UNIT-I

Linear Modulation Schemes

1. Define Modulation.

Modulation is the process of changing the parameters of the carrier signal, in accordance with the instantaneous values of the modulating signal.

2. Explain Need for Modulation

- Antenna size gets reduced.
- No signal mixing occurs.
- Communication range increases.
- Multiplexing of signals occur.
- Adjustments in the bandwidth are allowed.
- Reception quality improves.

3. Explain about DSBSC modulation.

If this carrier is suppressed and the saved power is distributed to the two sidebands, then such a process is called as **Double Sideband Suppressed Carrier** system or simply **DSBSC.**

4. What is Bandwidth of DSBSC Wave?

We know the formula for bandwidth (BW) is

$$BW=fmax-fmin$$

$$BW=fc+fm-(fc-fm) \Rightarrow BW=2fm$$

5. Define Amplitude modulation.

According to the standard definition, "The amplitude of the carrier signal varies in accordance with the instantaneous amplitude of the modulating signal." This means, the amplitude of the carrier signal containing no information varies as per the amplitude of the signal containing information, at each instant. This can be well explained by the following figures.

6. Explain about SSBSC modulation.

The DSBSC modulated signal has two sidebands. Since, the two sidebands carry the same information, there is no need to transmit both sidebands. We can eliminate one sideband. The process of suppressing one of the sidebands along with the carrier and transmitting a single sideband is called as **Single Sideband Suppressed Carrier** system or simply **SSBSC.**

7. Write Hilbert Transform Properties.

A signal x(t) and its Hilbert transform x^(t) have

- The same amplitude spectrum.
- The same autocorrelation function.
- The energy spectral density is same for both x(t) and x^(t).
- x(t) and x^(t) are orthogonal.
- The Hilbert transform of x^(t) is -x(t)
- If Fourier transform exist then Hilbert transform also exists for energy and power signals.

8. Explain about VSB modulation.

SSBSC modulated signal has only one sideband frequency. Theoretically, we can get one sideband frequency component completely by using an ideal band pass filter. However, practically we may not get the entire sideband frequency component. Due to this, some information gets lost. To avoid this loss, a technique is chosen, which a compromise between DSBSC and SSBSC is. This technique is known as **Vestigial Side Band Suppressed Carrier (VSBSC)** technique. The word "vestige" means "a part" from which, the name is derived.

9. Bandwidth of VSBSC Modulation

We know that the bandwidth of SSBSC modulated wave is f_m. Since the VSBSC modulated wave contains the frequency components of one side band along with the vestige of other sideband, the bandwidth of it will be the sum of the bandwidth of SSBSC modulated wave and

10. What are the types of AM Modulators.

The circuit that generates the AM waves is called as amplitude modulator and in this post we will discuss two such modulator circuits namely

1. Square Law Modulator
2. Switching Modulator

Both of these circuits use non-linear elements such as a diode for their implementation. Both these modulators are low power modulator circuits.

11. What are the types of AM Demodulators.

The process of extracting an original message signal from the modulated wave is known as **detection** or **demodulation**. The circuit, which demodulates the modulated wave is known as the **demodulator**. The following demodulators (detectors) are used for demodulating AM wave.

- Square Law Demodulator
- Envelope Detector

12. What are the types DSBSC Modulators?

The following two modulators generate DSBSC wave.

- Balanced modulator
- Ring modulator

13. What are the types DSBSC Demodulators?

The process of extracting an original message signal from DSBSC wave is known as detection or demodulation of DSBSC. The following demodulators (detectors) are used for demodulating DSBSC wave.

- Coherent Detector
- Costas Loop

13. What are the types SSBSC Modulators?

We can generate SSBSC wave using the following two methods.

- Frequency discrimination method
- Phase discrimination method

14. What are the types SSBSC Demodulators?

The process of extracting an original message signal from SSBSC wave is known as detection or demodulation of SSBSC. Coherent detector is used for demodulating SSBSC wave.Here, the same carrier signal (which is used for generating SSBSC wave) is used to detect the message signal. Hence, this process of detection is called as **coherent** or **synchronous detection.**

15. What are the Advantages and Disadvantages of VSBSC modulation?

Following are the advantages of VSBSC modulation.

- Highly efficient.
- Reduction in bandwidth when compared to AM and DSBSC waves.
- Filter design is easy, since high accuracy is not needed.
- The transmission of low frequency components is possible, without any difficulty.
- Possesses good phase characteristics.

Following are the disadvantages of VSBSC modulation.

- Bandwidth is more when compared to SSBSC wave.
- Demodulation is complex.

16. What are the Applications of VSBSC modulation?

The most prominent and standard application of VSBSC is for the transmission of television signals. Also, this is the most convenient and efficient technique when bandwidth usage is considered.

17. Define Modulation Index?

The **modulation index** (or **modulation depth**) of a modulation scheme describes by how much the modulated variable of the carrier signal varies around its unmodulated level. It is defined differently in each modulation scheme.

18. What is the Formula to calculate total transmitted power in Amplitude Modulated System?

$$\mathbf{P_t = Pc\ (1+\mu^2/2)}$$

where P_t is Total Transmitted power

Pc is carrier power, μ is Modulation index

19. Define Quadrature Null Effect?

Quadrature null effect is caused due to phase error in the DSB-SC signal that has been received. Due to disturbance in the channel there can be a phase error and this phase error reduces the output of the demodulator. When phase error is 90 degrees the output is 0. When phase error is 0 degrees the output is maximum.

20. What are the Advantages, Disadvantages and applications of SSBSC modulation?

Advantages

- Bandwidth or spectrum space occupied is lesser than AM and DSBSC waves.
- Transmission of more number of signals is allowed.
- Power is saved.
- High power signal can be transmitted.
- Less amount of noise is present.
- Signal fading is less likely to occur.

Disadvantages

- The generation and detection of SSBSC wave is a complex process.
- The quality of the signal gets affected unless the SSB transmitter and receiver have excellent frequency stability.

Applications

- For power saving requirements and low bandwidth requirements.
- In land, air, and maritime mobile communications.
- In point-to-point communications.
- In radio communications.
- In television, telemetry, and radar communications.
- In military communications, such as amateur radio, etc.