Review Syllabus

The Big Picture

- What has been covered in previous courses, and where are we headed in future courses in the microelectronics sequence?

- Text covers "Microelectronics" which relates to the design of ICs.
  - Concepts are the same for design of discrete circuits.

ECE 2280: - covered chapters 1-5 in the text.
  - 3 major topics: - Opamps (functional perspective, use & circuits)
    - Devices: - MOSFETS > FNs?
    - BJTs
  - covered the basic building blocks for integrated circuits, and the use of specific ICs (opamps)

ECE 3110 (This course): - start with a review of chapters 1-5 (first week)
  - Design of ICs using building blocks from 2280
    - both analog and digital.
  - Talk about what is inside an op-amp, other circuits
  - Change focus to deal more with MOSFETS (less BJTs)
  - MOSFETS more prevalent, but BJTs still used.
  - Labs updated to use MOSFETS, still discrete.

Major goal: be able to design and analyze basic transistor circuits.

Future courses:

ECE 5710/6710: - digital circuit design using MOSFETS.
  - Large project to design a microprocessor (and fabricate)

ECE 5720/6720: - analog circuit design using MOSFETS
  - Review and build on concepts in this course
  - Project to design an analog circuit (and fabricate) (eg. A/D converter)

ECE 6730: - radio frequency IC design
  - Design integrated radios (eg. WiFi, cell phones, etc.)
  - Focus on communications applications
  - Project to design a radio front end

- Lots of interesting applications and tons of job opportunities, you should take all of these courses!!!
Now review a couple of important concepts from 2280.

- **Decibels**: used to express gain on a logarithmic scale.
  - Deals with ratios (e.g. $V_{out}/V_{in}$), i.e. **NO UNITS**!
  - Commonly used in electronics, might as well get used to them now.
  - Basic form is $dB = 10 \cdot \log \left( \frac{V_1}{V_2} \right)$
  - If used for power gain, $dB = 10 \cdot \log \left( \frac{P_{out}}{P_{in}} \right)$
  - When used for voltage/current gain, $dB = 20 \cdot \log \left( \frac{V_{out}}{V_{in}} \right)$.
  - This is because power is related to the square of voltage, (e.g. $P = \frac{V^2}{R}$)
  - So upon subbing in, we get:
    
    $dB = 10 \cdot \log \left( \frac{V_{2+}^2}{V_{1-}^2} \right)$
    
    $= 2 \cdot 10 \cdot \log \left( \frac{V_{out}}{V_{in}} \right)$
    
    $= 20 \cdot \log \left( \frac{V_{out}}{V_{in}} \right)$ (can always derive this if you forget).

**Small Signal Approximations** (VERY IMPORTANT!!!) (read 1.4.8)

- You **MUST** understand this to do analog circuit design.
- Used to make analyses/design of a non-linear system tractable.
- Really just a simple application of a Taylor Series (from Calculus).

$$f(x_0 + \Delta x) = f(x_0) + \Delta x \cdot \frac{f(x_0)}{1!} + \Delta x^2 \cdot \frac{f''(x)}{2!} + \Delta x^3 \cdot \frac{f'''(x)}{3!}$$

- Now apply to a non-linear amplifier.

- Use approximation with first two terms of Taylor Series
  - Let input signal be $\text{VIN} = \text{VIN} + \text{Vin}(t)$
  - $\text{Vin}(t)$ variable with time
  - Evaluate full expression
  - Write small $\text{Vin}$ linearization of actual behavior