EE C247B – ME C218
Introduction to MEMS Design
Spring 2020

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Lecture Module 1: Admin & Overview

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Instructor: Prof. Clark T.-C. Nguyen

- *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*: exactly the topic of this course, with a heavy emphasis on vibrating RF MEMS
- *Teaching*: (at the UofM) mainly transistor circuit & physics; (UC Berkeley) 140/240A, 143, 243, 245,247B/ME218
- *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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Course Overview

- Goals of the course:
  - Accessible to a broad audience (minimal prerequisites)
  - Design emphasis
    - Exposure to the techniques useful in analytical design of structures, transducers, and process flows
  - Perspective on MEMS research and commercialization circa 2020
- Related courses at UC Berkeley:
  - EE 143: Microfabrication Technology
  - EE 147/247A: Introduction to MEMS
  - ME 119: Introduction to MEMS (mainly fabrication)
  - BioEng 121: Introduction to Micro and Nano Biotechnology and BioMEMS
- Assumed background for EE C247B/ME C218:
  - graduate standing in engineering or physical/bio sciences
  - knowledge of microfabrication technology

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Course Overview

- The mechanics of the course are summarized in the course handouts, described in lecture today
  - Course Information Sheet
    - Course description
    - Course mechanics
    - Textbooks
    - Grading policy
  - Syllabus
    - Lecture by lecture timeline w/ associated reading sections
    - Midterm Exam: Thursday, March 19
    - Final Exam: Wednesday, May 13, 11:30 a.m.-2:30 p.m. (Group 10)
    - Project due date TBD (but near semester's end)

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What Should You Know?

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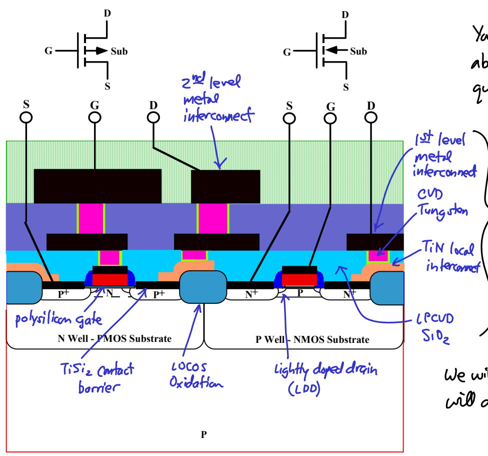
Typical mid-2000's CMOS Process (good down to ~0.25μm)



You should either already know or be able to learn independently & very quickly:

1. How to deposit or grow these different layers.
2. How to pattern or otherwise form the shapes of the layers shown.
3. What determines the order by which the different layers are formed, e.g., temperature limits, topography limits, etc...

We will review these things, but we will do this very fast!

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What Should You Know?

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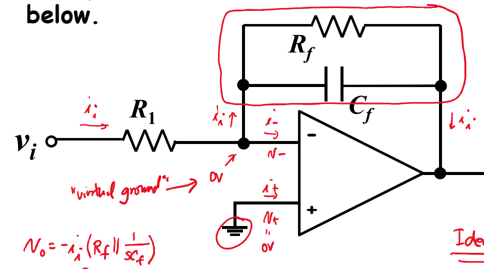
- Basic circuit analysis & design using op amps
- *Example*: Find the transfer function $v_o(s)/v_i(s)$ of the circuit below.



$v_o = A_o(v_+ - v_-)$

$= \infty (v_+ - v_-) = \text{finite}$

$v_+ = v_-$

$v_o = -i_i\left(R_f \| \frac{1}{sC_f}\right)$

$\left[i_i = \frac{v_i}{R_1}\right] = -\frac{v_i}{R_1}\left(\frac{R_f}{1+sR_fC_f}\right)$

$\frac{v_o}{v_i}(s) = -\frac{R_f}{R_1}\frac{1}{1+sR_fC_f} = -\frac{R_f}{R_1}\frac{1}{1+\frac{s}{\omega_o}}$, $\omega_o = \frac{1}{R_fC_f}$

Ideal Op Amp: (apply when have neg. FB)

1. $v_- = v_+$
2. $R_i = \infty \rightarrow i_- = i_+ = 0$
3. $R_o = 0$
4. $A_o = \infty$

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