EE16A - Lecture 15 Notes

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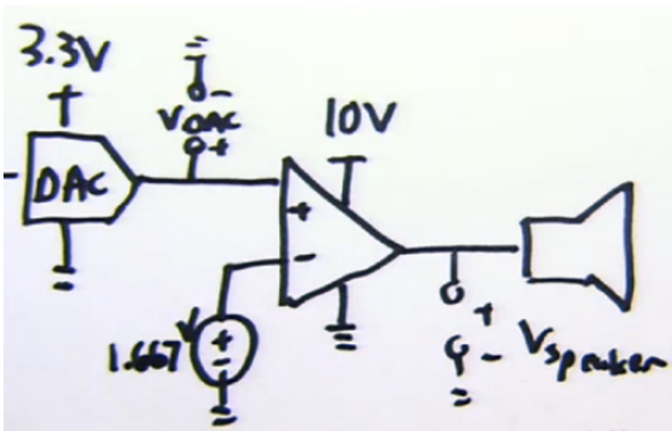
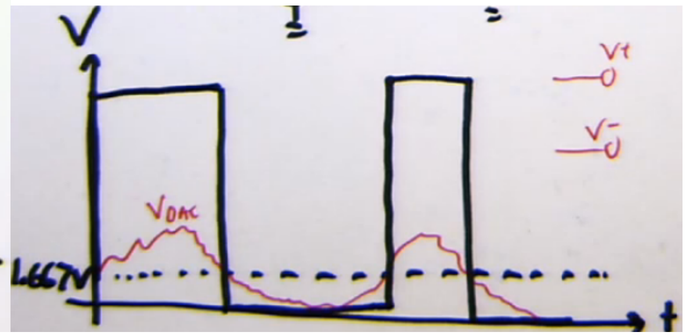
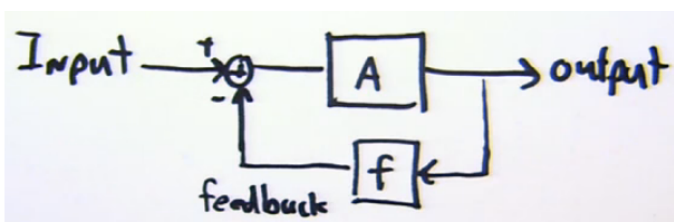
Scaling OpAmps





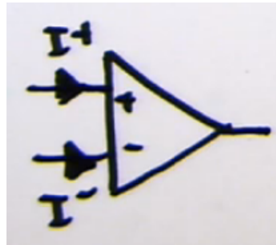
- Example at 46:53
- DAC: $V_{max} = 3.3V$, $V_{min} = 0$
- Speakers can be modeled with an 8Ω resistor to ground
- Need OpAmp to scale V_{DAC} to the range of the speaker without creating a blocking pattern (shown above)

Negative Feedback Loop



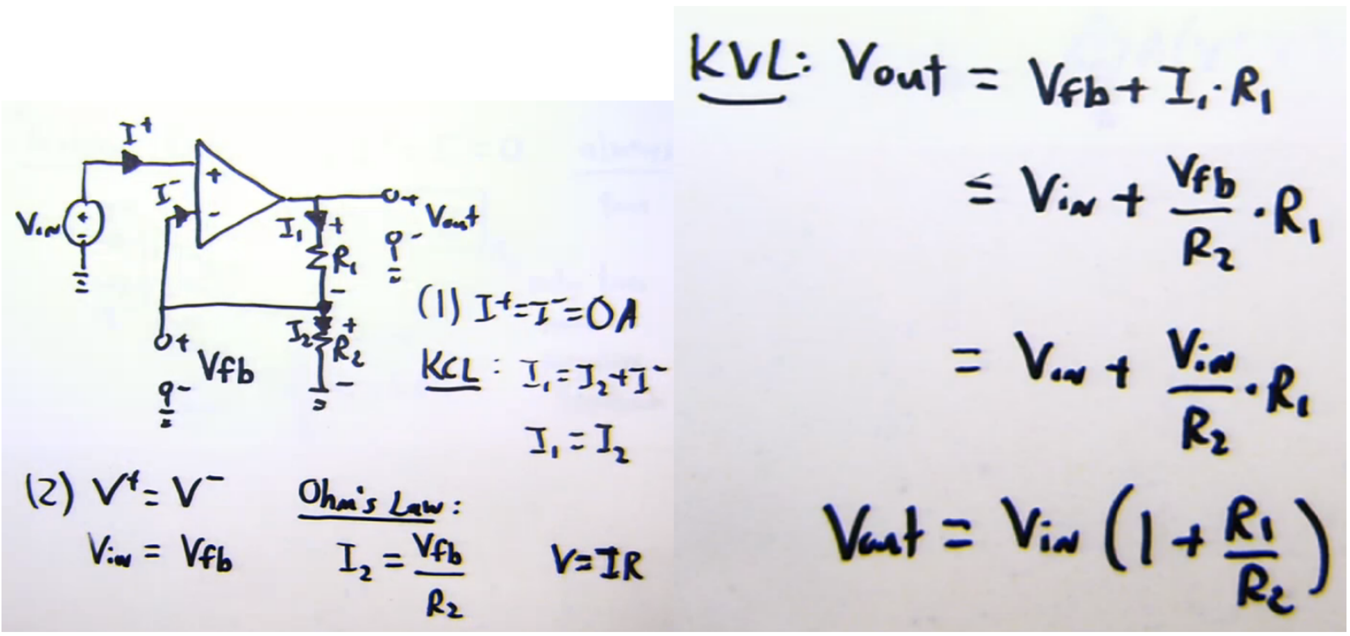
- Compare input against scaled feedback (from output)
- Feed result into a linear gain (A) to produce the output
- Send output into scaled feedback loop to compare against input
- If feedback > input, error is negative, output is pushed down, which causes the feedback to go down... etc.
- If feedback < input, error is positive, output is pushed up, which causes the feedback to go up... etc.
- Big Picture: Feedback will approach the input

Golden Rules



1. $I^+ = I^- = 0$ (always true for ideal op amps)
2. $V^+ = V^-$ (only true with negative feedback)

OpAmp Negative Feedback Loop Analysis



- Input voltage V_{in} connected to OpAmp, with V_{out}
- Negative Feedback loop with R_1 connected to ground through parallel R_2 in and V_{fb} between V_{out} and V^-
- Because V^- is an open circuit: $I_1 = I_2$
- GR 1. $I^+ = I^- = 0$: KCL at node between R_1, R_2: $I_1 = I_2$ (because $I^- = 0$)
- GR 2. $V^+ = V^-$: $V_{in} = V_{fb}$
- Ohm's Law on R_2 because $V_2 = V_{fb}$: $I_2 = \frac{V_{fb}}{R_2} = \frac{V_{in}}{R_2} = I_1$
- KVL of path from ground to V_{out} through R_1 : $V_{out} = V_{fb} + I_1 R_1 = V_{in} + \frac{V_{in} R_1}{R_2} = V_{in}(1 + \frac{R_1}{R_2})$

OpAmp Negative Feedback Loop Equations

$$I^+ = I^- = 0 \tag{1}$$

$$V^+ = V^- \tag{2}$$

$$V_{out} = V_{in}(1 + \frac{R_1}{R_2}) \tag{3}$$