Feedback

- Assume you are familiar with feedback benefits, issues
  - Review: G&M Ch. 8 & 9, Razavi Ch. 8
- Focus here on:
  - Stability
  - Analysis and simulation
  - Settling
    - Often amplifying pulses and not sinusoids
    - More next lecture

Stability

- Nearly all circuits are actually non-linear and time-varying
  - “Poles” only accurate for given bias, temp., etc.
- What we usually mean by stability:
  - Circuit always converges to the “origin” for zero input within finite time
    - (Exponential stability)
  - Another common definition: BIBO stability

Generic Feedback Circuit

- Open-loop gain: \( a \)
- Feedback factor: \( f \)
- Loop gain: \( T = a_f \)
- Closed-loop gain:
  \[
  A = \frac{V_o}{V_i} = \frac{a}{1+T} = \frac{1}{1+\frac{1}{f}+\frac{1}{f}}
  \]

Electronic Feedback Circuit

- Careful with mapping circuit feedback to generic diagram...

Stability In Practice

- Linearize the circuit and look at its poles
  - Remember: this is only an approximation!
    - Perform linear analysis over several corners, temps, supplies, etc.
    - May want to do a couple of transient sims too
Linear Circuit Stability

- Stability set by $T(s)$
- $T(s)$ is an open-loop parameter - need to break the loop
  - Easy to do in hand analysis: break at controlled source
  - Not as easy in simulation... (next lecture)

Phase Margin

- Approximate method to evaluate stability: phase margin
- Works well for most circuits of interest
  - Sometimes have to use Nyquist stability test

Multi-Loop Feedback