

Concept of Gain

Voltage, Current, Power

Elementrix Classes

Concept of Gain

Gain is a measure of the ability of a system to increase or decrease the amplitude, power, voltage, or current of a signal. It is a crucial parameter in electronics and is used to quantify the amplification or attenuation provided by a device or circuit.

Formula for Gain:

The formula for gain depends on the specific type of gain being considered. However, a general representation of gain in decibels (dB) can be expressed as follows:

$$Gain(dB) = 10 \cdot \log_{10} \left(\frac{\text{Output Power or Voltage or Current}}{\text{Input Power or Voltage or Current}} \right)$$

This formula is commonly used when expressing gain in a logarithmic scale.

When this ratio is **greater than one**, the signal is being **amplified**. When it is **less than one**, the signal is being **attenuated** and when it is 0 dB means no change in signal.

Types of Gains:-

1. Voltage Gain (A_v):

Voltage gain (A_v) is a measure of how much an amplifier increases or decreases the input voltage to produce a corresponding output voltage. It is a crucial parameter in amplifiers and other electronic devices where the goal is to amplify a signal for various applications.

Formula:

$$A_v = \frac{V_{out}}{V_{in}} \left(\frac{\text{Output Voltage}}{\text{Input Voltage}} \right)$$

Example: Consider a operational amplifier with an input voltage (V_{in}) of 2 V and an output voltage (V_{out}) of 20 V. The voltage gain (A_v) is calculated as:

$$A_v = \frac{V_{out}}{V_{in}} = \frac{20V}{2V} = 10$$

This means the voltage is amplified by a factor of 10.

2. Current Gain

Current gain (A_i) is a measure of how much an amplifier increases or decreases the input current to produce a corresponding output current. It is particularly relevant in devices like transistors, where a small input current controls a larger output current.

Formula:

$$A_i = \frac{I_{out}}{I_{in}}$$

Example:

Consider a common-emitter transistor amplifier with an input current (I_{in}) of 10 mA and an output current (I_{out}) of 100 mA. The current gain (A_i) is calculated as:

$$A_i = \frac{I_{out}}{I_{in}} = \frac{100mA}{10mA} = 10$$

This means the current is amplified by a factor of 10.

3. Power Gain

Power gain (A_p) is a measure of how much an amplifier increases or decreases the input power to produce a corresponding output power. It takes into account both the change in voltage and the change in current.

Formula:

$$A_p = \frac{P_{out}}{P_{in}} \left(\frac{\text{Output Power}}{\text{Input Power}} \right)$$

Example:

Consider a power amplifier with an input power (P_{in}) of 1 W and an output power (P_{out}) of 100 W. The power gain (A_p) is calculated as:

$$A_p = \frac{P_{out}}{P_{in}} = \frac{100W}{1W} = 100$$

This means the power is amplified by a factor of 100.

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