UNIT-3 MPHYCC-7

Submitted by:

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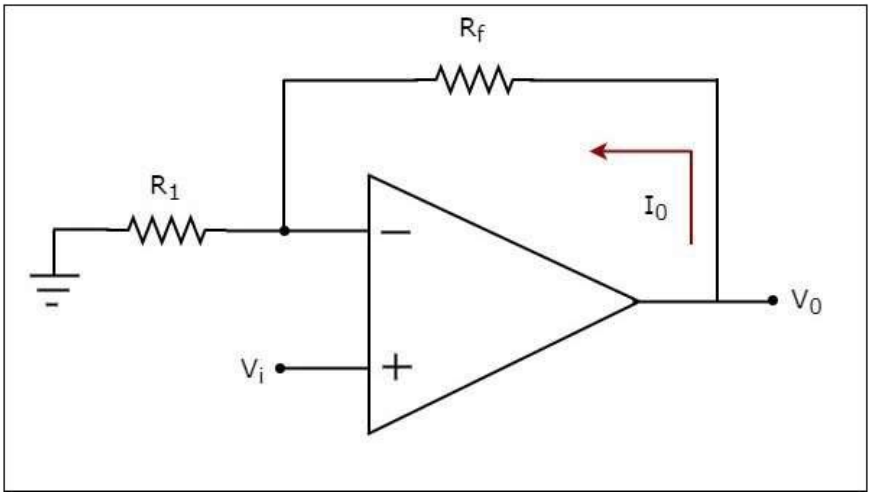
Current to Voltage Converter

Voltage and current are the basic electrical quantities. They can be converted into one another depending on the requirement. Voltage to Current Converter and Current to Voltage Converter are the two circuits that help in such conversion. These are also linear applications of op-amps.

Voltage to Current Converter:

A voltage to current converter or V to I converter, is an electronic circuit that takes current as the input and produces voltage as the output. Here we will discuss about the op-amp based voltage to current converter. An op-amp based voltage to current converter produces an output current when a voltage is applied to its non-inverting terminal. The circuit diagram of an op-amp based voltage to current converter is shown in the following figure.



In the circuit shown above, an input voltage V_i 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 of the op-amp will be V_i. The nodal equation at the inverting input terminal's node is −

$$\frac{V_i}{R_1} - I_0 = 0$$

$$I_0 = \frac{V_i}{R_1}$$

Thus, the output current I_0 of a voltage to current converter is the ratio of its input voltage V_i and resistance R_1.

We can re-write the above equation as –

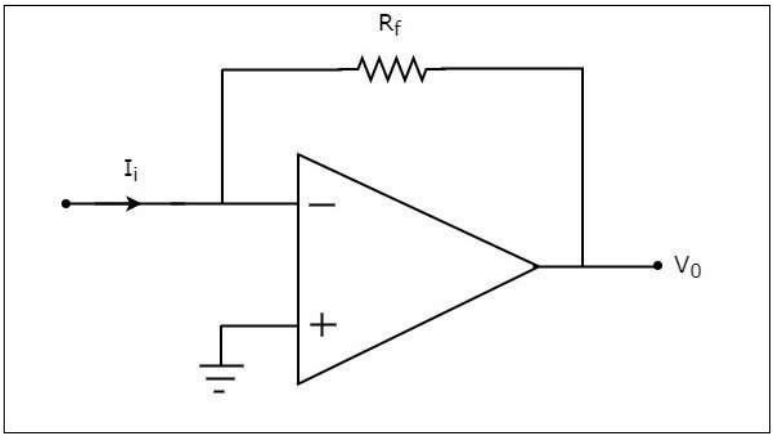
$$\frac{I_0}{V_i} = \frac{1}{R_1}$$

The above equation represents the ratio of the output current I_0 and the input voltage V_i & it is equal to the reciprocal of resistance R_1 The ratio of the output current I_0 and the input voltage V_i is called as Transconductance.

We know that the ratio of the output and the input of a circuit is called as gain. So, the gain of an voltage to current converter is the Transconductance and it is equal to the reciprocal of resistance R_1.

Current to Voltage Converter

A current to voltage converter or I to V converter is an electronic circuit that takes current as the input and produces voltage as the output. This section discusses about the op-amp based current to voltage converter. An op-amp based current to voltage converter produces an output voltage when current is applied to its inverting terminal. The circuit diagram of an op-amp based current to voltage converter is shown in the following figure.



In the circuit shown above, the non-inverting input terminal of the op-amp is connected to ground. That means zero volts is applied at its non-inverting input terminal. 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 of the op-amp will be zero volts.

The nodal equation at the inverting terminal's node is –

$$-I_i + \frac{0 - V_0}{R_f} = 0$$

$$-I_i = \frac{V_0}{R_f}$$

$$V_0 = -R_f I_i$$

Thus, the output voltage, V_0 of current to voltage converter is the (negative) product of the feedback resistance, R_f and the input current, I_i. Observe that the output voltage, V_0 is having a negative sign, which indicates that there exists a 180^0 phase difference between the input current and output voltage. We can re-write the above equation as –

$$\frac{V_0}{I_i} = -R_f$$

The above equation represents the ratio of the output voltage V_0 and the input current Ii, and it is equal to the negative of feedback resistance, R_f. The ratio of output voltage V_0 and input current Ii is called as Transresistance.

We know that the ratio of output and input of a circuit is called as gain. So, the gain of a current to voltage converter is its transresistance and it is equal to the (negative) feedback resistance R_f.