Lecture 19

• Last time:
  – DC and small-signal model of the forward-biased diode

• Today:
  – the npn bipolar junction transistor (BJT):
    large-signal characteristics

nnp Bipolar Transistor Structure
npn Bipolar Transistor Layout

BJT Symbol
Measuring the BJT’s Collector Characteristics

\[ I_C = I_C(I_B, V_{CE}) \]

Collector Characteristics

- \( I_B = 2.5 \mu A \)
- \( I_B = 2 \mu A \)
- \( I_B = 1.5 \mu A \)
- \( I_B = 1 \mu A \)
- \( I_B = 500 \text{ nA} \)
- \( I_B = 1 \text{ mA} \)
- \( I_B = 2 \text{ mA} \)
- \( I_B = 0 \) (cutoff)
- \( I_B = 0 \) (reverse active)
Base-Emitter Voltage Control

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"Transistor Action"

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Diffusion Currents

BJT Currents

Collector current is nearly identical to the (magnitude) of the emitter current … define

\[ I_C = -\alpha_F I_E \]

Kirchhoff:

\[ -I_E = I_C + I_B \]

DC Current Gain:
Origin of $\alpha_F$

Base-emitter junction: some reverse injection of holes into the emitter $\rightarrow$ base current isn’t zero

Typical $\alpha_F$