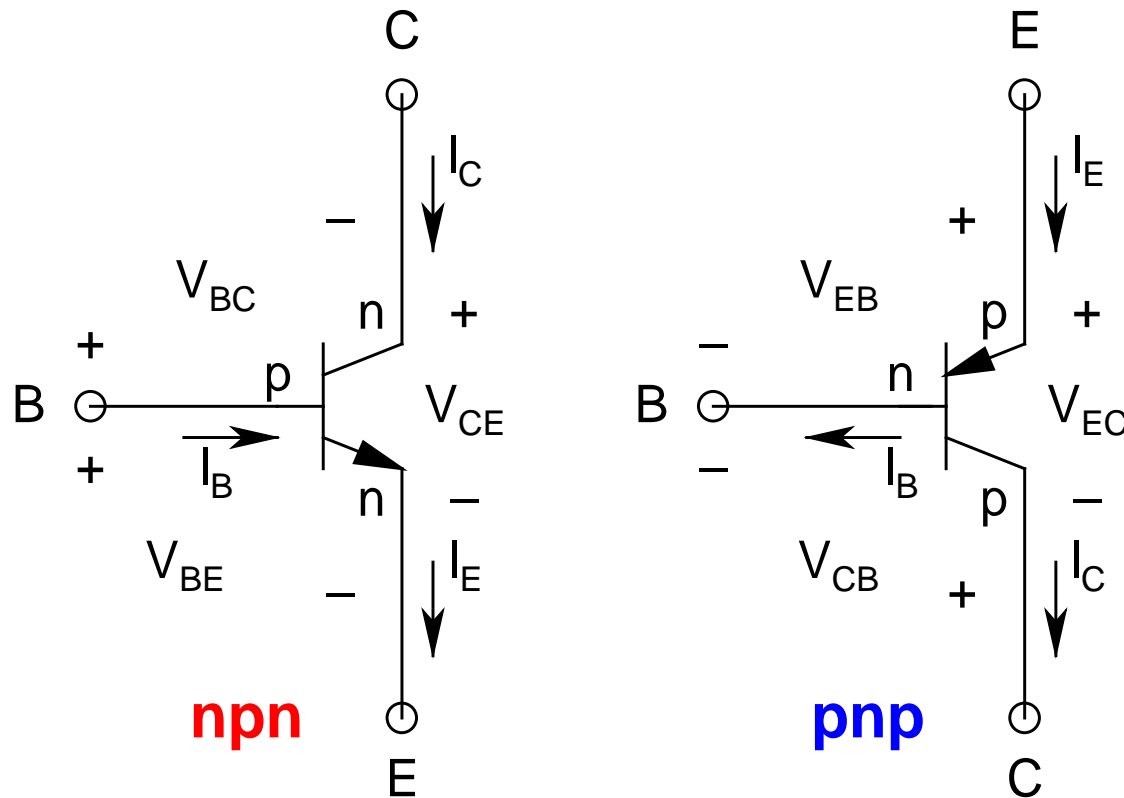# Symbols and Current-Voltage Conventions

npn

pnp

- *Voltage Convention*:
  - *p-side first*:
    - *Sign of the voltage* immediately lets us know the *biasing state* (*forward or reverse*)
  - *npn*: V_{BE} (*base-emitter voltage*), V_{BC} (*base-collector voltage*), and V_{CE} (*collector-emitter voltage*)
  - *pnp*: V_{EB} (*emitter-base voltage*), V_{CB} (*collector-base voltage*), and V_{EC} (*emitter-collector voltage*)
  - Note: *Collector-Emitter is NOT a junction*

- *Current Convention*:
  - *npn*:
    - I_C *and* I_B *flow in*, I_E *flows out*
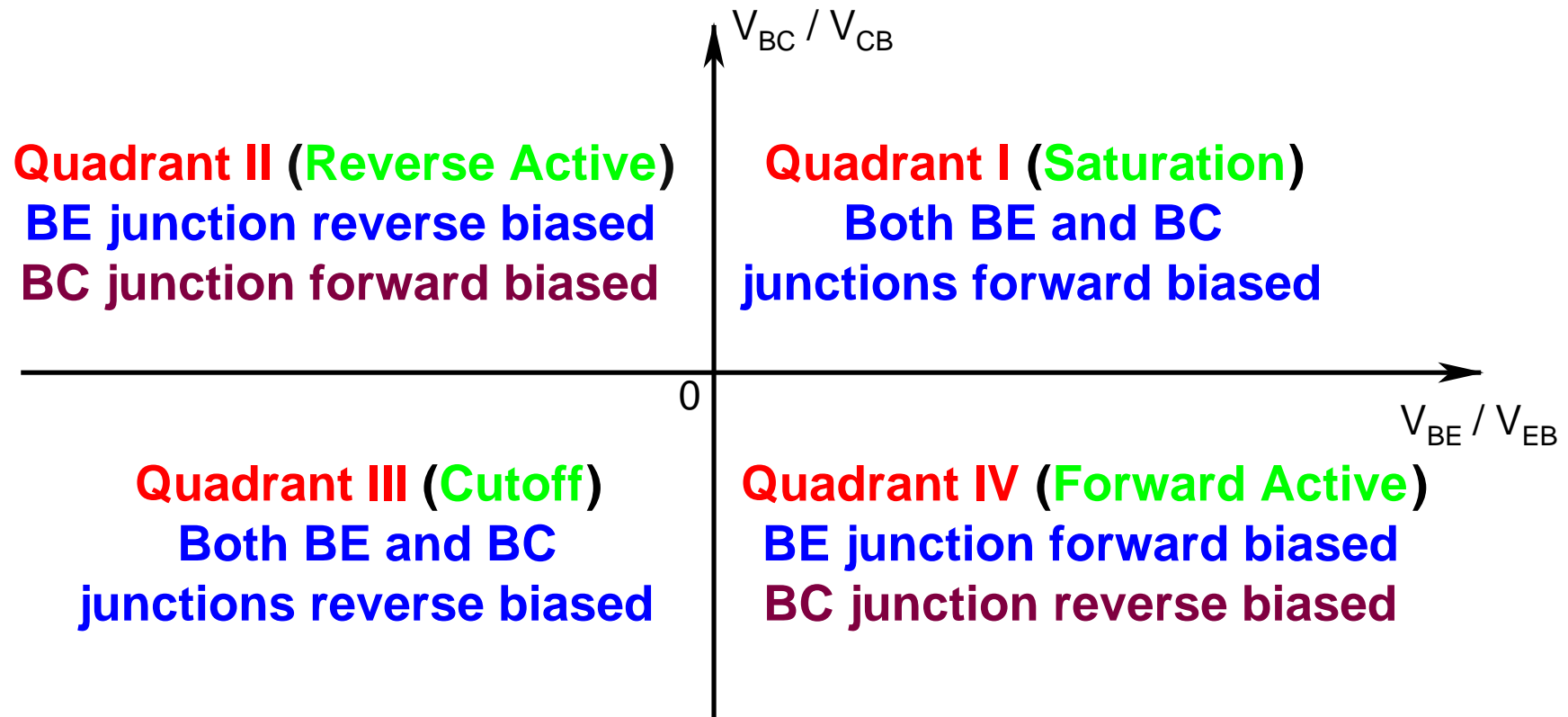 - *pnp*:
    - I_E *flows in*, I_C *and* I_B *flow out*
- *Applying KCL*, treating the whole BJT as a *big node*, for *both npn and pnp*:
  - $I_E = I_C + I_B$
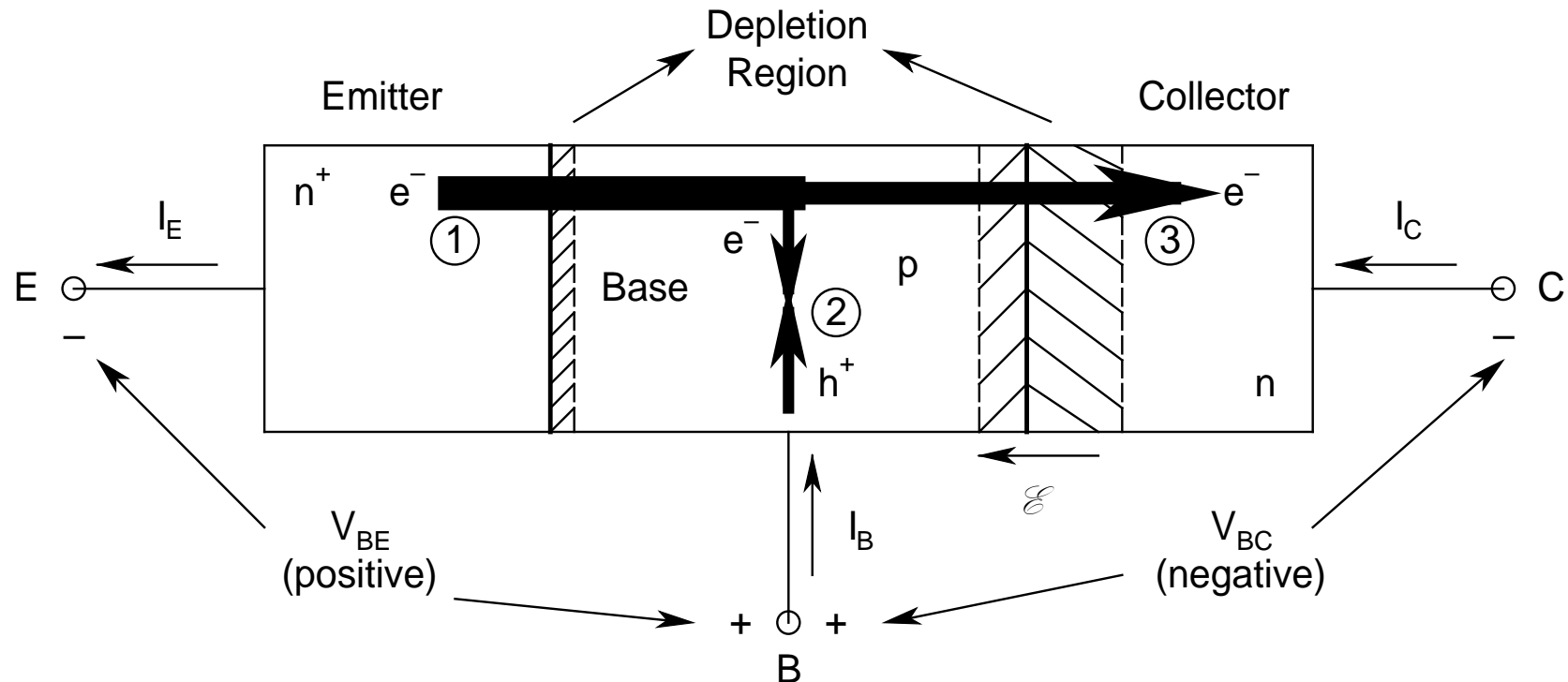 - *Extremely important KCL for the BJT*

Modes of Operation

V_{BC} / V_{CB}

Quadrant II (Reverse Active)
BE junction reverse biased
BC junction forward biased

Quadrant I (Saturation)
Both BE and BC
junctions forward biased

0

V_{BE} / V_{EB}

Quadrant III (Cutoff)
Both BE and BC
junctions reverse biased

Quadrant IV (Forward Active)
BE junction forward biased
BC junction reverse biased

Quadrants III and IV: Analog Domain
Quadrants I and III: Digital Domain
Quadrant II: Finds use only in TTL circuits

Operation in the Forward Active (FA) Mode

① Injection Component, ② Recombination Component, ③ Collection Component