1. Define transmission impairment. Explain its causes.(Attenuation, Distortion, Noise).
   Transmission impairment refers to any degradation or distortion of a signal as it travels over a communication channel. Several factors can contribute to transmission impairment, including attenuation, distortion, and noise.

   i. Attenuation: Attenuation refers to the reduction in signal strength as it travels through a medium, such as a cable or a wireless channel. It is often measured in decibels (dB).

   Causes:

   - Distance: The longer the transmission distance, the more likely attenuation will occur.
   - Medium Characteristics: Different mediums have different inherent attenuation properties. For example, signals may attenuate more in a long copper cable compared to a shorter fiber optic cable.
   - Frequency: Higher-frequency signals generally experience more attenuation than lower-frequency signals.

   ii. Distortion: Distortion occurs when the shape of the signal waveform is altered during transmission. This alteration may result in the inability to accurately reconstruct the original signal at the receiving end.

   Causes:

   - Dispersion: Dispersion is the spreading of signal pulses as they travel through a medium. This can be caused by variations in the propagation speed of different frequency components of the signal.
   - Nonlinearities: Nonlinearities in the transmission medium can cause distortion. For instance, nonlinearities in amplifiers can lead to signal distortion.

   iii. Noise: Noise refers to any unwanted or random interference that disrupts the original signal. It can be caused by various factors and can manifest in different forms, such as thermal noise, impulse noise, or crosstalk.

   -Causes:

   - External Interference: Signals may pick up interference from other electronic devices or external sources.

- Thermal Noise: Also known as Johnson-Nyquist noise, it is caused by the random motion of electrons in conductors and increases with temperature.
- Impulse Noise: Sudden and unexpected changes in signal amplitude, often caused by external events like lightning or power surges.
- Crosstalk: Signal interference that occurs when signals from one channel bleed into another adjacent channel.

2. Explain performance parameter of signal with example.

   Performance parameters of a signal are measures used to evaluate and quantify the characteristics of a signal in a communication system. These parameters help assess the quality and efficiency of signal transmission. Here are some common performance parameters along with examples:

   **1. Bandwidth:** Bandwidth is the range of frequencies that a signal occupies in a given transmission medium. In data communication, it often refers to the data transfer rate, indicating how much data can be transmitted in a specific amount of time. A common example is internet bandwidth, often measured in bits per second (bps) or its multiples (kbps, Mbps, Gbps). For instance, if you have a 100 Mbps internet connection, it means that the maximum data transfer rate is 100 megabits per second.

   **2. Throughput**: Throughput is the actual amount of data that successfully passes through a communication system in a given time period. It accounts for factors like protocol overhead, retransmissions, and any other inefficiencies that may reduce the effective data transfer rate. Consider a file transfer scenario where you are sending a 10 MB file over a network. The throughput would be measured in terms of how quickly the file is transmitted and received by the destination in Mbps or another appropriate unit.

   **3. Latency**: Latency is the time delay between the transmission of a signal and its reception. It includes various components such as propagation delay, transmission delay, queuing delay, and processing delay. In online gaming, latency is critical. A player's actions need to be quickly transmitted to the game server, and the server's response must be rapidly received. High latency can result in lag, affecting the gaming experience.

**4.Jitter**: Jitter refers to the variation in the time delay of received packets in a data stream. It represents the irregularity in the arrival times of successive packets. VoIP (Voice over Internet Protocol) calls require low jitter to maintain voice quality. If packets arrive at irregular intervals, it can lead to choppy or distorted voice communication. Consistent and minimal jitter is crucial for real-time applications.

3. Define multiplexing and its type with example.

Multiplexing is a technique used in communication systems to combine multiple signals onto a single transmission medium, allowing the efficient use of bandwidth and resources. It enables multiple data streams or signals to share the same communication channel without interfering with each other. The purpose of multiplexing is to make more effective use of available resources and improve the overall efficiency of communication systems.

There are several types of multiplexing, each designed for specific applications. Here are some common types of multiplexing:

**1. Frequency Division Multiplexing (FDM):** FDM involves dividing the available frequency spectrum into multiple non-overlapping frequency bands, with each band dedicated to a different communication channel. Analog television broadcasting uses FDM, where different TV channels are allocated different frequency bands within the radio frequency spectrum. Each channel carries a unique television signal.

**2. Time Division Multiplexing (TDM):** TDM divides the transmission time into fixed, non-overlapping time slots, and each time slot is allocated to a different communication channel. TDM is commonly used in digital telephony. In a TDM-based system, each voice conversation is assigned a specific time slot, allowing multiple conversations to share the same communication channel.

**3. Wavelength Division Multiplexing (WDM):** WDM is similar to FDM but is used in optical fiber communication. It involves dividing the available optical spectrum into multiple wavelength channels, and each channel carries a separate data stream. In fiber optic communication,

different wavelengths of light (colors) are used to transmit multiple data streams simultaneously. This allows for high-capacity data transmission over a single optical fiber.

4. Define Spread Spectrum. Differentiate between frequency hopping and direct sequence spread spectrum.

   Spread spectrum is a communication technique that spreads the transmission of a signal over a wide frequency band, contrary to traditional narrowband communication where the signal is confined to a narrow frequency range. The fundamental idea behind spread spectrum is to enhance the reliability and security of communication systems by distributing the signal energy across a broad spectrum of frequencies.

| **FHSS** | **DSSS** |
|---|---|
| Multiple frequencies are used. | Single frequencies are used. |
| Hard to find user's frequency at any instant of time | User frequency, once allotted is always the same. |
| Frequency reused is allowed. | Frequency reused is not allowed. |
| Sender need not wait. | Sender need to wait if the spectrum is busy. |
| Power strength of the signal is high. | Power strength of the signal is low. |
| Stronger and penetrates through the obstacles | It is weaker compared to FHSS |
| It is never affected by the interference. | It can be affected by the interference. |
| It is cheaper | It is expensive. |
| This is commonly used technique. | This technique is not commonly used. |

5. Differentiate between Analog and Digital signal.

| Parameter | Analog Signal | Digital Signal |
|---|---|---|
| Definition | A signal for conveying information which is a continuous function of time is known as analog signal. | A signal which is a discrete function of time, i.e. non-continuous signal, is known as digital signal. |
| Typical representation | An analog signal is typically represented by a sine wave function. There are many more representations for the analog signals also. | The typical representation of a signal is given by a square wave function. |
| Signal values | Analog signals use a continuous range of values to represent the data and information. | Digital signals use discrete values (or discontinuous values), i.e. discrete 0 and 1, to represent the data and information. |
| Signal bandwidth | The bandwidth of an analog signal is low. | The bandwidth of a digital signal is relatively high. |
| Suitability | The analog signals are more suitable for transmission of audio, video and other information through the communication channels. | The digital signals are suitable for computing and digital electronic operations such as data storage, etc. |
| Effect of electronic noise | Analog signals get affected by the electronic noise easily. | The digital signals are more stable and less susceptible to noise than the analog signals. |
| Accuracy | Due to more susceptibility to the noise, the accuracy of analog signals is less. | The digital signals have high accuracy because they are immune from the noise. |
| Power consumption | Analog signals use more power for data transmission. | Digital signals use less power than analog signals for conveying the same amount of information. |
| Observational errors | The analog signals give observational errors. | The digital signals do not given observational errors. |
| Examples | The common examples of analog signals are temperature, current, voltage, voice, pressure, speed, etc. | The common example of digital signal is the data store in a computer memory. |