FACULTY OF ENGINEERING
DEPARTMENT OF ELECTRONICS AND COMMUNICATIONS

GEE336
Electronic Circuits II

Lecture #1
Course Introduction and Amplifier Feedback Concepts

Instructor:
Dr. Ahmad El-Banna

SUMMER 2015

Agenda

- Course Objectives
- Course Information
- Lectures List
- Amplifier Feedback Basics

Course Objectives

- By the end of this course, students should be able to:
  - Analyze a Feed-Back Amplifier
  - Design a Function Generator
  - Design Active Filters
  - Design ADC and DAC
  - Design a Regulated Power Supply
  - Implement Simple Projects Using Op-Amps, IC555 , …etc

Course Information

Instructor:	Dr. Ahmad El-Banna *http://bu.edu.eg/staff/ahmad.elbanna* Office: Room # Email: ahmad.elbanna@feng.bu.edu.eg
Lectures:	Sunday ~ Wednesday 11:00 -12:40 Prerequisite: GEE 331
Office Hours:	Sunday ~ Wednesday 12:50 -13:40
T.A.:	Eng.
Texts/Notes:	• Lectures slides, available by each lecture, and found online at *http://bu.edu.eg/staff/ahmad.elbanna-courses/12884* • T. Floyd, **Electronic devices** - Conventional Current Version, 9th edition, Prentice Hall. • R. Boylestad, **Electronic Devices and Circuit Theory**, 11th edition, Prentice Hall.

Course Information..

Additional References:	• Sedra & Smith, **Microelectronic Circuits**, 6th edition. • Horowitz & Hill, **The Art of Electronics**, 2nd edition, Cambridge Press. • EE113 Course Notes Electronic Circuits by Prof. G. Kovacs, Stanford University, Department of Electrical Engineering.

Assessment schedule:

Assessment 1	**Fifth-week examination**	**week**	**5**
Assessment 2	Mid-term examination	week	**9**
Assessment 3	Project discussion	Week	**14**
Assessment 4	**Final-term examination**	**week**	**15**

Grading:

Fifth-week examination	**5**	**%**
Mid-term examination	30	**%**
Final-term examination	40	**%**
Quizzes	5	**%**
Oral examination	-	**%**
Practical examination	10	**%**
Laboratory examination	-	**%**
Semester work	10	**%**
Design Project	-	**%**
Total	**100**	**%**

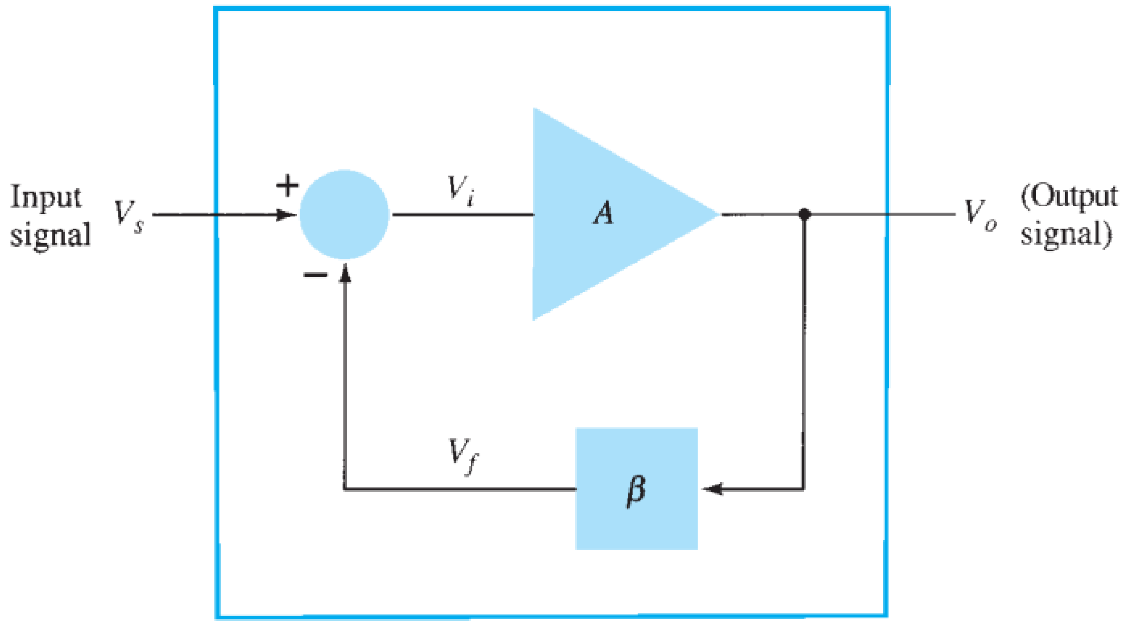
Lectures List

Week#1	• Introduction and Feedback Basics
Week#2:4	• Op-AMP Linear Applications & Sawtooth Generators
Week#5:6	• Sinusoidal Oscillators
Week#7:8	• Active Filters
Week#9	• Mid-Term Exam
Week#10:11	• 555 Timer & Multivibrators
Week#12:13	• VCO & Design of DAC and ADC
Week#14	• Project Discussion & Final Review

FEEDBACK BASICS

Feedback Amplifier

- Block diagram of a typical feedback amplifier



Feedback amplifier

- Types:
  1. Negative feedback.
  2. Positive feedback.

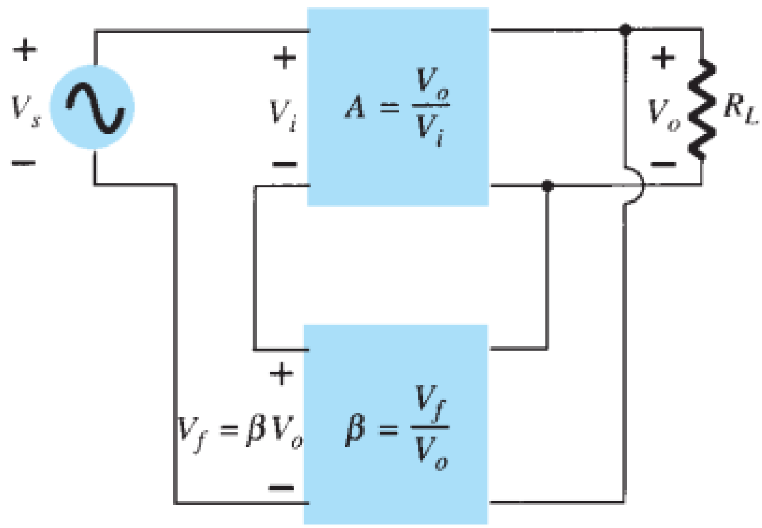
Feedback Amplifier

- **Depending on** the relative **polarity** of the signal being fed back into a circuit, one may have **negative** or **positive** feedback.
- **Positive** feedback drives a circuit into **oscillation** as in various types of oscillator circuits.
- **Negative** feedback results in decreased voltage gain, for which a number of circuit **features** are **improved**.
- Some **improvements** of negative feedback are :

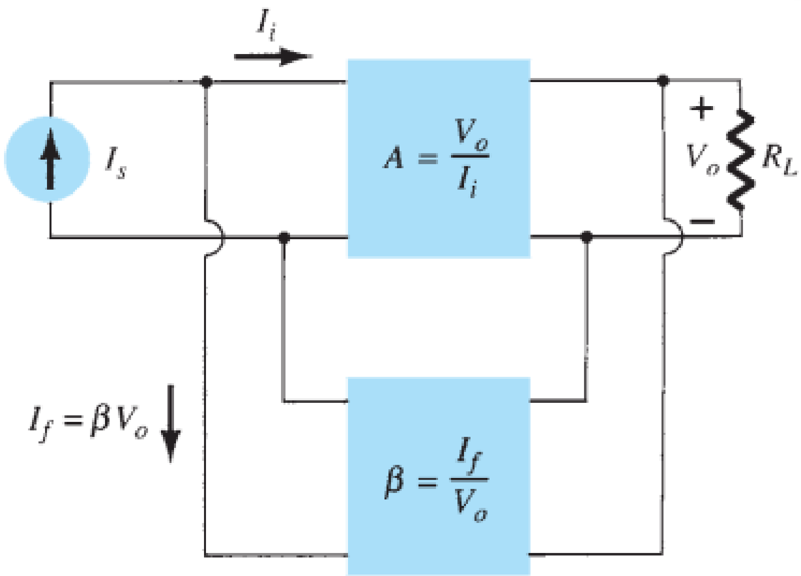
1. Higher input impedance.
2. Better stabilized voltage gain.
3. Improved frequency response.
4. Lower output impedance.
5. Reduced noise.
6. More linear operation.

FEEDBACK CONNECTION TYPES

1. Voltage-series feedback

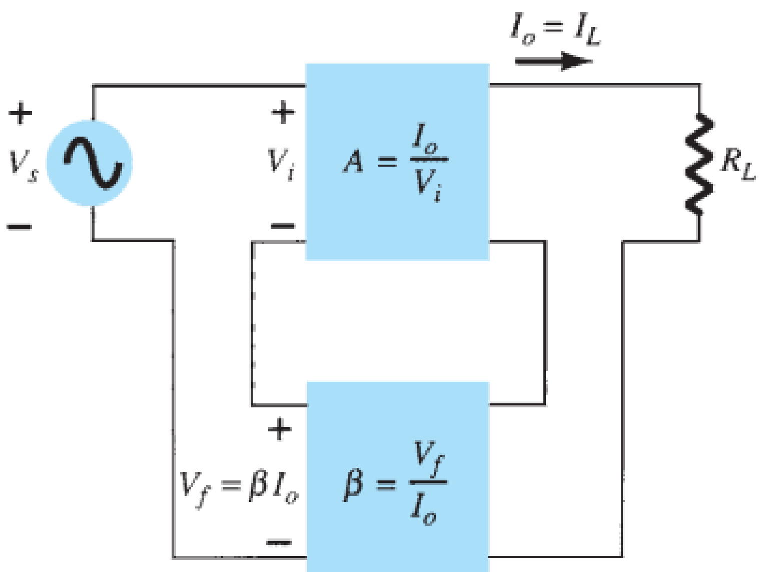


2. Voltage-shunt feedback

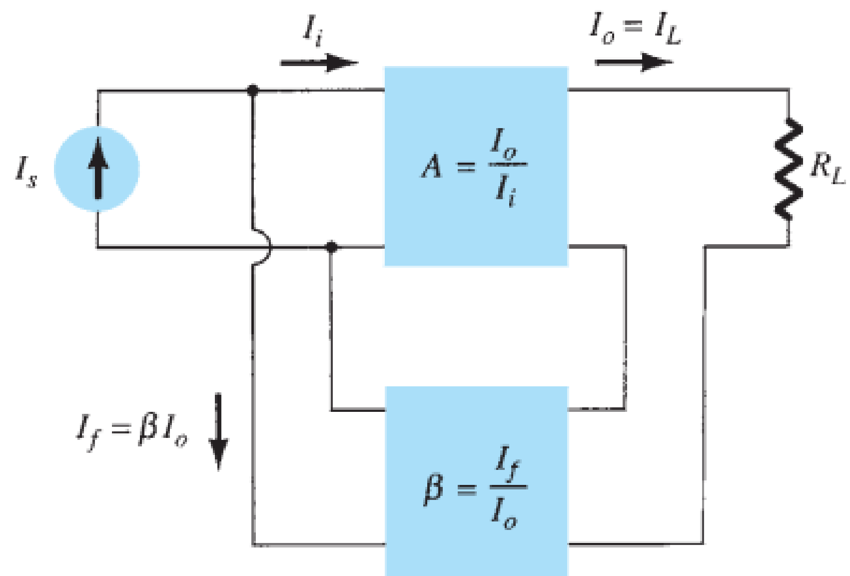


FEEDBACK CONNECTION TYPES..

3. Current-series feedback



4. Current-shunt feedback



FEEDBACK CONNECTION TYPES…

- **Series** feedback connections tend to **increase** the **input resistance**, whereas **shunt** feed-back connections tend to **decrease** the **input resistance**.

- **Voltage** feedback tends to **decrease** the **output impedance**, whereas **current** feedback tends to **increase** the **output impedance**.

- We will apply it on Op-Amp circuits.

INTRO. TO OP-AMP

Basic Internal Arrangement of an Op-Amp.

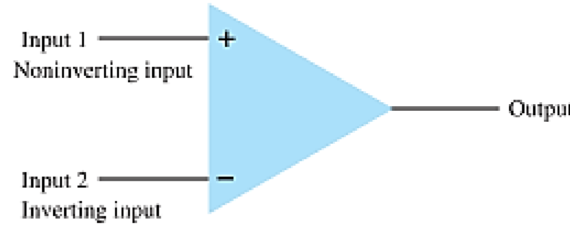
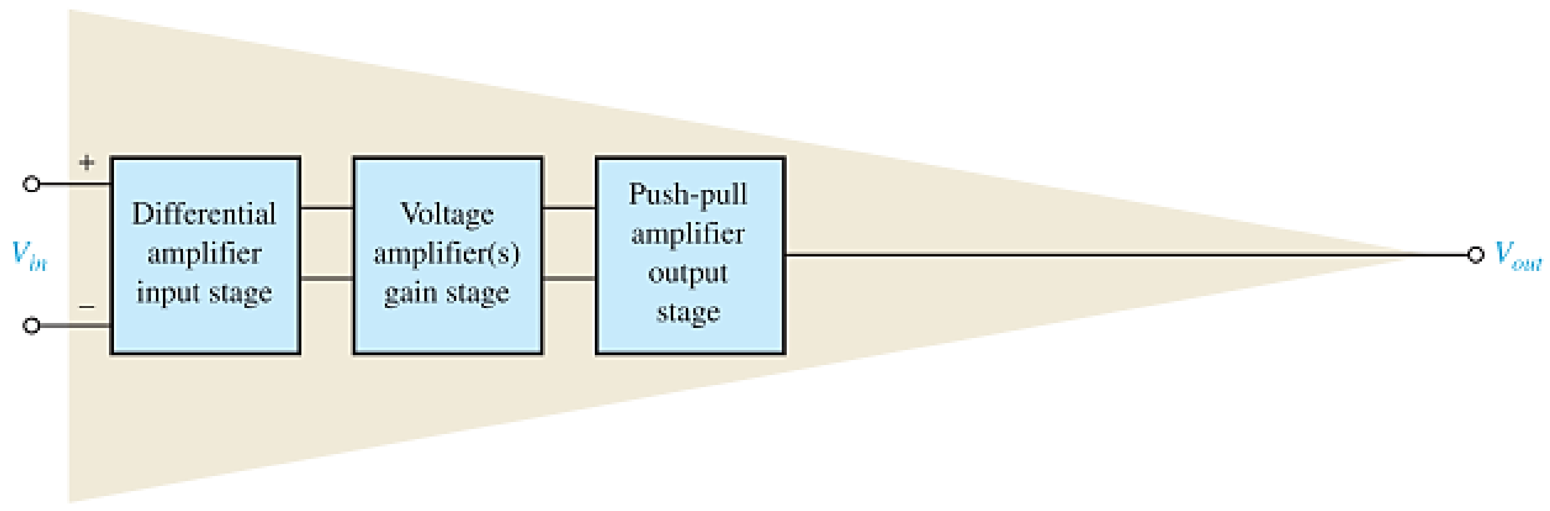


FIG. 10.1
Basic op-amp.



Stage#1 → Differential Amplifier

Single-Ended Input & Double-Ended (Differential) Input

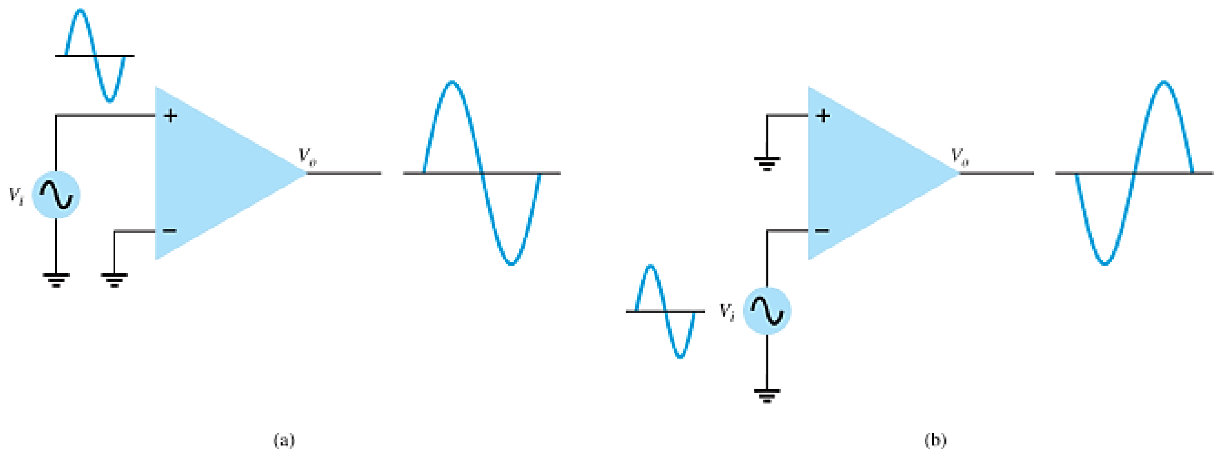


FIG. 10.2
Single-ended operation.

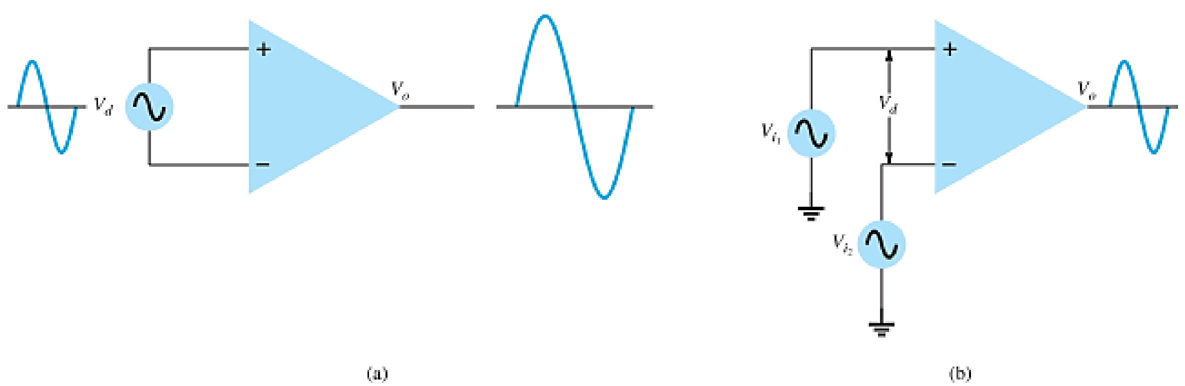


FIG. 10.3
Double-ended (differential) operation.

Double-Ended Output

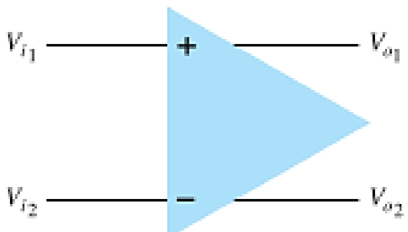


FIG. 10.4
Double-ended input with double-ended output.

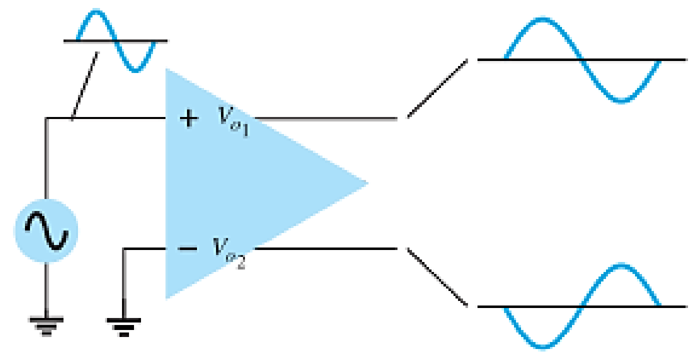


FIG. 10.5
Single-ended input with double-ended output.

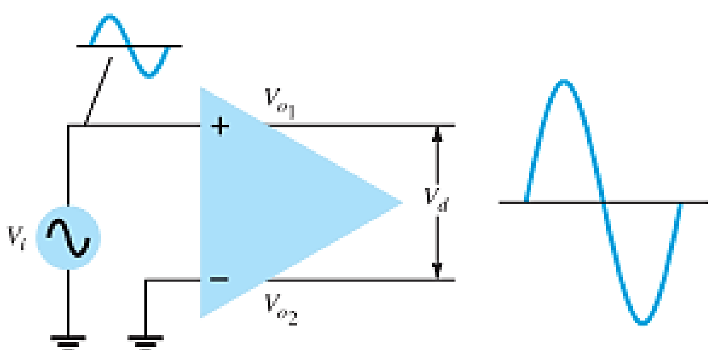


FIG. 10.6
Differential-output.

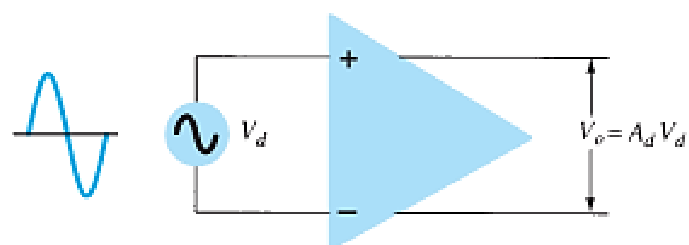


FIG. 10.7
Differential-input, differential-output operation.

Common Mode Operation

- **Ideally**, the two **inputs** are **equally amplified**, and since they result in opposite-polarity signals at the output, these signals cancel, resulting in **0-V output**.

- **Practically**, a **small output signal** will **result**.

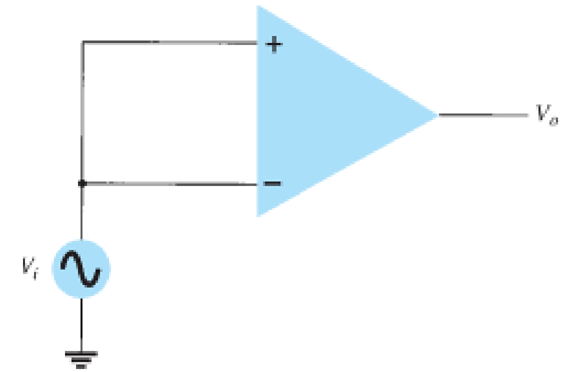


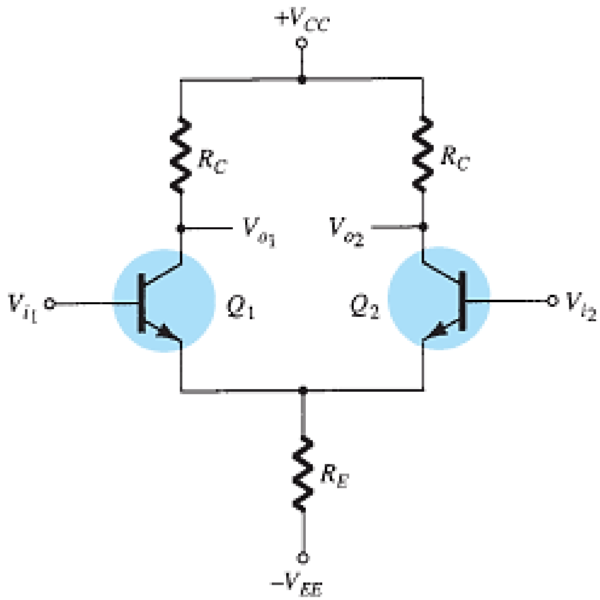
FIG. 10.8
Common-mode operation.

- **Common-Mode Rejection**

- **Noise** (any unwanted input signal) is generally **common** to both inputs, the differential connection tends to provide **attenuation** of this unwanted input while providing an amplified output of the difference signal applied to the inputs.

- This **operating feature** is referred to as ***common-mode rejection*** .

Differential Amplifier Circuit



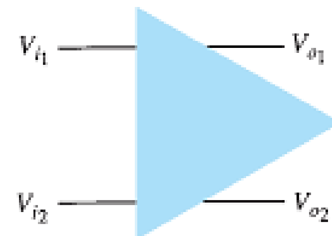


FIG. 10.9
Basic differential amplifier circuit.

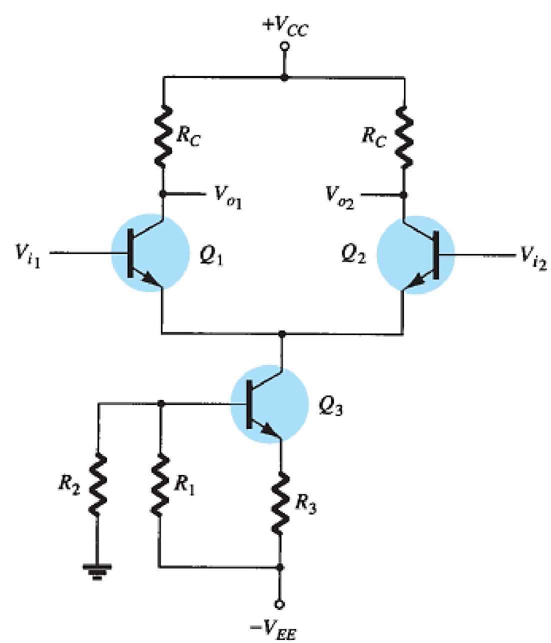
Single-Ended AC Voltage Gain → $$A_v = \frac{V_o}{V_i} = \frac{R_C}{2r_e}$$

Double-Ended AC Voltage Gain → $$A_d = \frac{V_o}{V_d} = \frac{R_C}{r_e}$$ where $V_d = V_{i_1} - V_{i_2}$.

Common mode AC Voltage Gain → $$A_c = \frac{V_o}{V_i} = \frac{\beta R_C}{r_i + 2(\beta + 1)R_E}$$

Use of Constant-Current Source

- A good differential amplifier has a very large difference gain A_d, which is much larger than the common-mode gain A_c.
- The common-mode rejection ability of the circuit can be considerably improved by making the common-mode gain as small as possible (ideally, 0)
- The larger R_E, the smaller is A_c.
- One popular method for increasing the ac value of R_E is using a constant-current source circuit.



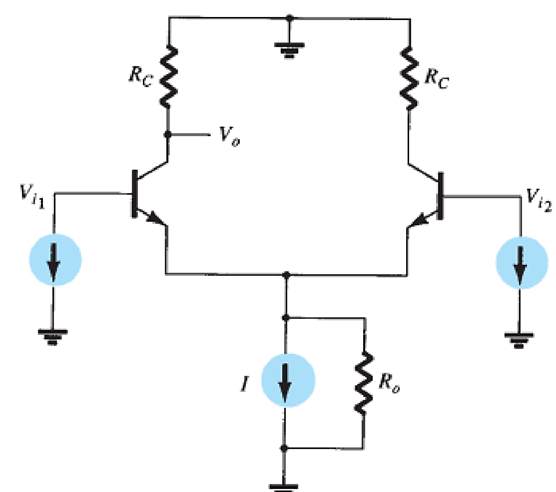


FIG. 10.21
AC equivalent of the circuit of Fig. 10.20.

Ideal & Practical Op-Amp

equivalent circuit

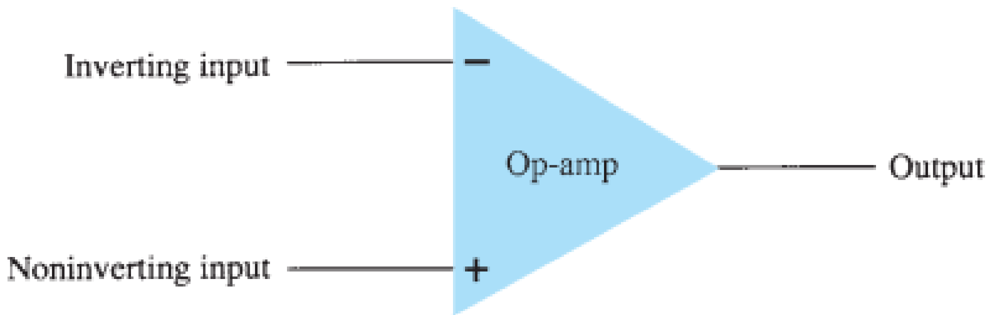


FIG. 10.29

Basic op-amp.

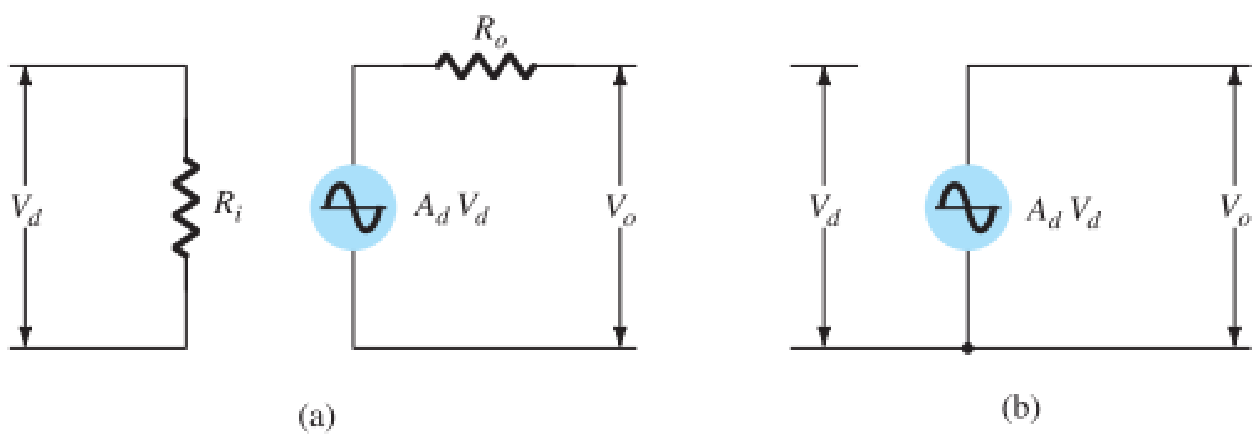


FIG. 10.30

AC equivalent of op-amp circuit: (a) practical; (b) ideal.

- For more details, refer to:
  - Chapter 10,14, R. Boylestad, **Electronic Devices and Circuit Theory**, 11th edition, Prentice Hall.
- The lecture is available online at:
  - http://bu.edu.eg/staff/ahmad.elbanna-courses/12884
- For inquires, send to:
  - ahmad.elbanna@feng.bu.edu.eg