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Department of Medical Instrumentation Techniques Engineering
Class: Third
Subject: Medical Communication Syatems
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Lecture:9

Lecture 9

Noise in Analogue and Digital System

Noise may be defined as any unwanted signal that interferes with the communication, measurement or processing of an information-bearing signal. Noise is present in various degrees in almost all environments. For example, in a digital cellular mobile telephone system, there may be several variety of noise that could degrade the quality of communication, such as acoustic background noise, thermal noise, electromagnetic radio-frequency noise, co-channel interference, radio-channel distortion, echo and processing noise. Noise can cause transmission errors and may even disrupt a communication process.

TYPES OF NOISE

Noise in a communication system can be classified into two broad categories, depending on its source.

1. **External Noise:** Results from sources outside a communication system, including atmospheric, man-made, and extraterrestrial sources.

a) Atmospheric noise

b) Man-made noise:

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c) Extraterrestrial noise:

d) **Fading:**

2. Internal Noise:

It is the noise generated by components within a communication system, such as resistors, electron tubes, and solid-state active devices.

a) Thermal Noise (Johnsons Noise, Nyquist Noise).

b) shot noise.

c) Flicker Noise.

THERMAL NOISE

Thermal noise is the noise arising from the random motion of charge carriers in a conducting or semiconducting medium. Such random agitation at the atomic level is a universal characteristic of matter at temperatures other than absolute zero. Nyquist was one of the first to have studied thermal noise.

$$P_n \propto TB$$

$$P_n = kTB$$

k = Boltzmann's constant = 1.38×10^{-23} J/K

T: temperature in kelvin

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B: noise bandwidth in hertz

the mean-square noise voltage appearing across the terminals of a resistor of R ohms is given by

$$V_n = \sqrt{kTBR}$$

Example:

An Operational Amplifier with a frequency range of (18-20)MHz has input resistance of 10$k\Omega$. Calculate noise voltage at the input if the amplifier operate at ambient temperature of 27c^o.

Solution:

$$B = 20 - 18 = 2MHz$$

$$V_n = \sqrt{kTBR}$$

$$V_n = \sqrt{1.38 \times 10^{-23} \times (27 + 273) \times 2 \times 10^6 \times 10 \times 10^3}$$

$$V_n = 18\mu V$$

How to determine noise level in communication System:

Noise effect can be determined by measuring:

1. Signal to noise ratio (SNR) for analog system: measures the ratio of the power of the signal to the power of the noise affecting the

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signal. It's commonly used in analog systems to quantify the quality of the received signal. The higher the SNR, the better the quality of the signal. SNR can be calculated using the following formula:

$$SNR = \frac{P_{signal}}{P_{noise}}$$

where P_{signal} is the power of the signal and P_{noise} is the power of the noise.

2. Bit Error Rate (BER) for digital system is a measure of the number of bit errors occurring in a transmission system relative to the total number of bits transmitted. It's used in digital communication systems to evaluate the quality of the received data. BER is usually expressed as a ratio or a percentage. Lower BER indicates better performance. BER can be determined by comparing the received bit stream to the transmitted one and counting the number of bit errors.

In both cases, measuring and analyzing the SNR for analog systems or the BER for digital systems helps in assessing the impact of noise on the communication system's performance. Lower SNR or higher BER indicates a higher level of noise interference, which can degrade the quality of the communication.