COLLEGE OF ENGINEERING AND TECHNOLOGIES
ALMUSTAQBAL UNIVERSITY

Electronics Circuits

CTE 204

Lecture 5

- Operational Amplifiers -

(2024 - 2025)

Dr. Zaidoon AL-Shammari

Lecturer / Researcher

zaidoon.waleed@mustaqbal-college.edu.iq

Learning Objectives

By using the information and exercises in this chapter you will be able to:

1. Comprehend how real operational amplifiers (op amps) function.
2. Understand that ideal op amps function nearly identically to real ones and that they can be used to model them effectively in a variety of circuit applications.

Learning Objectives

3. Realize how the basic inverting op amp is the workhorse of the op amp family.

4. Use the inverting op amp to create summers.

5. Use the op amp to create a difference amplifier.

6. Explain how to cascade a variety of op amp circuits.

Introduction

- The operational amplifier, or op amp for short.
- The op amp is a versatile circuit building block.
- It can also be used in making a voltage- or current - controlled current source.
- An op amp can sum signals, amplify a signal, integrate it, or differentiate it.

Introduction

- The ability of the op amp to perform these mathematical operations is the reason it is called an operational amplifier.
- It is also the reason for the widespread use of op amps in analog design.
- Op amps are popular in practical circuit designs because they are versatile, inexpensive, easy to use, and fun to work with.

Introduction

- We begin by discussing the ideal op amp and later consider the nonideal op amp.
- Using nodal analysis as a tool, we consider ideal op amp circuits such as the inverter, voltage follower, summer, and difference amplifier.
- Finally, we learn how an op amp is used in digital-to-analog converters and instrumentation amplifiers.

Operational Amplifiers

- An operational amplifier is designed so that it performs some mathematical operations when external components, such as resistors and capacitors, are connected to its terminals. Thus,

- An op amp is an active circuit element designed to perform mathematical operations of

Operational Amplifiers

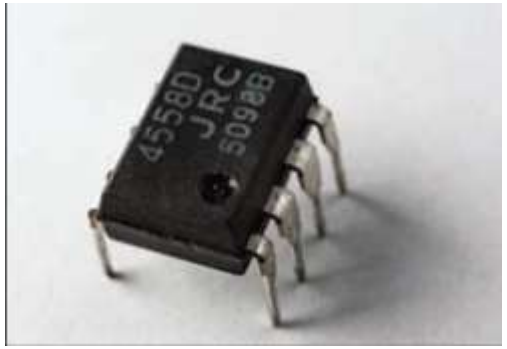
- Addition
- Subtraction
- Multiplication
- Division
- Differentiation
- Integration

- The op amp is an electronic device consisting of a complex arrangement of resistors, transistors, capacitors, and diodes.

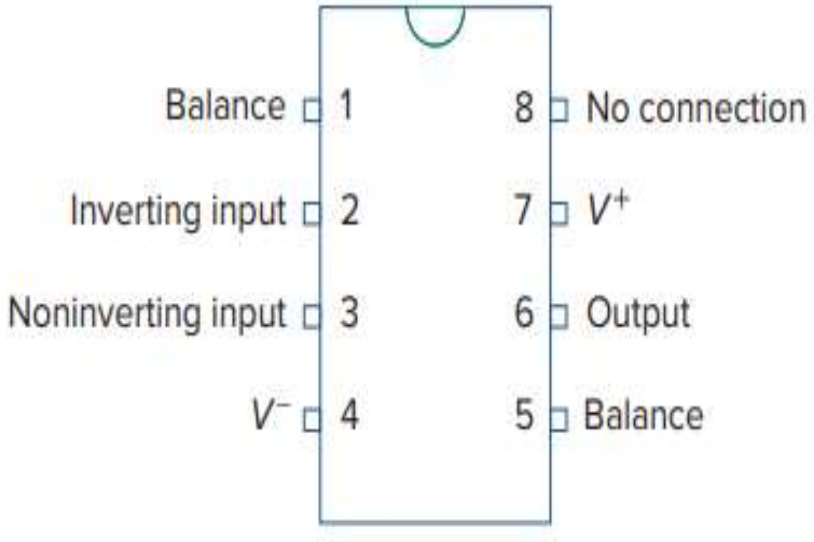
- A full discussion of what is inside the op amp is beyond the scope of this book.

- It will suffice to treat the op amp as a circuit building block and simply study what takes place at its terminals.

- Op amps are commercially available in integrated circuit packages in several forms.



- Figure 1 shows a typical op amp package.



- A typical one is the eight-pin dual in-line package (or DIP), shown in Fig. 2.

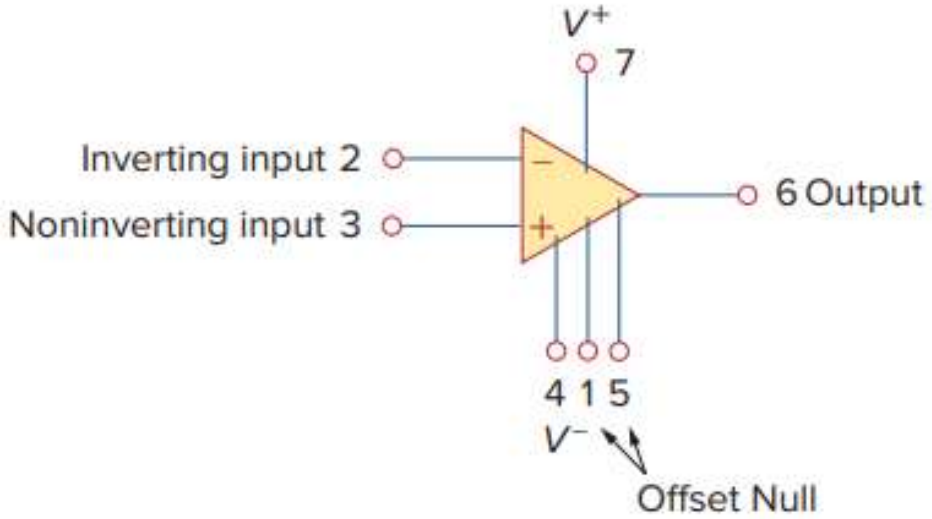
Pin or terminal 8 is unused, and terminals 1 and 5 are of little concern to us.

The five important terminals are:

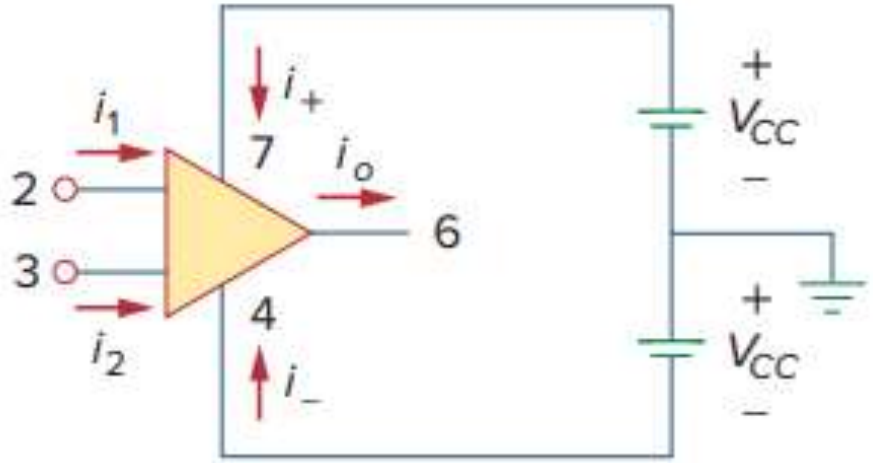
1. The inverting input, pin 2.
2. The noninverting input, pin 3.
3. The output, pin 6.
4. The positive power supply V+, pin 7.
5. The negative power supply V−, pin 4.

- The circuit symbol for the op amp is the triangle in Figure below; as shown, the op amp has two inputs and one output.

- The inputs are marked with minus (−) and plus (+) to specify inverting and noninverting inputs, respectively.



- An input applied to the noninverting terminal will appear with the same polarity at the output, while an input applied to the inverting terminal will appear inverted at the output.
- As an active element, the op amp must be powered by a voltage supply as typically shown in Figure below.



- Although the power supplies are often ignored in op amp circuit diagrams for the sake of simplicity, the power supply currents must not be overlooked. By KCL

$$i_o = i_1 + i_2 + i_+ + i_-$$