Lecture 28

- Last time:
  - Wrap-up MOS single-stage amplifiers

- Today:
  - Bipolar single-stage amplifiers: biasing, common-emitter, common-base, common-collector

Bipolar Amplifiers

Common-emitter amplifier:

\[ \text{Biasing: adjust } V_{\text{BIAS}} = V_{\text{BE}} \text{ so that } I_C = I_{\text{SPP}} \text{ or } V_{\text{BE}} = V_{\text{CES}} \]

\[ V_{\text{BE}} = V_{\text{CN}} \]

\[ I_C = I_{\text{SPP}} = I_E \]

\[ V_{\text{out}} = V_{\text{CES}} + V_{\text{beq}} \]
Small-Signal Two-Port Model

Parameters:

\[ R_{in} = 9 \Omega \]
\[ R_{out} = 100 \Omega \]
\[ G_m = 9 \, \text{mS} \]
\[ I_{dc} = 9 \, \text{mA} \]

\[ V_{th} = 9 \, \text{V} \]

\[ R_{in} = G_m \cdot R_{out} \]

\[ I_{in} = \frac{V_{in}}{R_{in}} \]

\[ I_{out} = \frac{V_{out}}{R_{out}} \]
Common Base Amplifier

To find $I_{\text{bias}}$, note that $I_{\text{bias}} = I_E = I_{\text{IC}} = 1.0 \Omega \times 1.$ Common-base current gain $A_i = -\alpha_F.$

$$I_{L} + I_{C} = I_{E}$$

Summing currents at the input node:

$$V_{out} = V_{in} + i_c + V_m \times i_m$$
\[ V \frac{1}{V_0} \frac{1}{I} = \frac{1}{V_0} \frac{1}{I} = \frac{1}{V_0} \frac{1}{I} \]

\[ R_{in} = \frac{1}{\frac{g_m}{g_m + g_n}} = \frac{1}{\alpha} \]

\[ 250^\circ \]

CB Output Resistance

Same topology as CG amplifier, but with \( r_x \parallel R_s \) rather than \( R_s \)

\[ R_{out} = \frac{R_{s} || [R_{s} (1+g_m)]}{20 (1+g_m)} \]

Note polarity
Common-Base Two-Port Model

Why did we consider it a current amp?

\[ A_i = -1 \]

\[ \text{Pin: small} \]

\[ \text{Vout: huge} \]

DC Bias: output is one "V be drop" down from input

Very sensitive to \( V_{in} \)