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VKSU

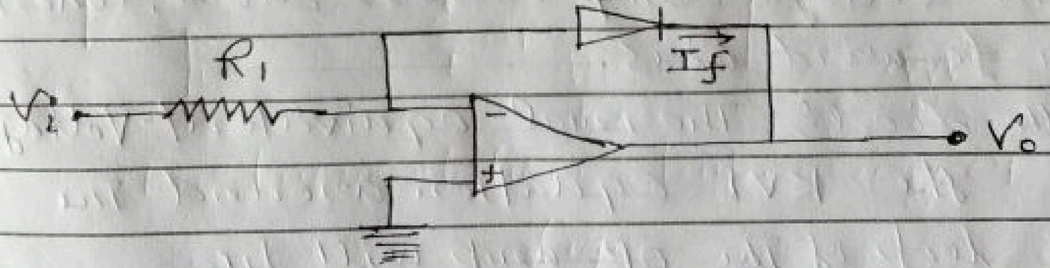
Logarithmic Amp. and Exponential Amp.

The electronic circuits which perform the mathematical operations such as logarithmic & exponential with an amplification are called as Logarithamic amp. and exponential (Antilogarithmic) Amp. respectively.

Logarithmic Amplifier:

A logarithamic amp. or a log amp. is an electronic circuit that produces an output that is proportional to the logarithm of the applied input. This section discusses about the op-amp. based logarithamic amplifier in detail.

An op-amp. based logarithamic amp. produces a voltage at the output, which is proportional to the logarithm of the voltage applied to the resistor connected to its inverting terminal. The circuit diagram of an op-amp. based logarithamic amp. is shown in the following figure.



In the above circuit, the non-inverting input terminal of the op-amp. is connected to ground. That means zero Volts is applied at The non-inverting input-terminal of The op-amp.

According to The virtual short concept, The voltage at The inverting input terminal of an op-amp will be equal to The Voltage at its non-inverting input terminal. So, The Voltage at The inverting input terminal will be zero volts.

The nodal equation at The inverting input terminal's node is—

$$\frac{0 - V_i}{R_1} + I_f = 0$$

$$\boxed{\Rightarrow \quad I_f = V_i / R_1} \quad \text{—— (1)}$$

The following is The equation for Current flowing Through a diode, when it is in forward bias

$$I_f = I_S e^{(V_f / nV_T)} \quad \text{—— (2)}$$

- I_S, is The Saturation Current of the diode.
- V_f, is The Voltage drop across diode, when it is in forward bias.
- V_T, is The diod's Thermal equivalent Voltage.

The KVL equation around The feed back loop of The op-amp will be

$$0 - V_f - V_0 = 0$$

$$\Rightarrow \quad V_f = -V_0$$

Substituting the value of V_f in equation ②, we get

$$I_f = I_s e^{(-V_0/nVT)} \quad \text{--- ③}$$

Observe that the left hand side terms of both equn ① and ③ are same. Hence, equate the right hand side term of those two equations as shown below —

$$\frac{V_i}{R_1} = I_s e^{(-V_0/nVT)}$$

$$\frac{V_i}{R_1 I_s} = e^{(-V_0/nVT)}$$

Applying natural logarithm on both sides we get,

$$\ln\left(\frac{V_i}{R_1 I_s}\right) = \frac{-V_0}{nVT}$$

$$V_0 = -nVT \ln\left(\frac{V_i}{R_1 I_s}\right)$$

Note that in the above equation, the parameters n, V_T and I_s are constants. So, the output voltage V_0 will be proportional to the natural logarithm of the input voltage V_i, for a fixed value of resistance R_1.

Therefore, the OP-amp. based logarithmic amp. circuit discussed above will produce an output, which is proportional to the natural logarithm of the input voltage.

V_T, when $R_1 I_S = 1V$.

Observe that the output voltage V_0 has a -ve sign, which indicates that there exists a 180° phase difference between the input and the output.

<u>Logarithmic Amplifier</u> :-