(2\pi f_c + 2\pi f_m)t]$$

- Note that these are the sum and different frequencies or the upper and lower side bands.

- It is important to remember that a cosine wave is simply a sine wave shifted by 90. A cosine wave has exactly the same shape as a sine wave, but it occurs 90

- The 90 phase shifters create cosine waves of the carrier and modulating signal which are multiplied in balanced modulator to produce.

$$(V_m - \cos 2\pi f_m t)(V_c \cos 2\pi f_c t)(V_m - \cos 2\pi f_m t)(V_c \cos 2\pi f_c t)$$

- Another common trigonometric identity translates this to

$$(V_m \cos 2\pi f_m t)(V_c \cos 2\pi f_c t) 1/2[\ \cos(2\pi f_c - 2\pi f_m)t + \cos(2\pi f_c + 2\pi f_m)t]$$

- Now if you add these two expressions together the sum frequencies cancel while the difference frequencies add producing only the lower side band.

$$\mathrm{Cos}(2\pi f_c - 2\pi f_m)t$$