EE16A - Lecture 16 Notes

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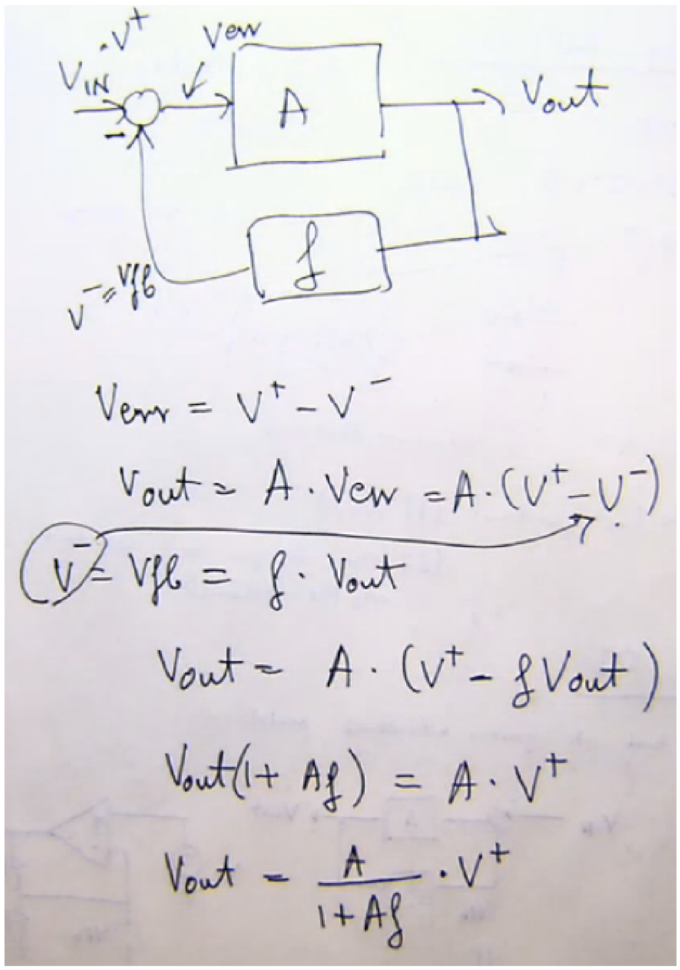
Negative Feedback Loop



Usually V^- is negative:

- $V_{err} = V_{in} - V_{fb}$
- V_{fb} unchanged, $A > 0$, $f > 0$: V_{in} increases $\Rightarrow$ V_{err} increases $\Rightarrow$ V_{out} increases $\Rightarrow$ V_{fb} increases $\Rightarrow$ V_{err} decreases... V_{in} stabilizes
- Eq 1. $V_{out} = \frac{A}{1+Af} \cdot V^+$: Derivation at 27:34
  - Use resistors to determine f, which in turn determines the scaling factor of $\frac{V_{out}}{V_{in}}$
  - V_{out} scales V_{in} by a factor of $\frac{A}{1+Af}$
  - $V^- = V_{fb} = fV_{out} = \frac{fA}{1+Af} \cdot V^+$ (approaches 1 as $A \to \infty$)
- V_{out} approaches $\frac{1}{f} \cdot V^+$ as $A \to \infty$: Amps does not have to be very precise, just very large

- **Changes to V_{in} should cause V_{err} to decrease (V_{fb} increases if V_{in} increases and decreases if V_{in} decreases)**

NFL Equations

$$V_{out} = \frac{A}{1+Af} \cdot V^+ ; \lim_{A\to\infty} V_{out} = \frac{1}{f} \cdot V^+ \tag{1}$$

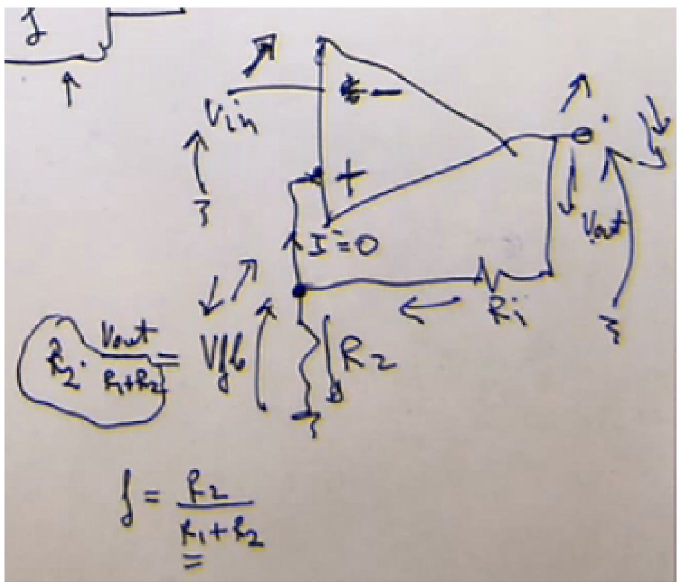
$$V^- = \frac{fA}{1+Af} \cdot V^+ ; \lim_{A\to\infty} V^- = V^+ \tag{2}$$

Positive Feedback Loop

Usually V^- is positive:

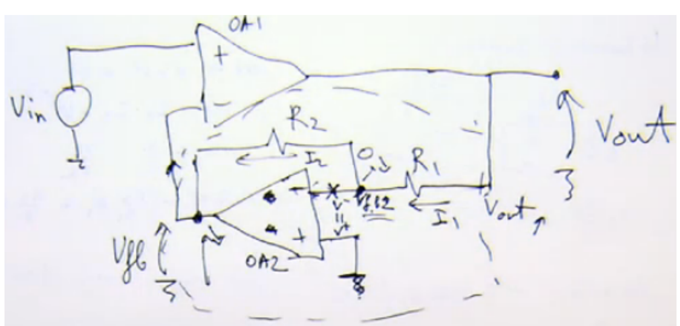
- V_{in} continuously increases (V^+ is positive): V_{out} hits max rail
- V_{in} continuously decreases (V^- is negative): V_{out} hits min rail

Determining if Negative Feedback Exists



1. GR 1. $I^- = 0$, so analyze circuit between V_{out} and V_{fb}
2. $V_{fb} = \frac{R_2}{R_1 R_2} V_{out}$: $f = \frac{R_2}{R_1 R_2}$
3. Negative feedback exists

Analyzing complex OpAmp Circuits



- Use GR 1 to locate open circuits ($I = 0$)

- Split OpAmps by open circuits and V_{out}
- Determine if negative feedback loop exists (If positive feedback loop exists, V_{out} will hit the rails)
- Apply GR 2 with KCL to determine current flows
- Analyze individual voltage drops across each resistor from V_{in} to V_{fb} to V_{out} to get V_{out}

Example OA_2 : Inverting Amplifier

- Inverts the sign and is determined by the ratio of the two resistors
- $V_{fb} = -\frac{R_2}{R_1} \cdot V_{out}$

Find Polarity of OpAmp

- Polarity of inverse amplifier should be the opposite sign of the disturbance (If V^+ is inserted as positive, the polarity of OpAmp must be negative to generate a proper negative feedback)