PRINCIPLES OF COMMUNICATION (BEC-28)

UNIT-3
NOISE

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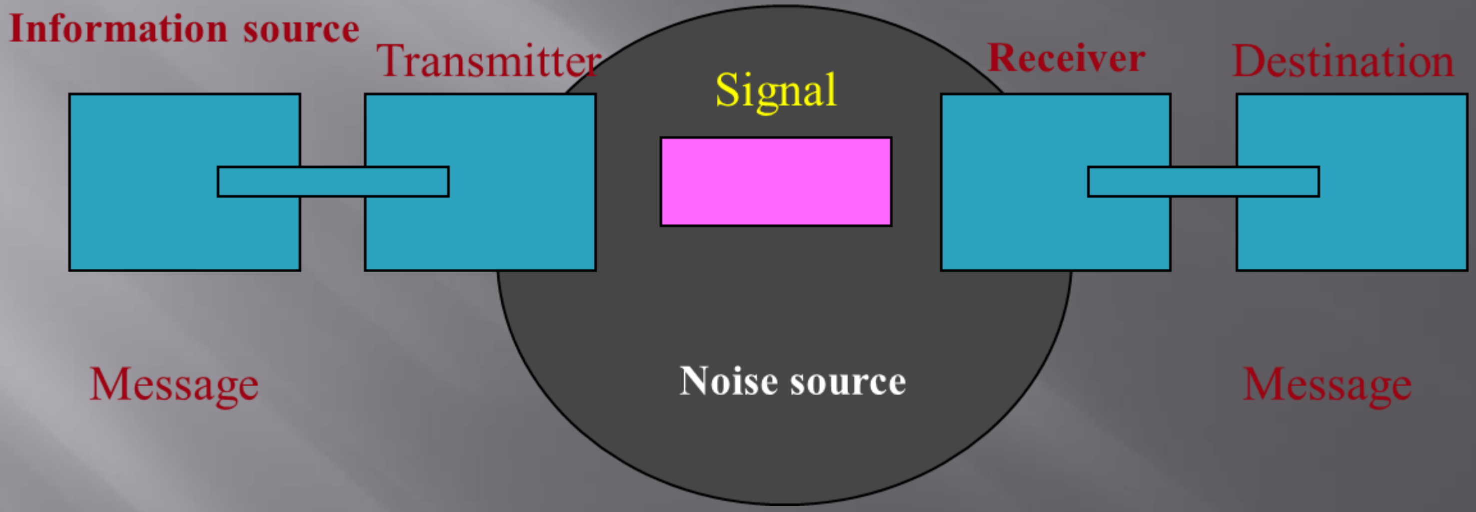
Content of Unit-3

- **Noise:** Source of Noise, Frequency domain, Representation of noise, Linear Filtering of noise, Noise in Amplitude modulation system, Noise in SSB-SC,DSB and DSB-C, Noise Ratio, Noise Comparison of FM and AM, Pre-emphasis and De-emphasis, Figure of Merit.

Noise in Communication Systems

- Claude E. Shannon conceptualized the communication theory model in the late 1940s.
- It remains central to communication study today.
- Noise is random signal that exists in communication systems



- Channel is the main source of noise in communication systems
- Transmitter or Receiver may also induce noise in the system

There are mainly 2-types of noise sources

- Internal noise source (are mainly internal to the communication system)
- External noise source

Noise Effects

Noise is an inconvenient feature which affects the system performance. Following are the effects of noise

- Degrade system performance for both analog and digital systems
- Noise limits the operating range of the systems

  Noise indirectly places a limit on the weakest signal that can be amplified by an amplifier. The oscillator in the mixer circuit may limit its frequency because of noise. A system's operation depends on the operation of its circuits. Noise limits the smallest signal that a receiver is capable of processing

- The receiver can not understand the sender
- the receiver can not function as it should be.
- Noise affects the sensitivity of receivers:

  Sensitivity is the minimum amount of input signal necessary to obtain the specified quality output. Noise affects the sensitivity of a receiver system, which eventually affects the output.

- Reduce the efficiency of communication system.

Noise Vs Interference

- Noise is a general term which is used to describe an unwanted signal which affects a wanted signal.

- Interference arises for example, from other communication systems (cross talk), 50 Hz supplies (hum) and harmonics, ignition (car spark plugs) motors … etc.

Types of Noise

The classification of noise is done depending on the type of the source, the effect it shows or the relation it has with the receiver, etc.

There are two main ways in which noise is produced. One is through some **external source** while the other is created by an **internal source**, within the receiver section.

External Noise

This noise is produced by the external sources which may occur in the medium or channel of communication, usually. This noise cannot be completely eliminated. The best way is to avoid the noise from affecting the signal.

Examples

Most common examples of this type of noise are −

- Atmospheric noise (due to irregularities in the atmosphere).
- Extra-terrestrial noise, such as solar noise and cosmic noise.
- Industrial noise.

Internal Noise

This noise is produced by the receiver components while functioning. The components in the circuits, due to continuous functioning, may produce few types of noise. This noise is quantifiable. A proper receiver design may lower the effect of this internal noise.

Examples

Most common examples of this type of noise are −

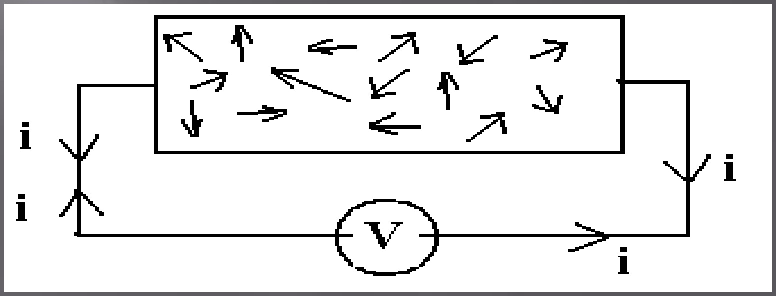
- Thermal agitation noise (Johnson noise or Electrical noise).
- Shot noise (due to the random movement of electrons and holes).
- Transit-time noise (during transition).
- Miscellaneous noise is another type of noise which includes flicker, resistance effect and mixer generated noise, etc.

Thermal Noise (Johnson Noise)

This type of noise is generated by all resistances (e.g. a resistor, semiconductor, the resistance of a resonant circuit, etc.).

Experimental results (by Johnson) and theoretical studies (by Nyquist) give the mean square noise voltage as

$$\bar{V}^2 = 4kTBR \ (volt^2)$$



Where k = Boltzmann's constant = 1.38 x 10^{-23} Joules per K
T = absolute temperature
B = noise bandwidth measured in (Hz)
R = resistance (ohms)

Example

1. An amplifier operating over the frequency range from 18 to 20 M Hz has a 10K ohm input register. Calculate the rms noise voltage at the input to this amplifier if the ambient temperature is 270 degree Centigrade

Solution: The rms noise voltage is given by the expression

$$\bar{V} = \sqrt{4kTBR}\ (volt)$$

Given that R=10K ohm

T=273+27=300 K

B=20-18=2 MHz

k=1.38× 10^{-23} Jule/deg-K

$$\bar{V} = \sqrt{4 \times 10 \times 10^3 \times 1.38 \times 10^{-23} \times 300 \times 2 \times 10^6}\ (volt)$$

$$\bar{V} = 1.82 \times 10^{-5}\ volt$$

2. Two register of 20 K ohm and 50 K ohm are at room temperature of 15 degree C or 290 K for the given bandwidth of 100 KHz . Determine the thermal noise voltage generated by

A) Each Register

B) Two register in parallel

C) two register in series

Thank you