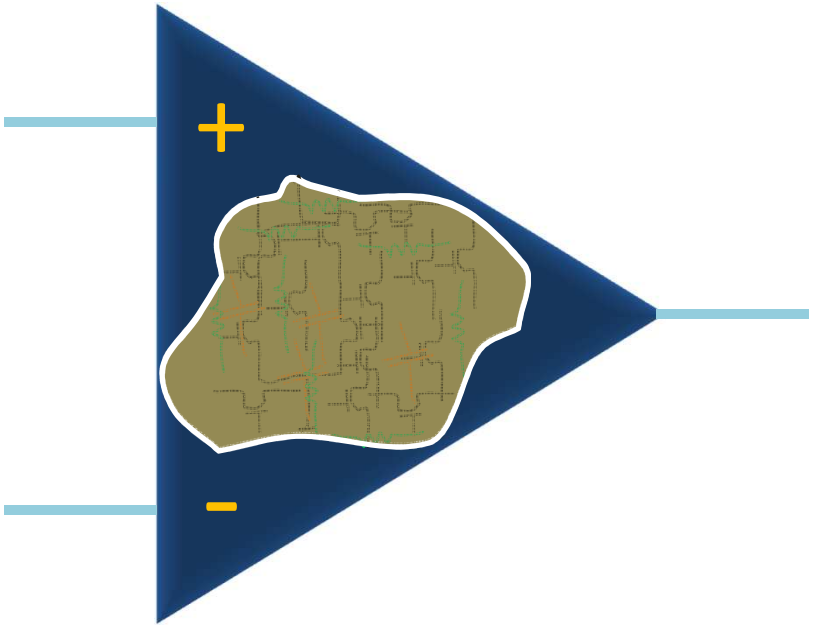
6.002x CIRCUITS AND ELECTRONICS

The Operational Amplifier Abstraction



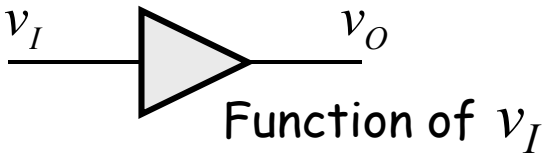
Chapter 15 of the textbook

Two big aha moments in this sequence

Review our Previous Amplifier Abstraction

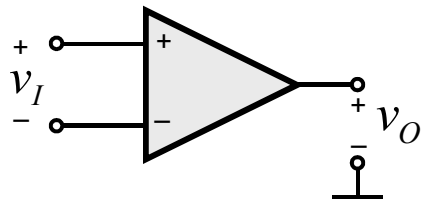
- MOSFET amplifier — 3 ports
- Amplifier abstraction

Amplifier Building Block



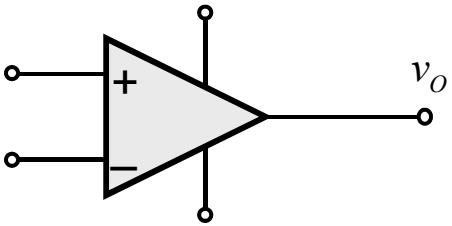
Operational Amplifier Op Amp

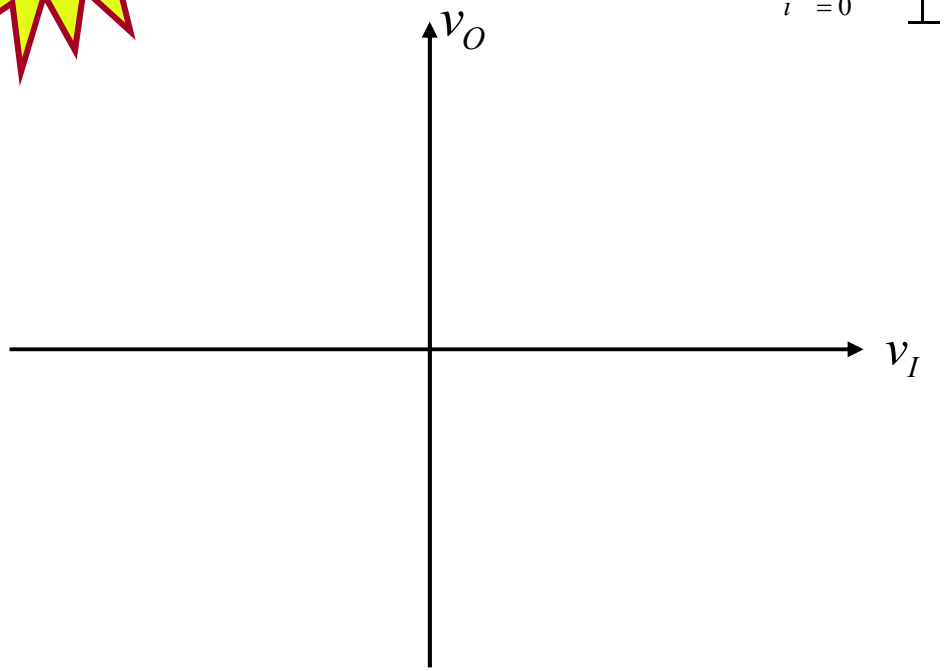
Circuit model of Op Amp (ideal):

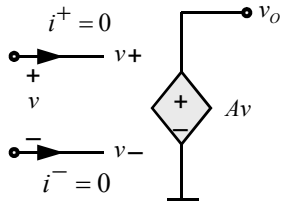


Using it…

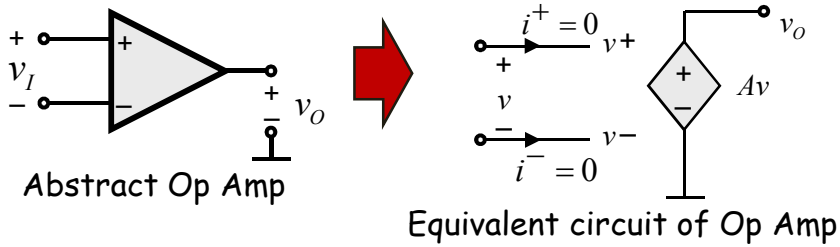
Demo





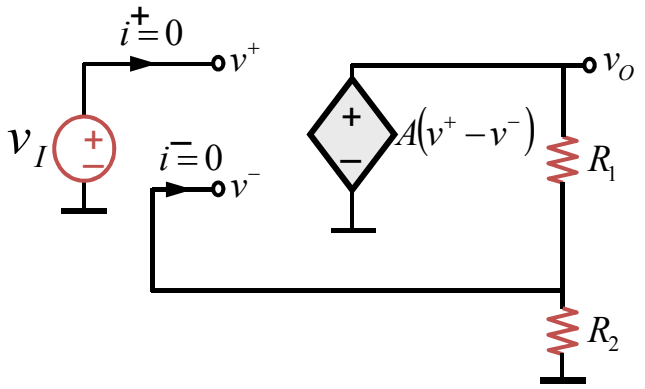


Let us build a circuit: noninverting amplifier



Let us analyze the circuit:

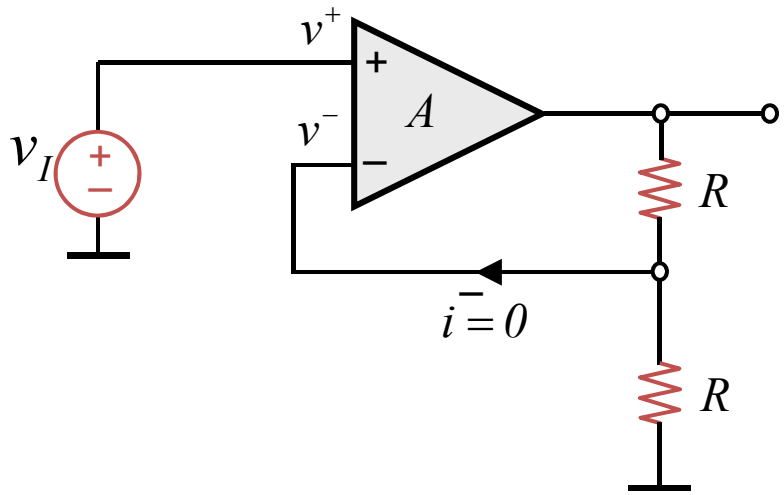
Find v_O in terms of v_I



Let's see… When A is large



Why did this (temp insensitivity) happen? Our next Aha! Insight:



Question: How to control a high-strung device?

Antilock brakes



Another cool op amp insight:

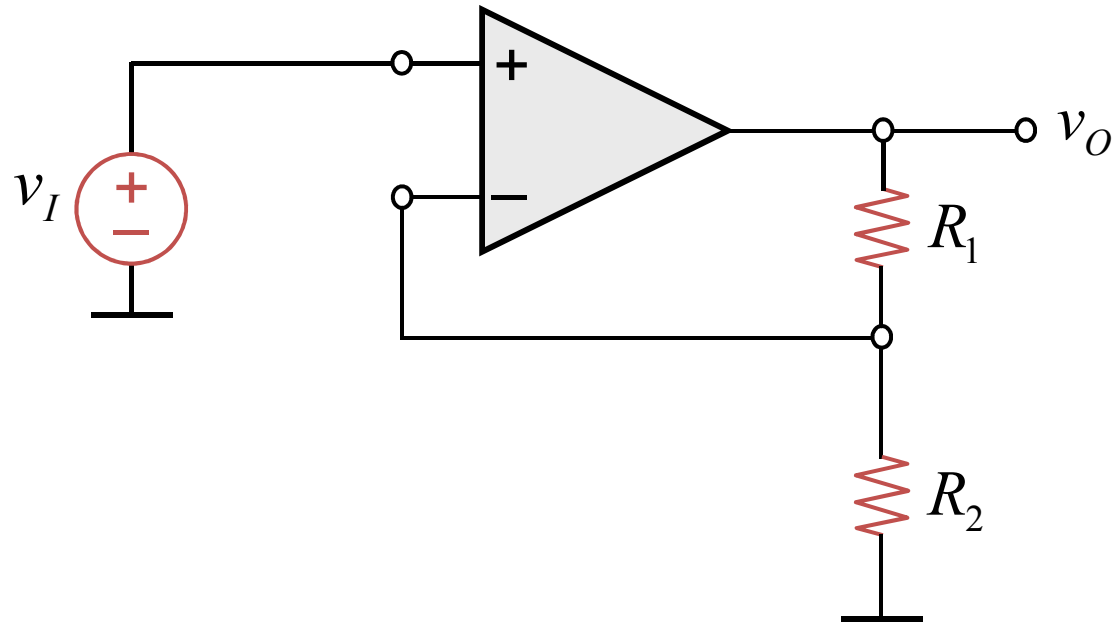
Observe, under negative feedback,

Insightful analysis method under negative feedback – the virtual short method

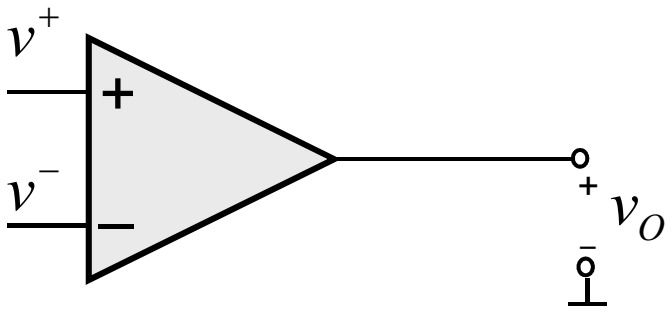
$$i^+ \approx 0$$

$$i^- \approx 0$$

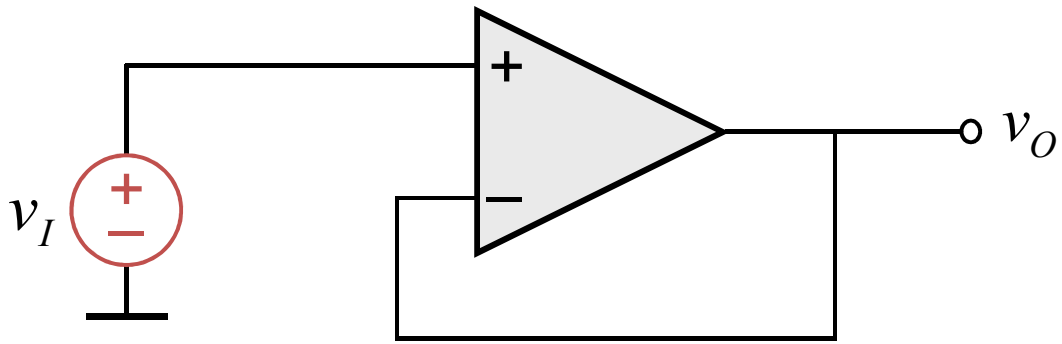
$$v^+ \approx v^-$$



Question: What does this circuit do?

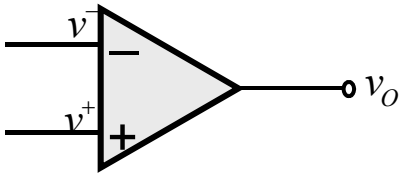


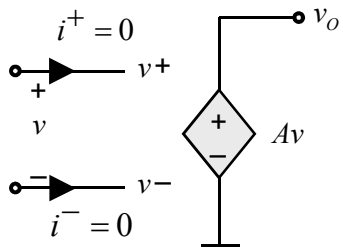
Why is this circuit useful?



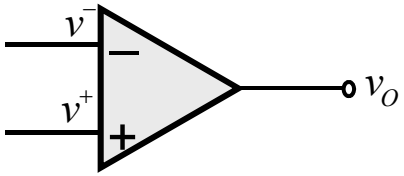
$$v_O \approx v_I$$

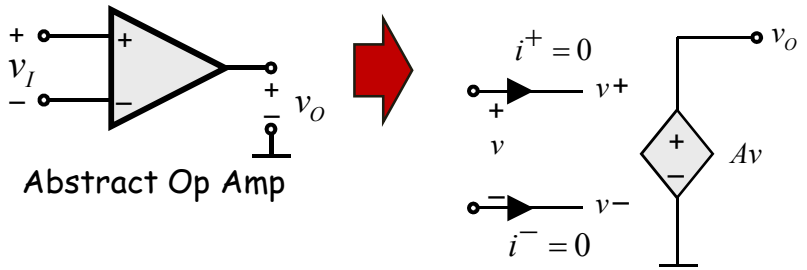
Inverting amplifier

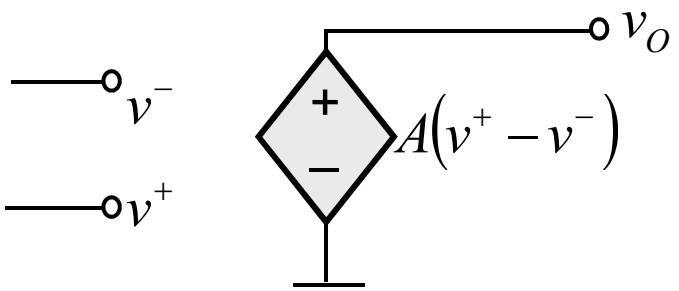




Inverting amplifier

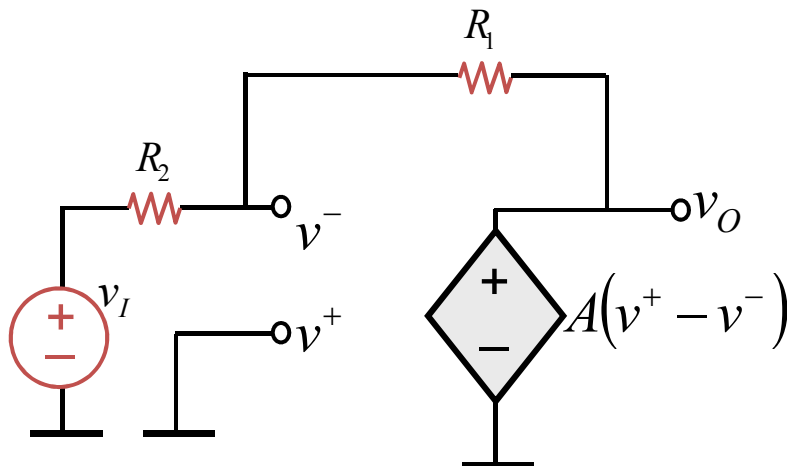






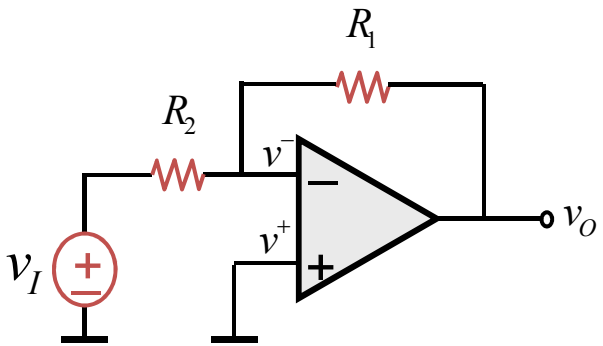
Let us analyze the circuit:

Find v_O in terms of v_I

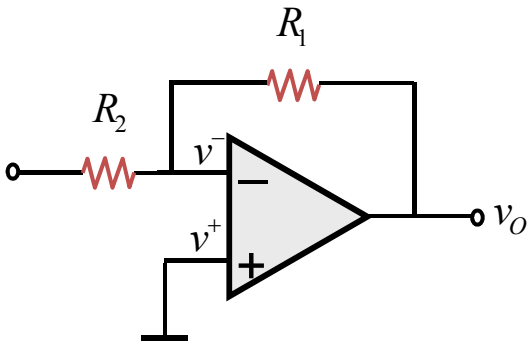


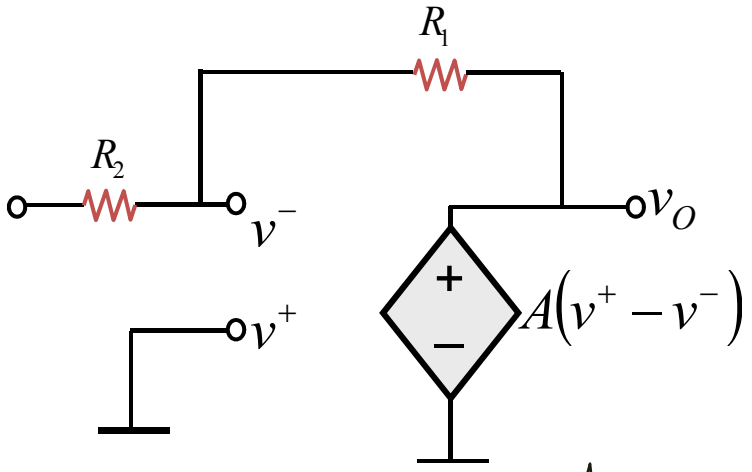
Inverting Amplifier analysis using virtual short

$$v^+ \approx v^-$$



Inverting amplifier input resistance

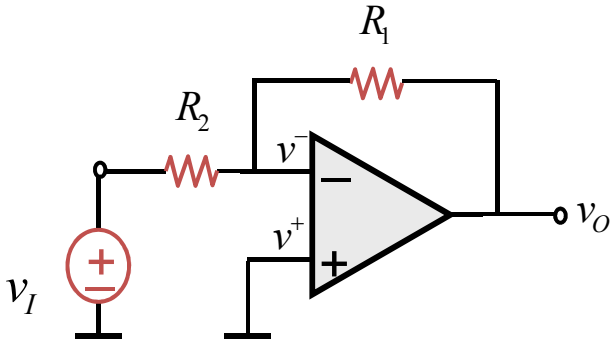


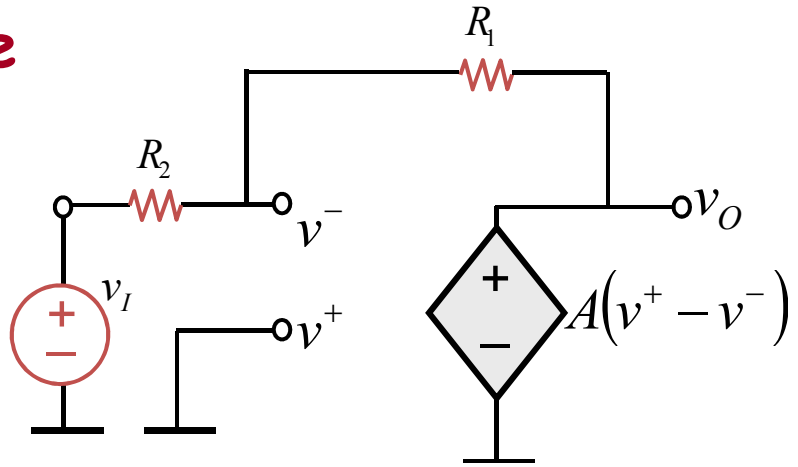


$$v_O = \frac{-Av_I R_1}{R_1 + R_2 + AR_2}$$

Inverting amplifier input resistance

Hard way!





$$v_O = \frac{-Av_I R_1}{R_1 + R_2 + AR_2}$$

Inverting amplifier input resistance using virtual short method

Easy way!

