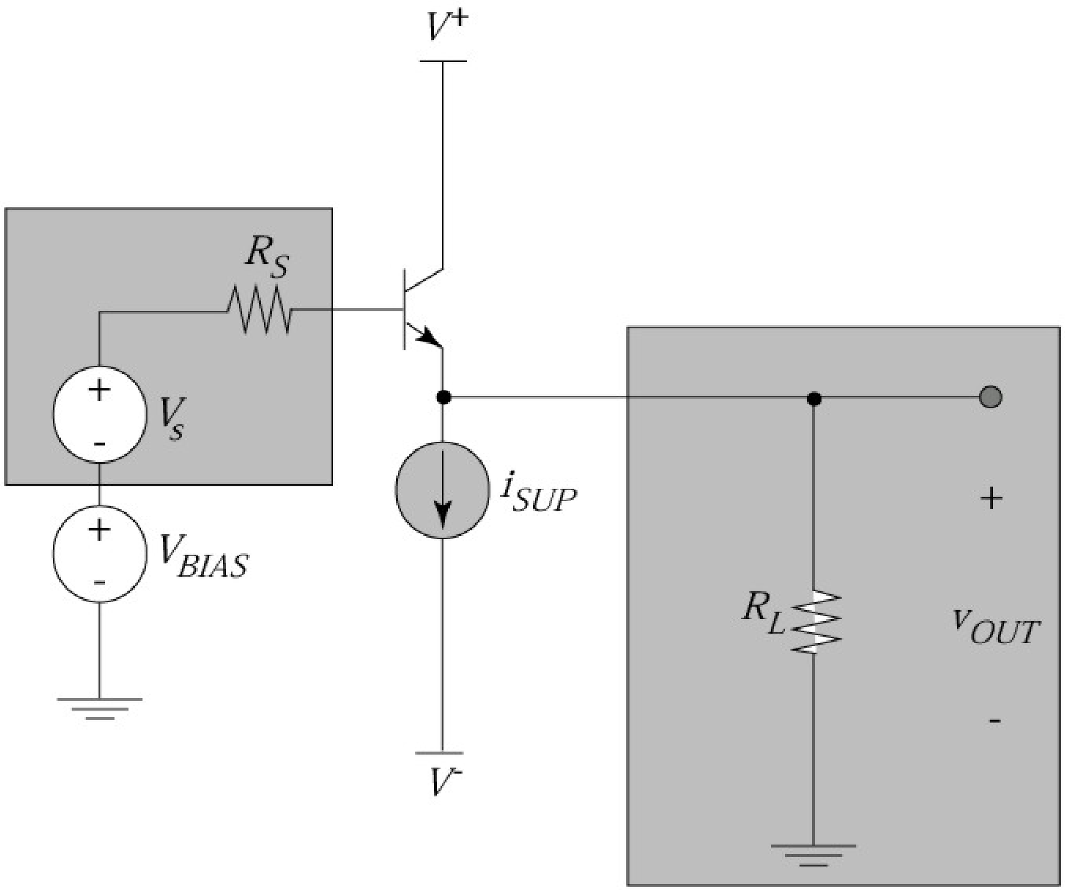
Lecture 32

- Last time:
  - Frequency response of the CE as voltage amp
  - The Miller approximation
- Today :
  - Frequency response of voltage and current buffers
  - Start multi-stage amplifiers: Chapter 9

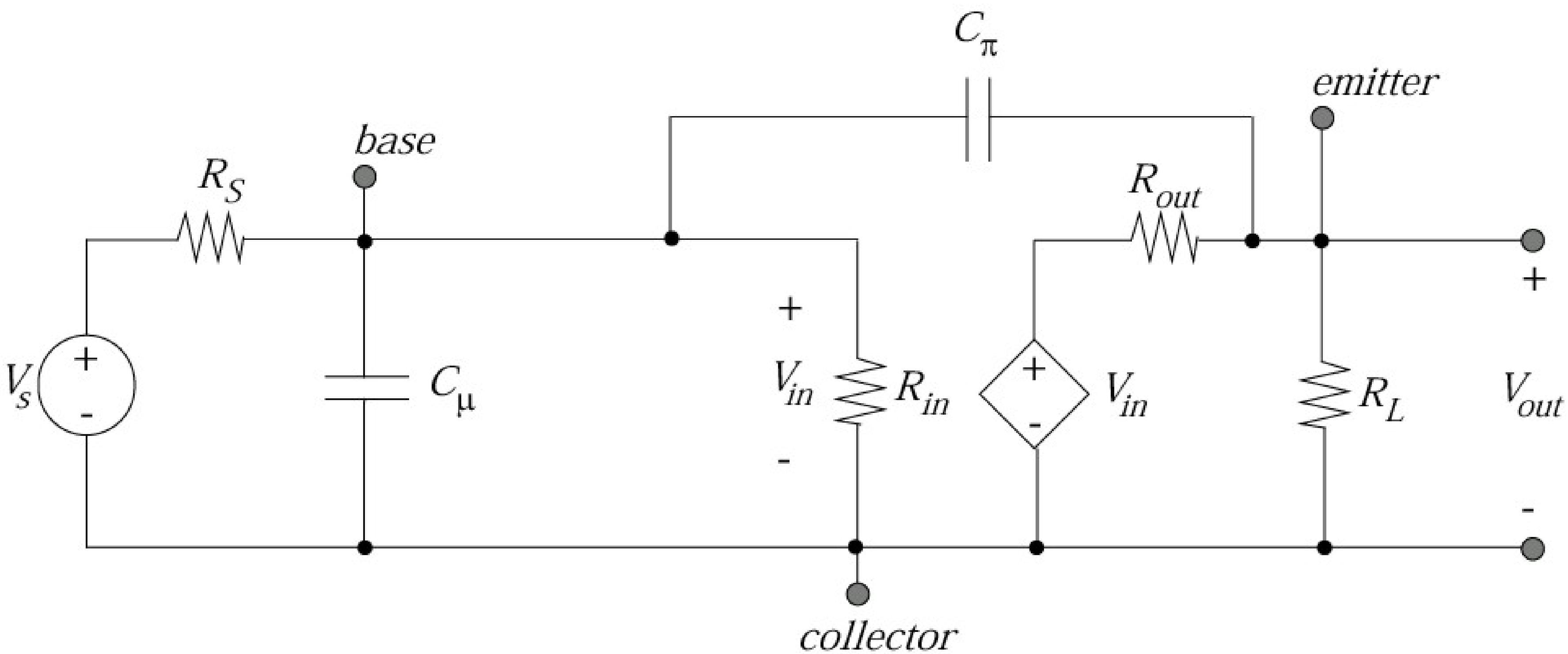
Common-Collector Amplifier



Procedure:

1. Small-signal two-port model
2. Add device (and other) capacitors

Two-Port CC Model with Capacitors



Find Miller capacitor for C_π -- note that the base-emitter capacitor is Between the input and output

Voltage Gain $A_{vC\pi}$ Across C_π

$$A_{vC_\pi} =$$

Note: this voltage gain is neither the two-port gain nor the "loaded" voltage gain

$$C_{in} = C_\mu + C_M = C_\mu + (1 - A_{vC_\pi})C_\pi$$

Bandwidth of CC Amplifier

Input low-pass filter's –3 dB frequency:

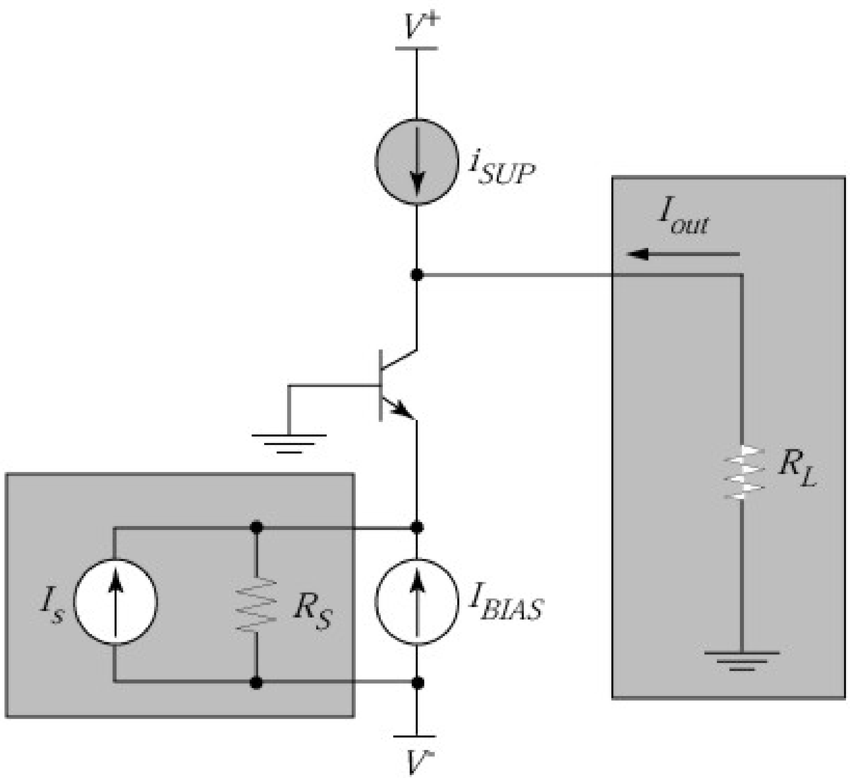
$$\omega_p^{-1} = (R_S \,||\, R_{in})\left(C_\mu + \frac{C_\pi}{1 + g_m R_L}\right)$$

Substitute favorable values of R_S, R_L:

$$R_S \approx 1/g_m \qquad R_L >> 1/g_m$$

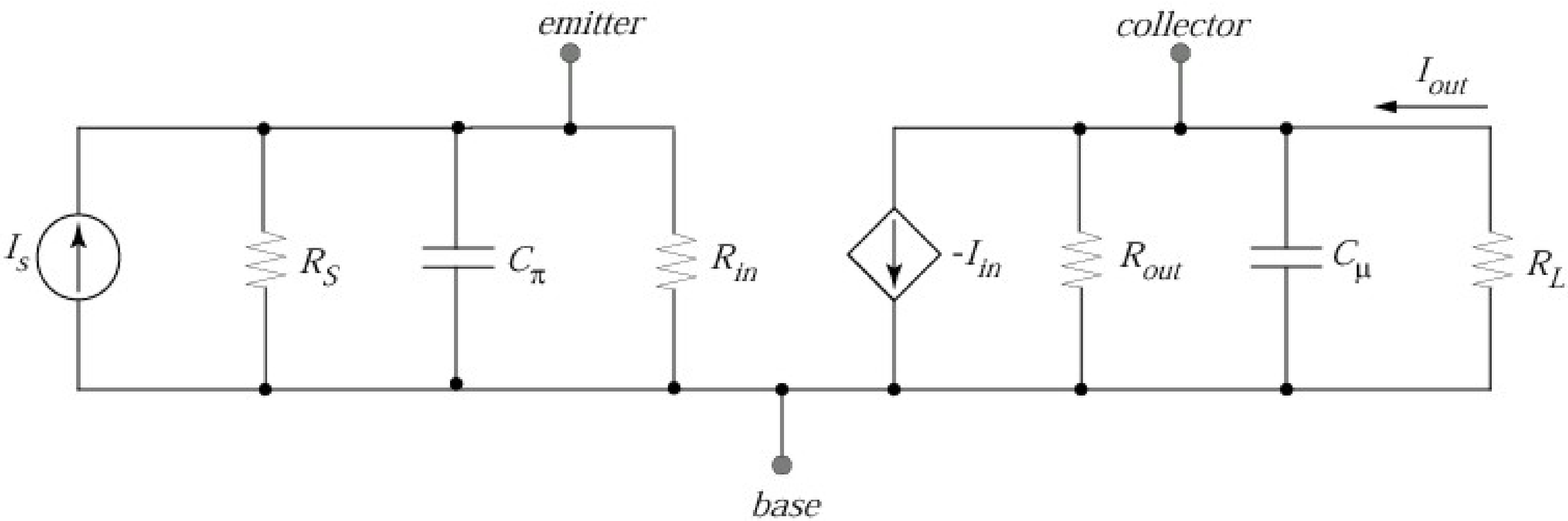
$$\omega_p^{-1} \approx (1/g_m)\left(C_\mu + \frac{C_\pi}{1 + BIG}\right) \approx C_\mu / g_m$$

Bandwidth of the Common-Base Current Buffer



Same procedure: start with two-port model and capacitors

Two-Port CB Model with Capacitors



No Miller-transformed capacitor!

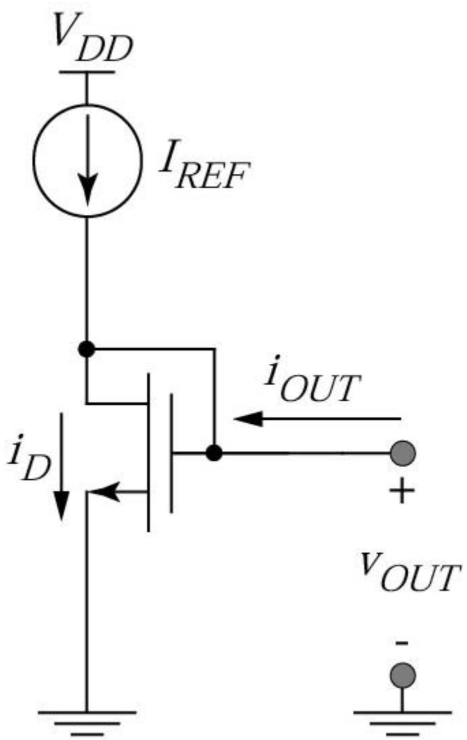
Unity-gain frequency is on the order of ω_T for small R_L

Summary of Single-Stage Amplifier Frequency Response

- CE, CS: suffer from Miller-magnified capacitor for high-gain case
- CC, CD: Miller transformation → nulled capacitor → "wideband stage"
- CB, CG: no Millerized capacitor → wideband stage (for low load resistance)

Multi-Stage Amplifiers: Chap. 9

- First topic: voltage and current sources (9.4)
- Generating a voltage: use a current source to set V_{GS} (or V_{BE})



Modeling the Voltage Source

Find i_{OUT} versus v_{OUT}

MOSFET is off or saturated: why?

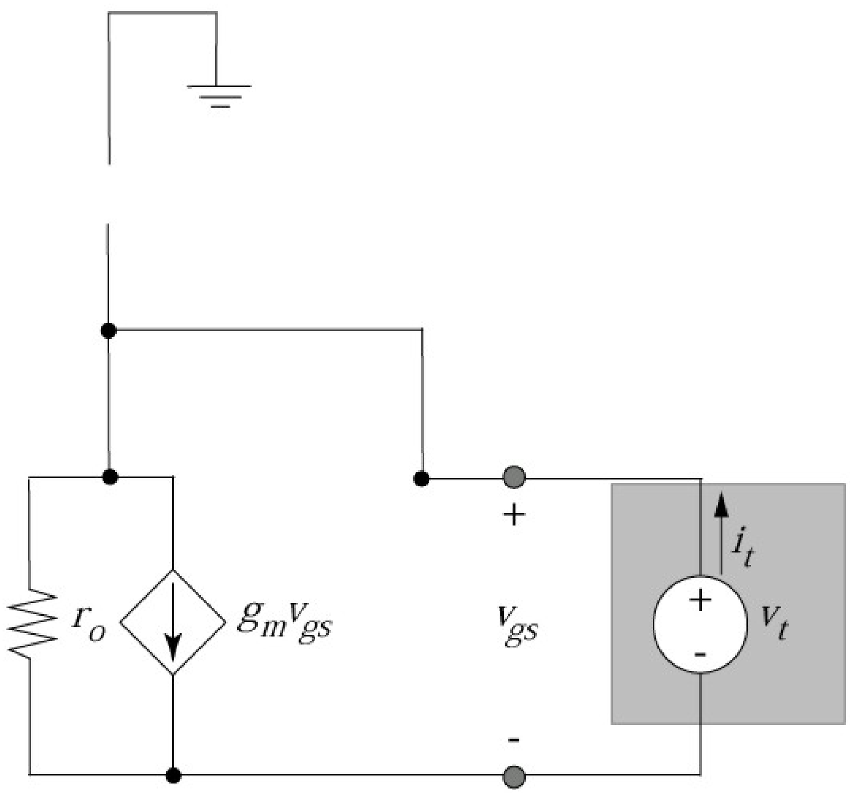
$$i_{OUT} = i_{D,SAT} - I_{REF} = \mu_n C_{ox}\left(\frac{W}{2L}\right)(v_{GS} - V_{Tn})^2(1 + \lambda_n v_{DS}) - I_{REF}$$

Typical operating point:

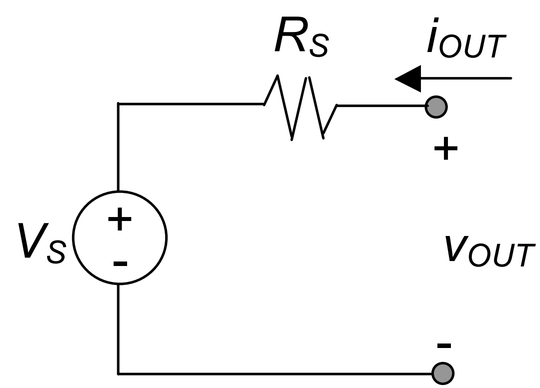
$i_{OUT} = 0$ A

Small-Signal Source Resistance

$$R_S = \left(\left. \frac{di_{OUT}}{dv_{OUT}} \right|_{I_{OUT}=0} \right)^{-1} = \frac{v_t}{i_t}$$



Equivalent Circuit:



Using a Voltage Source to Make a Current Source