COLLEGE OF ENGINEERING AND TECHNOLOGIES
ALMUSTAQBAL UNIVERSITY

Electronics Circuits

CTE 204

Lecture 7

- Basic Op-Amp -

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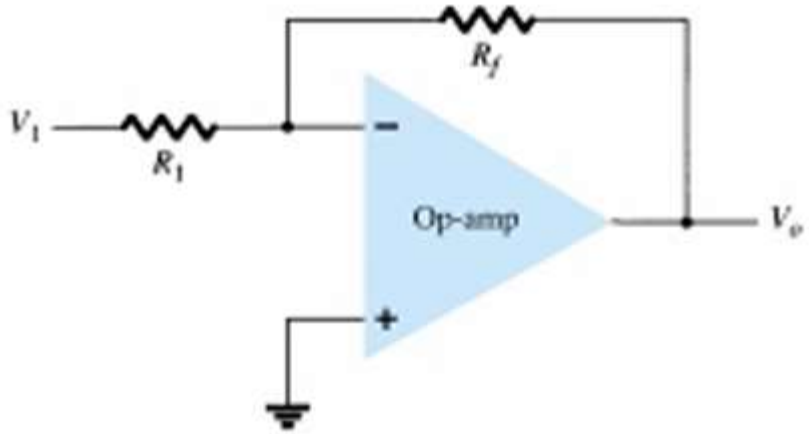
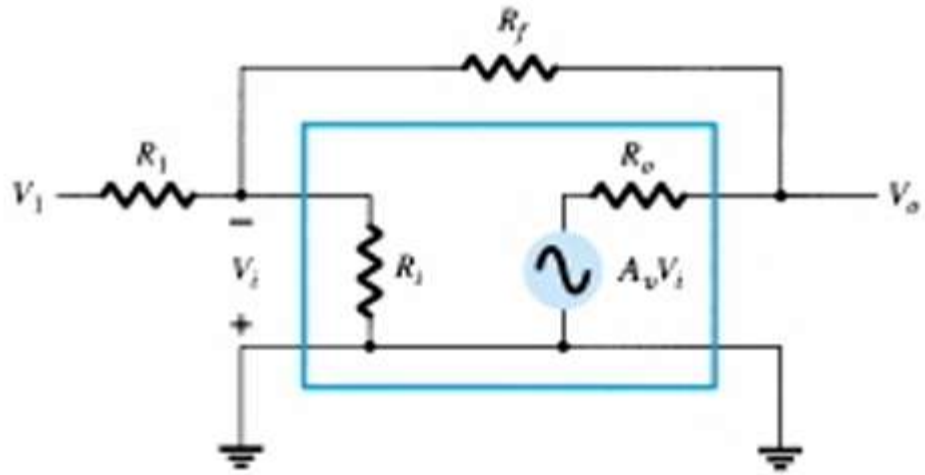
Basic Op-Amp

- The basic circuit connection using an op-amp is shown in Figure below.
- The circuit shown provides operation as a constant-gain multiplier.
- An input signal, V1, is applied through resistor R1 to the minus input.



- The output is then connected back to the same minus input through resistor Rf.
- The plus input is connected to ground.
- Since the signal V1 is essentially applied to the minus input, the resulting output is opposite in phase to the input signal.

- Figure below shows the op-amp replaced by its ac equivalent circuit.



Unity Gain

- If Rf = R1, the gain is

$$\text{voltage gain} = -\frac{R_f}{R_1} = -1$$

- So that the circuit provides a unity voltage gain with 180° phase inversion.

- If Rf is exactly R1, the voltage gain is exactly 1.

Constant Magnitude Gain

- If Rf is some multiple of R1.
- The overall amplifier gain is a constant.
- For example, if Rf = 10R1, then

$$\text{voltage gain} = -\frac{R_f}{R_1} = -10$$

- The circuit provides a voltage gain of exactly 10 along with an 180° phase inversion from the input signal.

Ideal Op Amp

- To facilitate the understanding of op amp circuits, we will assume ideal op amps.

- An op amp is ideal if it has the following characteristics:

1. Infinite open-loop gain, $A \simeq \infty$.
2. Infinite input resistance, $R_i \simeq \infty$.
3. Zero output resistance, $R_o \simeq 0$.

- An ideal op amp is an amplifier with infinite open-loop gain, infinite input resistance, and zero output resistance.

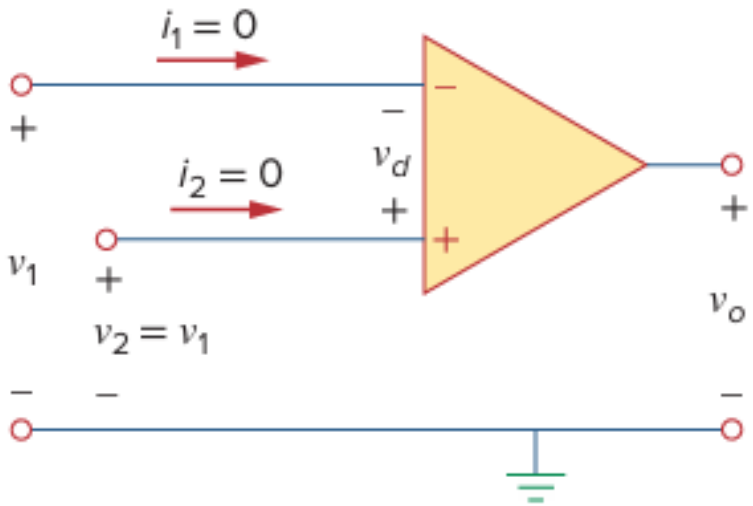
Ideal Op Amp

- Although assuming an ideal op amp provides only an approximate analysis.

- Most modern amplifiers have such large gains and input impedances that the approximate analysis is a good one.

- Unless stated otherwise, we will assume from now on that every op amp is ideal.

- For circuit analysis, the ideal op amp is illustrated in Figure below, which is derived from the nonideal model.



Ideal Op Amp

Two important properties of the ideal op amp are:

1. The currents into both input terminals are zero:

$$i_1 = 0, \quad i_2 = 0$$

- This is due to infinite input resistance.
- An infinite resistance between the input terminals implies that an open circuit exists there and current cannot enter the op amp.

2. The voltage across the input terminals is equal to zero; i.e

$$v_d = v_2 - v_1 = 0$$

or

$$\boxed{v_1 = v_2}$$

- Thus, an ideal op amp has zero current into its two input terminals and the voltage between the two input terminals is equal to zero.

- These equations below are extremely important and should be regarded as the key handles to analyzing op amp circuits.

$$i_1 = 0, \quad i_2 = 0$$

$$v_1 = v_2$$

Ideal Op Amp

- The two characteristics can be exploited by noting that
- For voltage calculations, the input port behaves as a short circuit.
- While for current calculations the input port behaves as an open circuit.