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 through
  - 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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[Diagram of Op Amps and Voltage-Controlled Voltage Source]

• Look at op amp usage examples using prepared pages

\[ V_{out} = A(V_{in} - V_{ref}) \]

Properties of Ideal Op Amps:
1. \( A \to \infty \to V_{out} = V_{in} \) (inverting FB)
2. \( R_{in} \to \infty \to i_{in} = 0 \)
3. \( R_{out} = 0 \)
4. \( BW = \infty \)
Inverting Amplifier

1. Verify that we have negative feedback.
2. So $\Delta V_o = \text{finite} \rightarrow V_{i_1} = V_{-}$
3. $i_2 = 0$
   \[ i_2 = \frac{V_i - 0}{R_1} = \frac{V_i}{R_1} = 0 \]
   \[ V_o = 0 - i_2 R_2 \]

4. $V_o = \frac{V_i}{R_1} R_2 \rightarrow \frac{V_o}{V_i} = -\frac{R_2}{R_1}$

Positive Feedback Example

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