Lecture 24

• Last time:
  – Multi-stage amplifiers: voltage, transconductance

• Today:
  – Cascode: merged CS/CG cascade

CG Cascade: Sharing a Supply

First stage has no current supply of its own → its output resistance is modified

Multistage Amplifier Design Examples

Start with basic two-stage transconductance amplifier:

Why do this combination?

Two-Stage Amplifier Topology

Direct DC connection: use NMOS then PMOS

\[ V^+ = +2.5 \text{ V} \]

\[ V^- = -2.5 \text{ V} \]
Current Supply Design

Assume that the reference is a “sink” set by a resistor

Must mirror the reference current and generate a sink for \( i_{SUP2} \)

Use Basic Current Supplies

Complete Amplifier Topology

What’s missing? The device dimensions and the bias voltage and reference resistor

The Cascode Configuration

Common source / common gate cascade is one version of a cascode (all have shared supplies)

DC bias:

Two-port model: first stage has no current supply of its own
Cascode Two-Port Model

\[ \text{Output resistance of first stage} = \frac{1}{R_{\text{out,CS}}} = \frac{1}{R_{\text{down,CS}}} = r_{\text{out}} \]

Why is the cascode such an important configuration?

Miller Capacitance of Input Stage

Find the Miller capacitance for \(C_{gd1}\)

Input resistance to common-gate second stage is low \(\Rightarrow\) gain across \(C_{gd1}\) is small.

Two-Port Model with Capacitors

Miller capacitance: \(C_M = (1 - A_{C_{gd1}})C_{gd1}\)

Other Cascode Configurations

Basic configuration: transconductance stage followed by current buffer

\(CE_n-CG_n\) \hspace{1cm} \(CS_n-CB\) \hspace{1cm} \(CS_p-CG_p\)