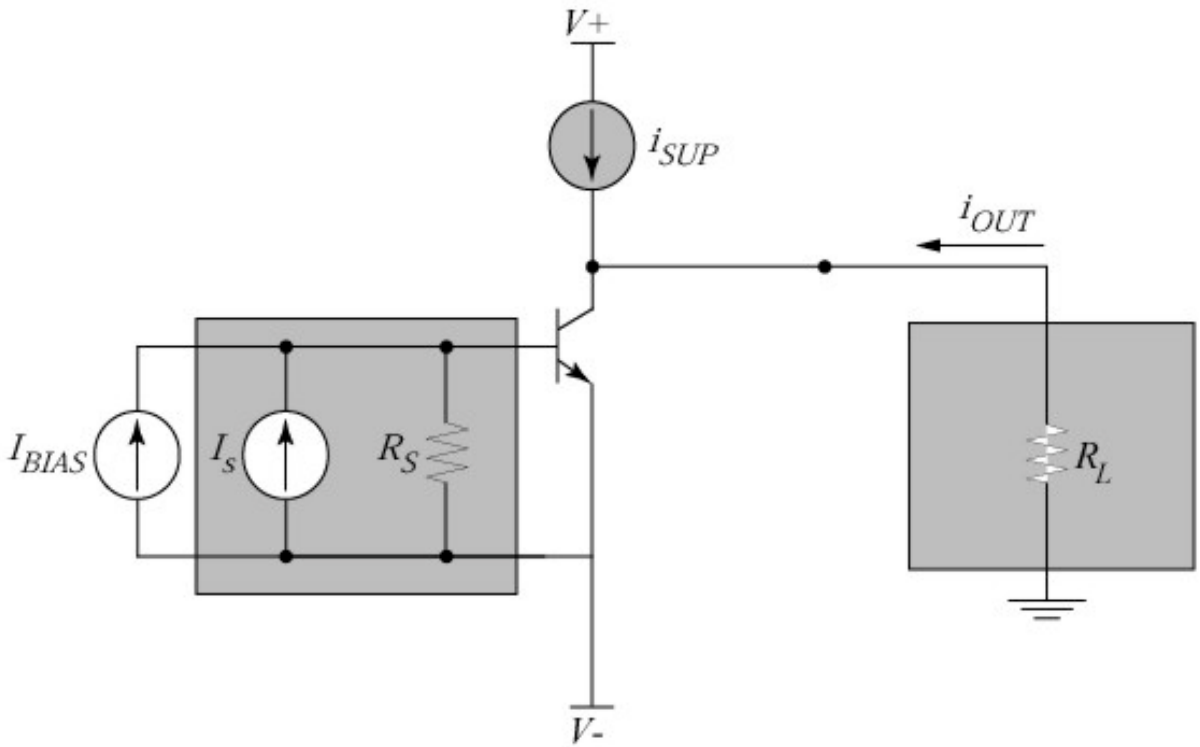
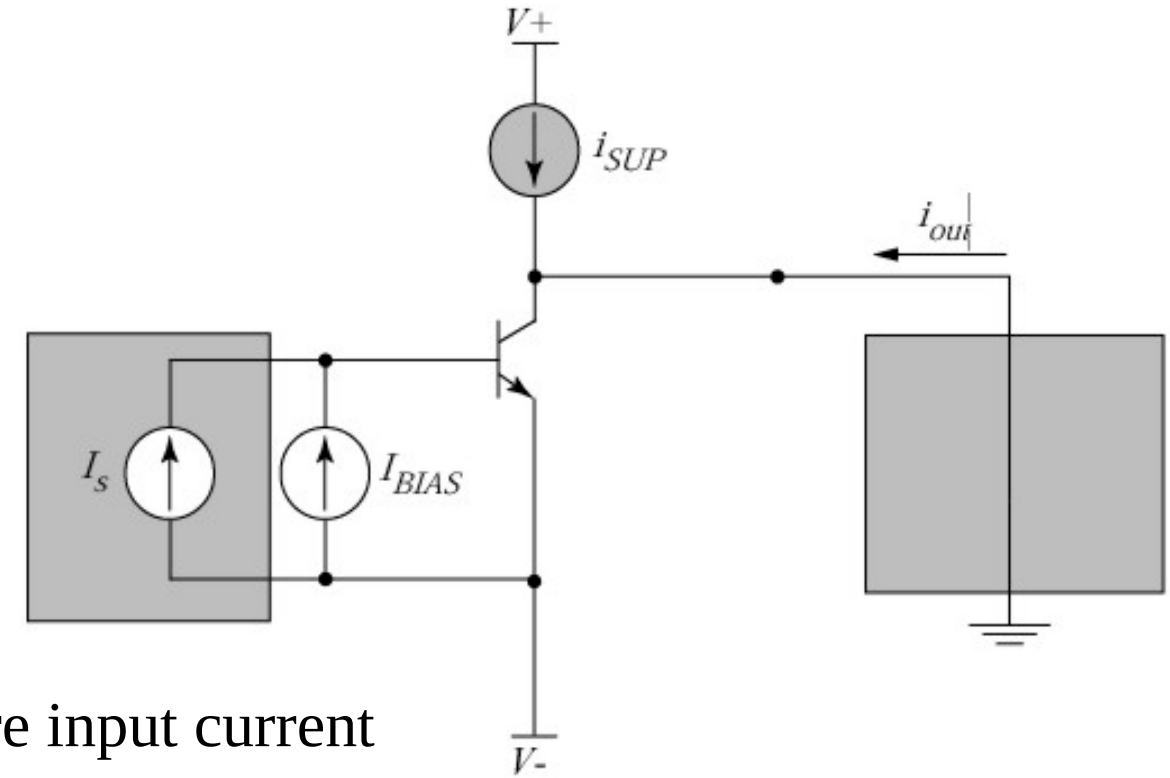
Lecture 30

- Last time:
  - Wrap-up of Chapter 8
- Today :
  - Frequency response of the CE and CS (?) current amplifiers
  - Unity-gain frequency ω_T

CE Amplifier with Current Input



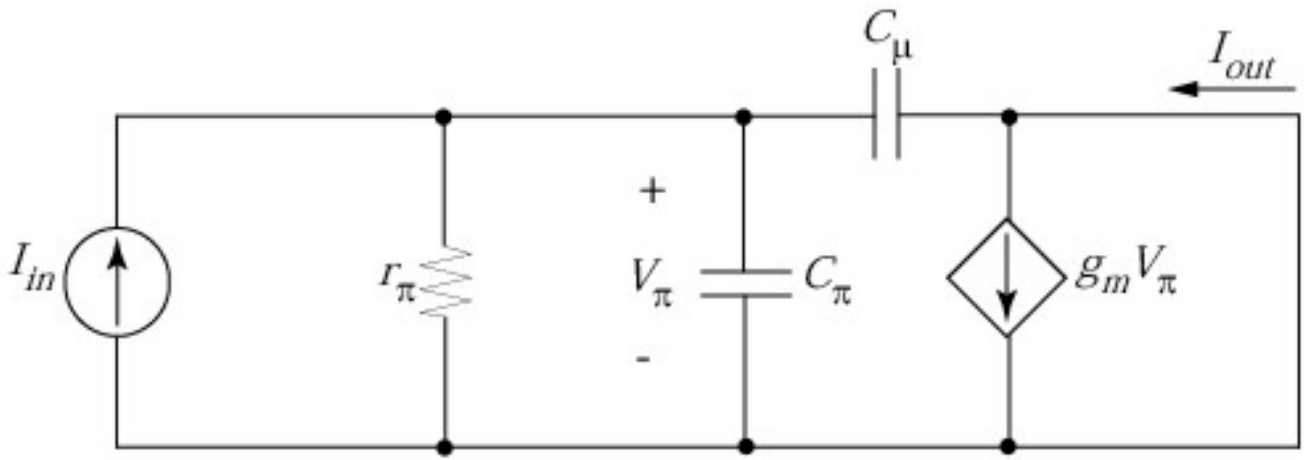
Short-Circuit Current Gain



Small-signal short circuit (could be a DC voltage source)

Pure input current ($R_S = 0\ \Omega$)

Small-Signal Model: A_i



Note that r_o, C_{cs} play no role (shorted out)

Phasor Analysis: Find A_i

KCL at the output node:

$$I_{out} = g_m V_\pi + (0 - V_\pi)/Z_\mu$$

KCL at the input node:

$$I_{in} = V_\pi / Z_\pi + (V_\pi - 0)/Z_\mu$$

Solve for V_π:

Phasor Analysis for A_i (cont.)

$$I_{out} = (g_m - j\omega C_\mu)V_\pi$$

Substituting for V_π

$$A_i(j\omega) = \frac{(g_m - j\omega C_\mu)}{(1/Z_\pi) + j\omega C_\mu}$$

Substituting for $Z_\pi = r_\pi \,||\, (1/j\omega C_\pi) =$

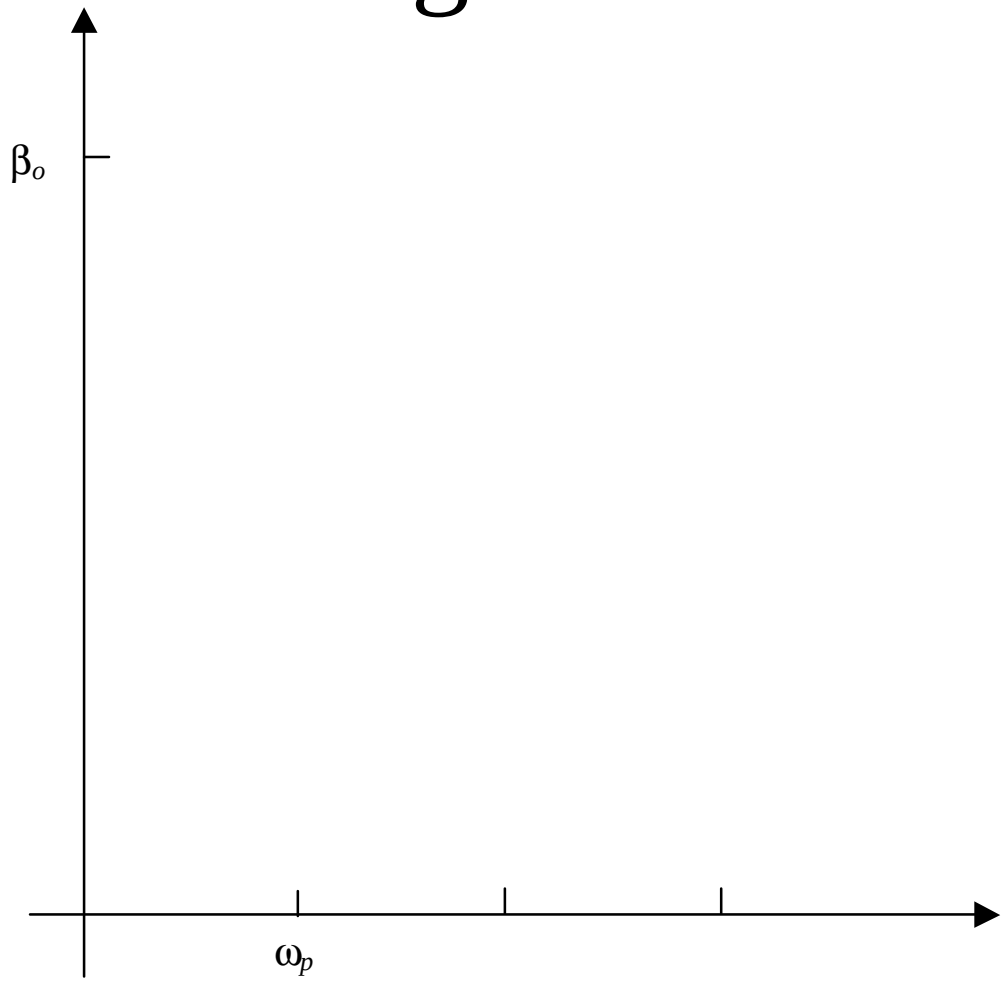
Short-Circuit Current Gain Transfer Function

Transfer function has one pole and one zero:

$$A_i(j\omega) = \frac{\beta_o(1 - j\omega[C_\mu / g_m])}{1 + j\omega[r_\pi(C_\pi + C_\mu)]}$$

$$A_i(j\omega) = \frac{\beta_o(1 - j\omega/\omega_z)}{(1 + j\omega/\omega_p)}$$

Magnitude Bode Plot



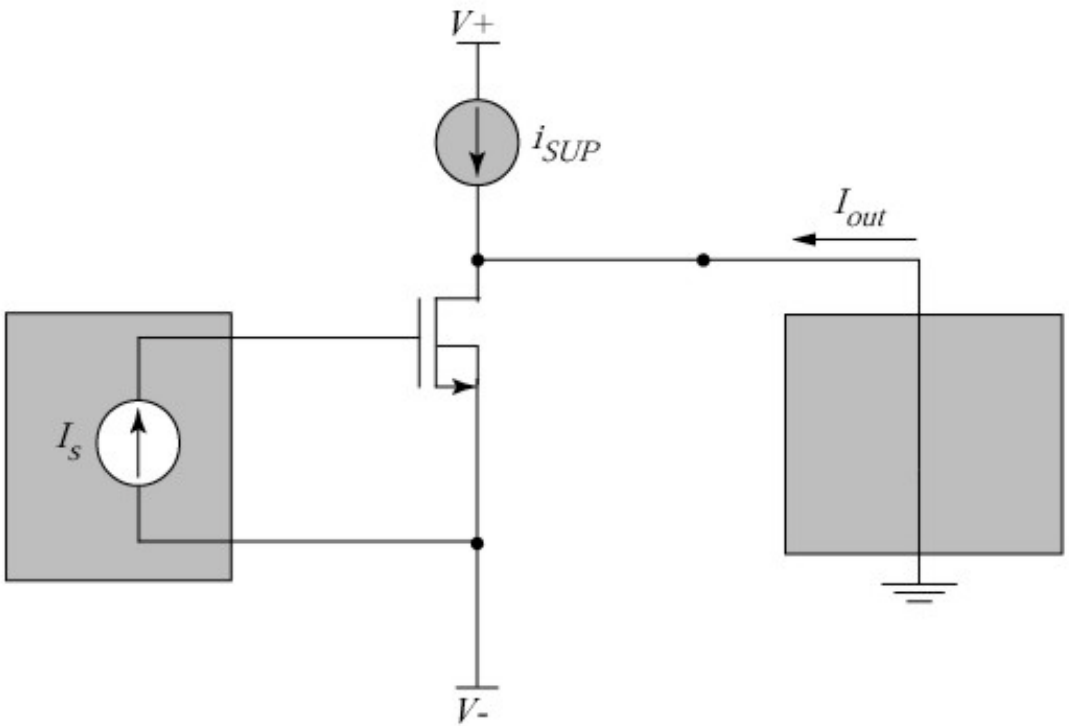
Transition Frequency ω_T

$$\omega_T = \frac{\omega_p}{\beta_o} = \frac{g_m}{C_\pi + C_\mu}$$

Dependence on DC collector current:

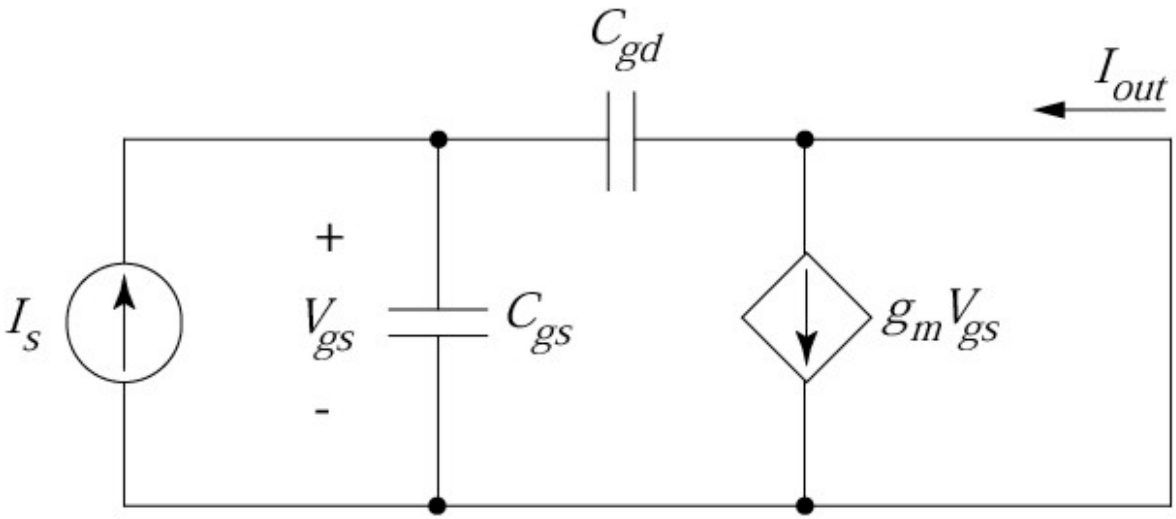
Limiting case: $f_T = \frac{\omega_T}{2\pi} \rightarrow \frac{1}{2\pi\tau_F}$ Current record:

Common Source Amplifer: $A_i(j\omega)$



DC Bias is problematic: what sets V_{GS}?

CS Short-Circuit Current Gain



Transfer function: $$A_i(j\omega) = \frac{g_m\left(1 - j\omega C_{gd}/g_m\right)}{j\omega(C_{gs} + C_{gd})}$$