Continuing transistors and how to use them.
Voltage requirements on transistors are finicky—often inputs aren't well matched.
(Clicker 4) \(\rightarrow\) Bias quiescent points.

Emitter follower: analyze quiescent behavior. Assume: \(V_{in}\) is DC.
Assume \(h_{fe} = 1000\).

\[ \text{Base voltage: from voltage divider: } 2.5V \text{ assuming } i_B \approx 0 \]

Emitter voltage: base \(-0.6V = 1.9V\)

Collector voltage: \(15V\)

Emitter current: \(\frac{1.9V}{1k\Omega} = 1.9\ mA\)

Base current: \(\frac{i_E}{h_{fe} + 1} = 0.019 mA = 1.9\ \mu A\)

Collector current: \(h_{fe} \cdot i_B = 1.9\ mA\)

\(\rightarrow\) All independent of \(V_{in}\).

Now, apply a short pulse \(\Delta V_{in}\) to input.
Capacitor gives high-pass behavior, and \(R_1, R_2 \gg R_{in}\) so input should override voltage divider \(\rightarrow \Delta V_{base} \approx \Delta V_{in}\).

Since \(V_E - V_B\) remains \(0.6V\), \(\Delta V_{out} \approx \Delta V_{in}\).

AC voltage gain is 1.

(Clicker 2-5) — Common emitter amplifier
Impedances: (AC)

Emitter follower:

$Z_{in} = R_1 \parallel R_2 \parallel R_{e\text{hfe}}$  "high"

$Z_{out} = \frac{R_s}{1 + h_{fe}}$, so always $< R_e$ ("low")

$\rightarrow$ Essentially what we expect for a follower.

Common emitter:

$Z_{in} \approx R_1 \parallel R_2 \parallel R_{e\text{hfe}}$  "high"

$Z_{out} = R_e$ "high"
Transistor as a switch:

"Load" is the circuit we want to switch.

If $V_b = 0$, no current flows through the load.
If $V_b > 0.6V$, current flows freely.

Model refinement:

Barr-Moll model: emitter has an effective resistance that can change with current.

\[ R_e = 25 \Omega \cdot \frac{1mA}{I_e} \]

Effect is to reduce small currents below ideal.

Modifies common emitter gain: \[ G = \frac{R_e}{R_e + r_e} \] as a function of current.