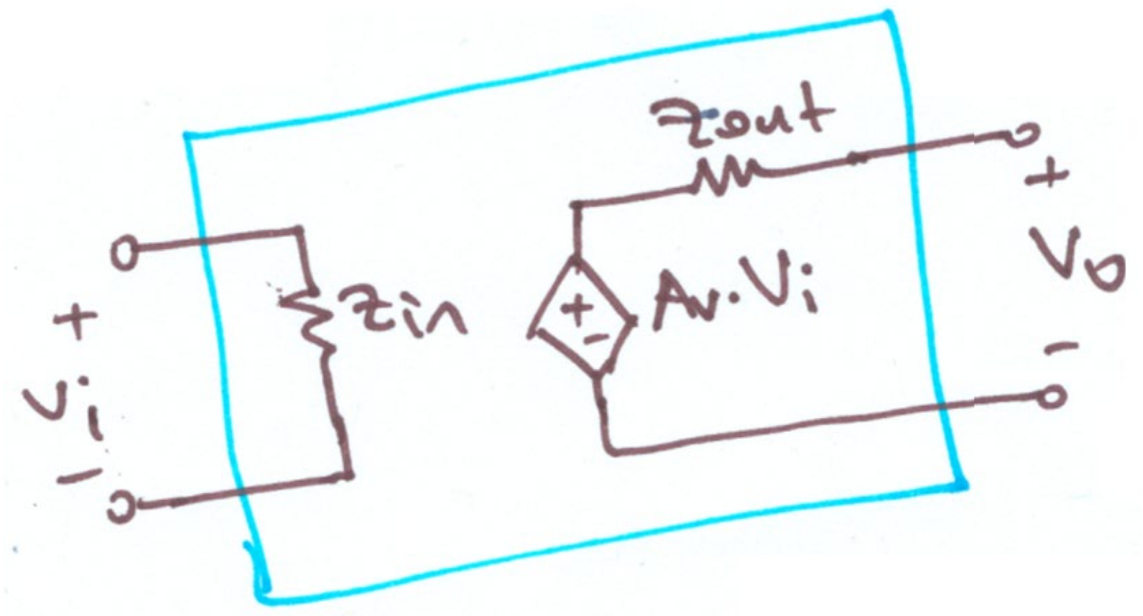
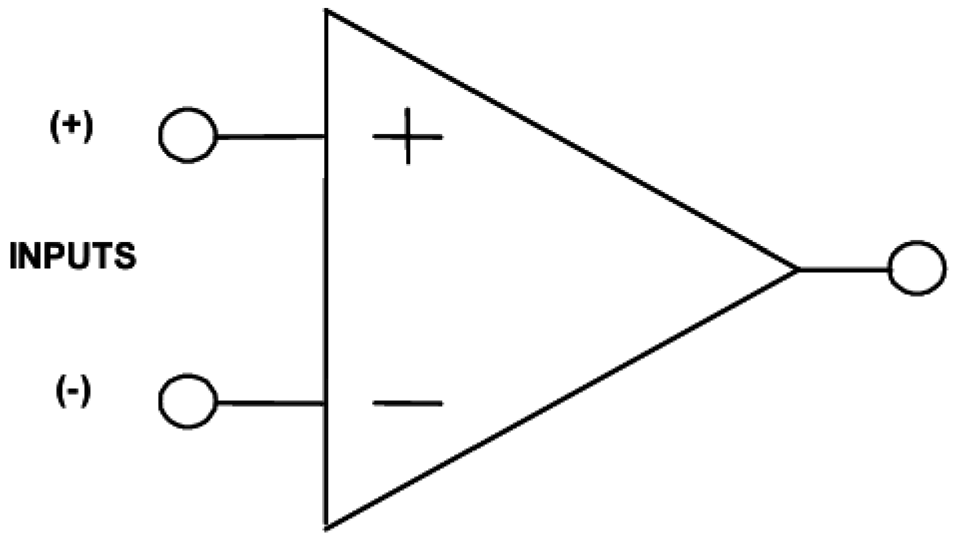
Electronic Circuits

Lecture 8.1: Operational Amplifiers (OPAMPs)

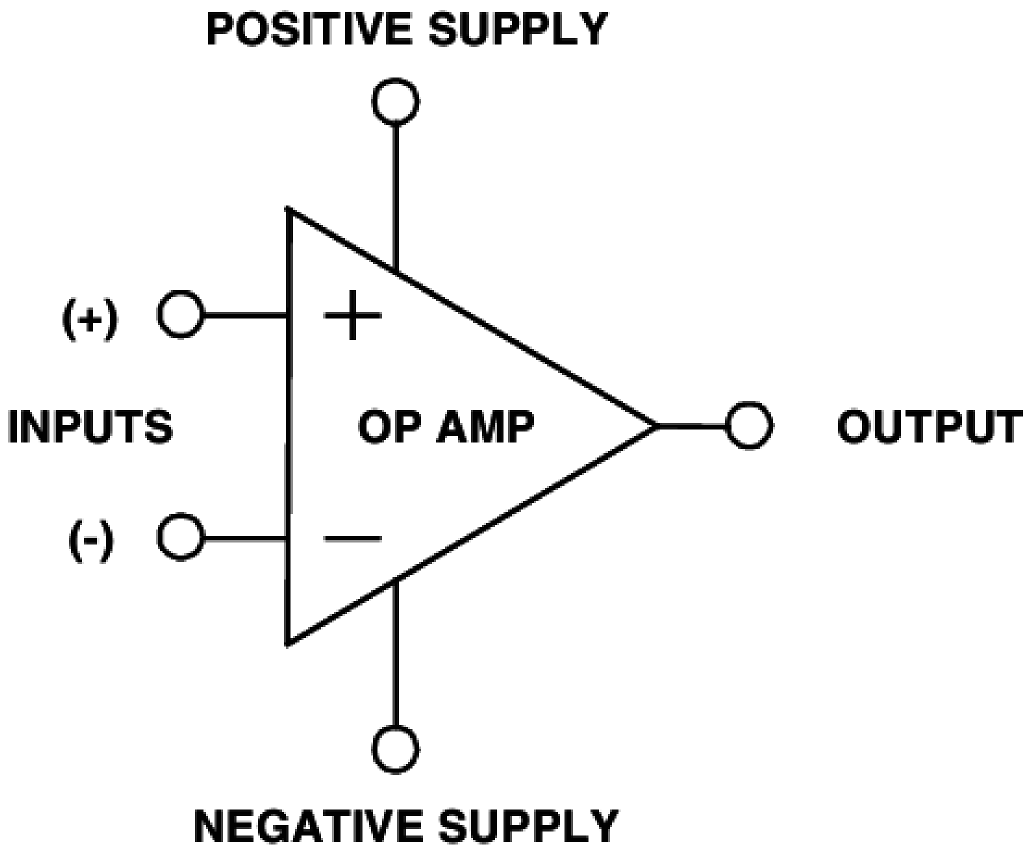
Amplifier Block and Ideal Opamp are EQUAL





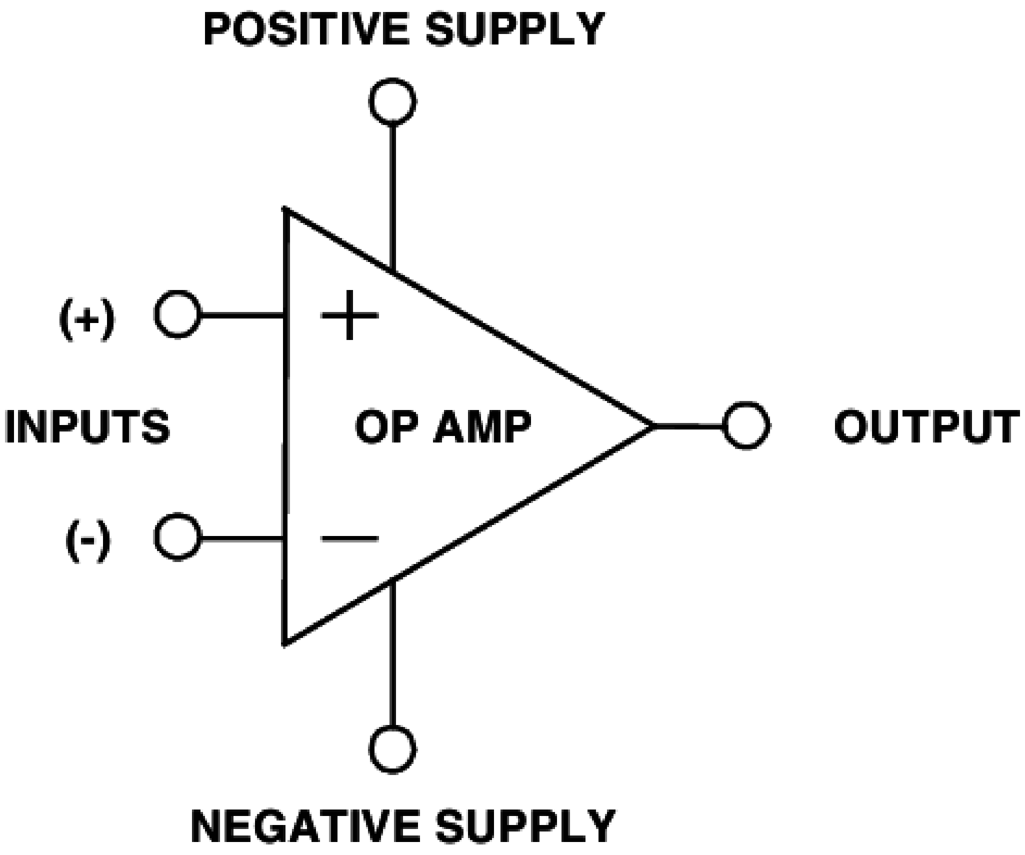
Zin → ∞
Av → ∞
Zout → 0

Ideal Opamp Properties



- IDEAL OP AMP ATTRIBUTES
  - Infinite Differential Gain
  - Zero Common Mode Gain
  - Zero Offset Voltage
  - Zero Bias Current
  - Infinite Bandwidth
- OP AMP INPUT ATTRIBUTES
  - Infinite Impedance
  - Zero Bias Current
  - Respond to Differential Voltages
  - Do Not Respond to Common Mode Voltages
- OP AMP OUTPUT ATTRIBITES
  - Zero Impedance

Comparator



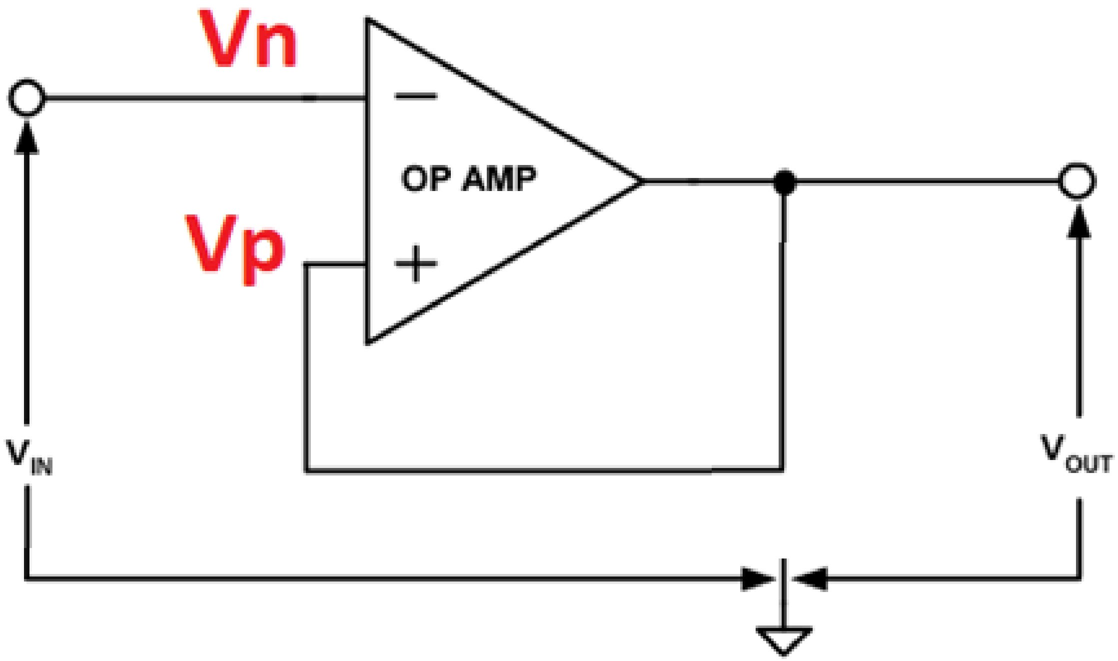
- Vout ≈ POSITIVE SUPPLY – 2 volts if Vin(+) > Vin(-)
- Vout ≈ NEGATIVE SUPPLY + 2 volts if Vin(-) > Vin(+)
- Vout ≈ 0 volts if Vin(+) = Vin(-) where almost impossible

Basic Properties for Feedback Connection

- Basic Properties:
  - Vin(+) ≈ Vin(-)
  - Iin(+) ≈ 0
  - Iin(-) ≈ 0

- Since its voltage gain is so high that a feedback connection (from output to input(s)) is used in general.

Buffer (Voltage Follower)



$$V_n = V_p$$

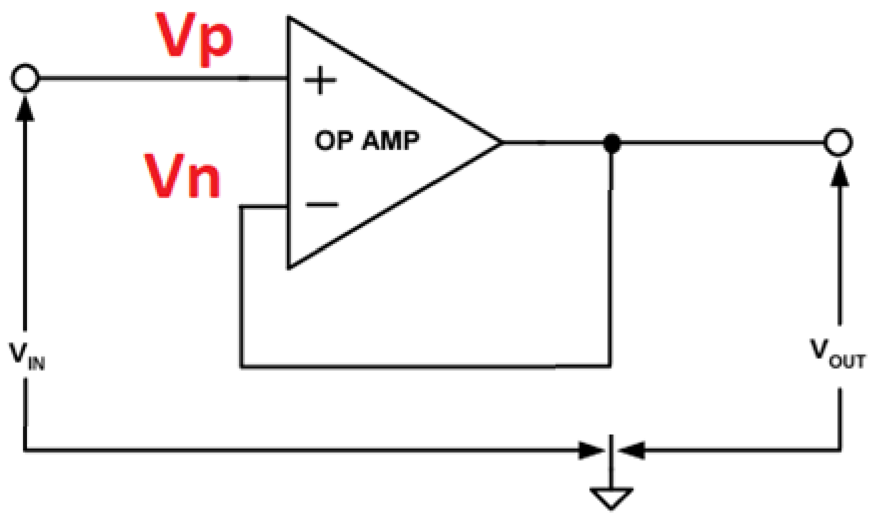
$$V_p = V_{IN}$$

$$V_n = V_{OUT}$$

$$V_{IN} = V_{OUT}$$

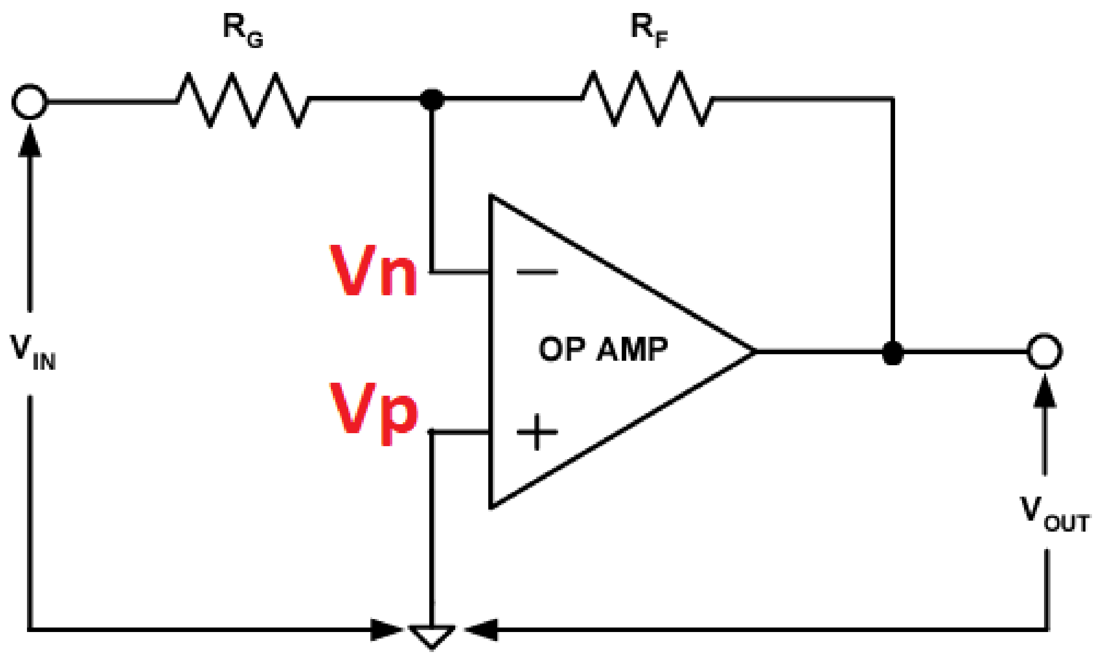
$$A_v = \frac{V_{OUT}}{V_{IN}} = 1$$

Left To Students (1)



- Av = ?

Inverting Amplifier



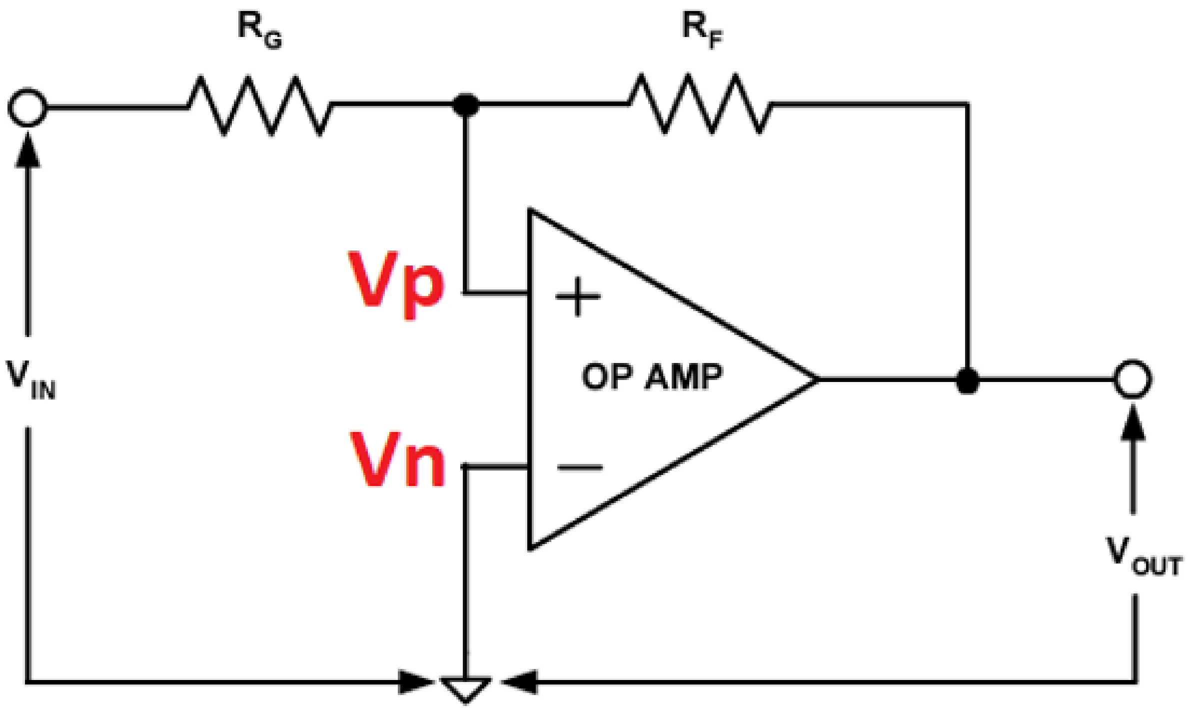
$$V_n = V_p = GND = 0$$

$$\frac{V_{IN} - V_n}{R_G} = \frac{V_n - V_{OUT}}{R_F}$$

$$\frac{V_{IN}}{R_G} = \frac{-V_{OUT}}{R_F}$$

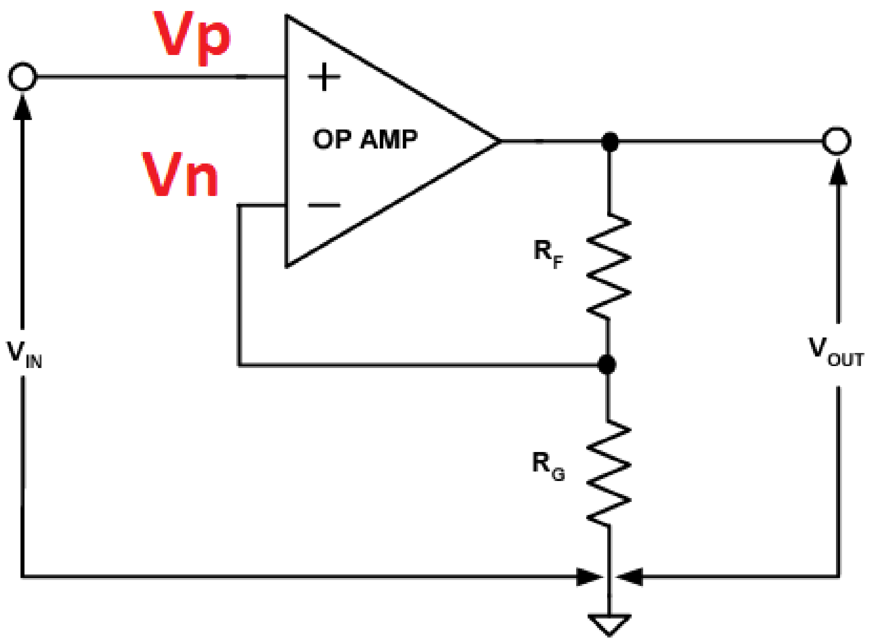
$$A_v = \frac{V_{OUT}}{V_{IN}} = -\frac{R_F}{R_G}$$

Left To Students (2)



- Av = ?

Non-Inverting Amplifier



$$V_n = V_p = V_{IN}$$

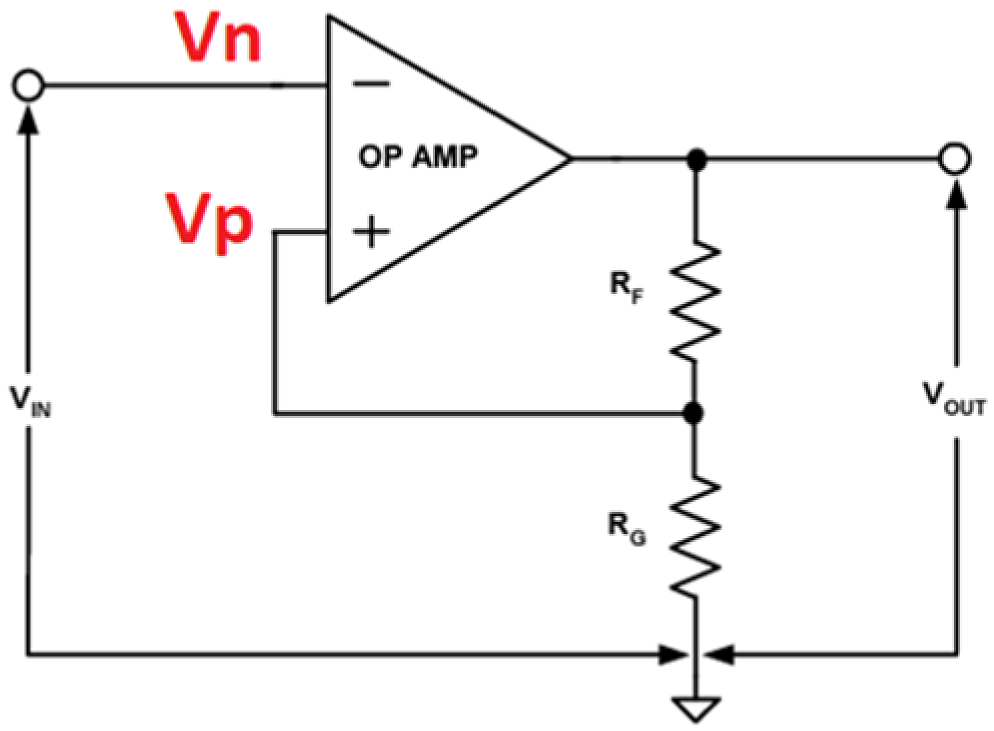
$$\frac{V_{OUT} - V_n}{R_F} = \frac{V_n - 0}{R_G}$$

$$\frac{V_{OUT} - V_{IN}}{R_F} = \frac{V_{IN}}{R_G}$$

$$\frac{V_{OUT}}{R_F} = \frac{V_{IN}}{R_G} + \frac{V_{IN}}{R_F} = V_{IN} * \left(\frac{R_F + R_G}{R_F * R_G}\right)$$

$$A_v = \frac{V_{OUT}}{V_{IN}} = \frac{R_F + R_G}{R_G} = 1 + \frac{R_F}{R_G}$$

Left To Students (3)



- Av = ?

Thanks for listening ☺

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