Welcome to EE 140/240A
Analog Integrated Circuits
Prof. Clark Nguyen

Lecture 1: Admin & Overview

- **Announcements**:
- **EE 140/240A**: Analog Integrated Circuits
- **Instructor**: Prof. Clark T.-C. Nguyen
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- Go though
  - Course information sheet
  - Syllabus
  - Grading Information and Policy
- Hand out class account sheets → Not yet... will do this next week!
- About Me:
- *Education*: Ph.D., University of California at Berkeley, 1994
- *1995*: joined the faculty of the Dept. of EECS at the University of Michigan
- *2006*: (came back) joined the faculty of the Dept. of EECS at UC Berkeley
- *Research*: microelectromechanical systems (MEMS) that employ transistor-level circuit design
- *Teaching*: (at the UofM) mainly transistor circuit design courses; (UC Berkeley) 140, 143, 240A, 243, 245
- *2001*: founded Discera, the first company to commercialize vibrating RF MEMS technology
- *Mid-2002 to 2005*: DARPA MEMS program manager
  - ran 10 different MEMS-based programs
  - *topics*: power generation, chip-scale atomic clock, gas analyzers, nuclear power sources, navigation-grade gyros, on-chip cooling, micro environmental control
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- For the course website, just google ee140
  - The website is already up and running
- This course will be screencast
  - EE 140 screencast previously, so you can actually view previous year lectures, too
  - If you miss a lecture … can watch the video, if successfully recorded
  - Won't be able to view lectures on itunes or youtube as in the past due to new rules
  - But can still see lectures from previous years
  - Warning: It's a very bad idea not to come to lecture in person
  - People who think they will watch the videos, often don't get time to do so
- This course now "contains" EE 240A
  - EE 240A same as 140, but with additional material for graduate students
  - Additional homework problems
  - Additional project specs or a different project altogether
- Office Hour Changes?:
- Discussion sections start week after next
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- Lecture Topics:
  - Review
    - —Op Amp Examples
    - —Ideal Op Amps
    - —Non-Ideal Op Amps
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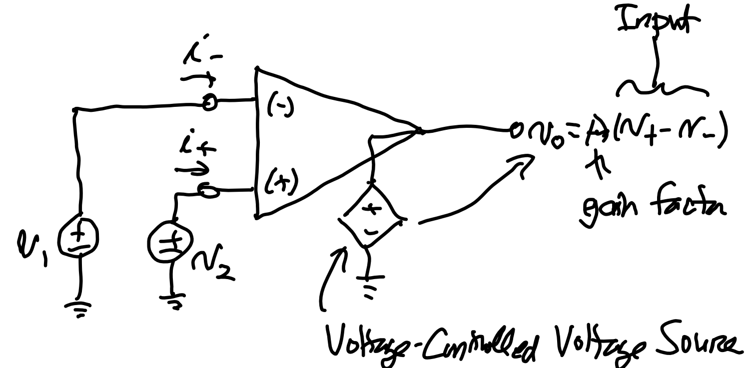
- Look at op amp usage examples using prepared pages

Review of Op Amps

Ideal Op Amp:

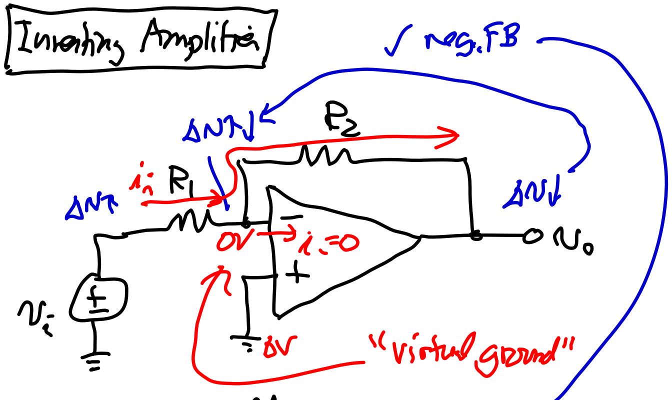


Properties of Ideal Op Amps: (given neg. FB)

1. $A = \infty \rightarrow v_+ = v_-$ (in a neg. FB ckt.)
2. $R_i = \infty \rightarrow i_- = i_+ = 0$
3. $R_o = 0$
4. $BW = \infty$

$v_o = A(v_+ - v_-)$: v_o finite, $A \rightarrow \infty$, $(v_+ - v_-) \rightarrow 0 \rightarrow v_+ = v_-$

Inverting Amplifier



Get the gain, $\frac{v_o}{v_i}$.

① Verify that we have neg. FB. ✓

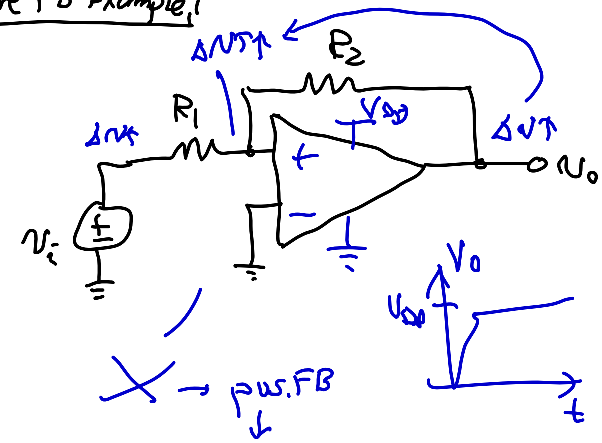
② So v_o = finite → $v_+ = v_-$

③ $i_- = 0$

$$i_i = \frac{v_i - 0}{R_1} = \frac{v_i}{R_1} \quad ; \quad v_o = 0 - i_i R_2$$

$$v_o = -\frac{v_i}{R_1} R_2 \rightarrow \boxed{\frac{v_o}{v_i} = -\frac{R_2}{R_1}}$$

Positive FB Example



→ pos. FB
↓
can't say $v_+ = v_-$

- Non-Ideal Op Amps:
- Actual op amps, of course, are not ideal; rather, they …
  - Have finite gain, A_o
  - Have finite bandwidth, BW
  - Have finite input resistance, R_i
  - Have finite input capacitance, C_i
  - Have finite output resistance, R_o
  - Generate noise
  - Have input bias currents (because R_i is not infinite)
  - Have input offset currents and voltages
  - Have finite slew rate
  - Have finite output swing
- All of the above can be temperature dependent!
- A major objective of this class is to understand what gives rise to the above non-idealities and to teach design strategies to get around them

- Then, start going through the Device Modeling Handout, on BJT modeling