Lecture 16: Bipolar Junction Transistors (BJTs) I

- Announcements:
- HW#6 online soon and due Friday two weeks from now via Gradescope
- Lab#3 for ~~Monday~~ all sections next week, ~~but no lab for the other sections~~
- By popular demand, it looks like we will hold lab sections next week
- Midterm 1: Friday, Oct. 5, from 5-6:30 p.m., in 277 Cory
  - Will go through a Midterm Info Sheet today
  - Midterm Info Sheet will be online soon
- Hopefully, those without access to 125 Cory will soon get access
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- Lecture Topics:
  - Midterm Info
  - Bipolar Junction Transistor (BJT)
    - —Regions of Operation
    - —Cutoff
    - —Forward-Active
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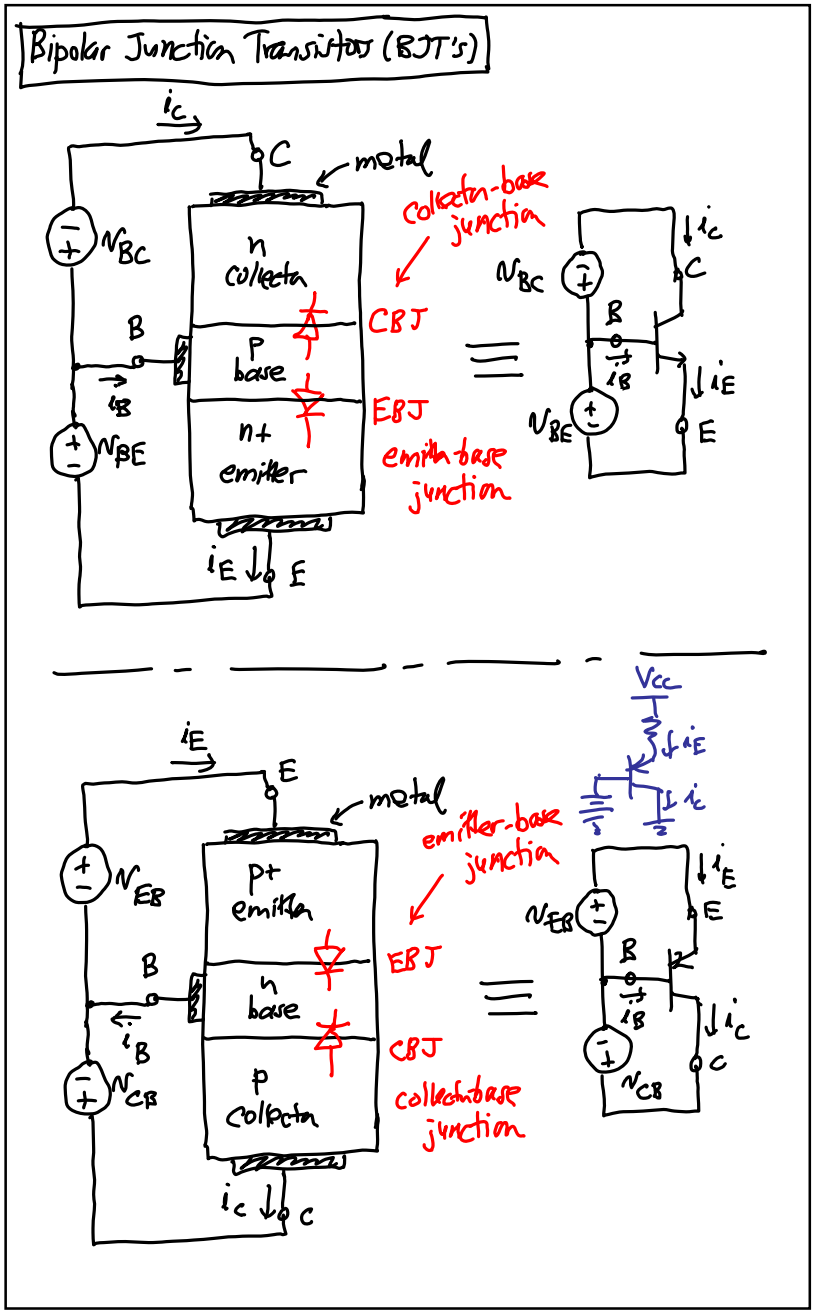
- Last Time:
- Finished MOS physics (for now)

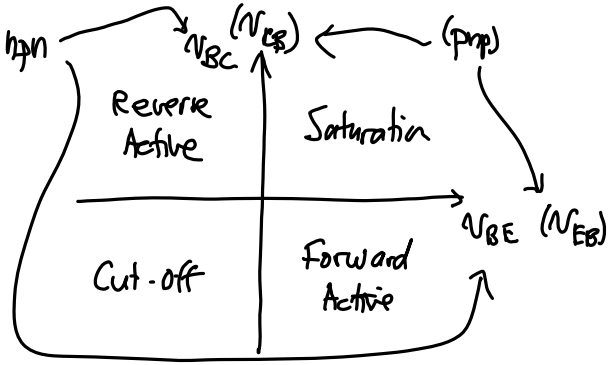


Regions of BJT Operation

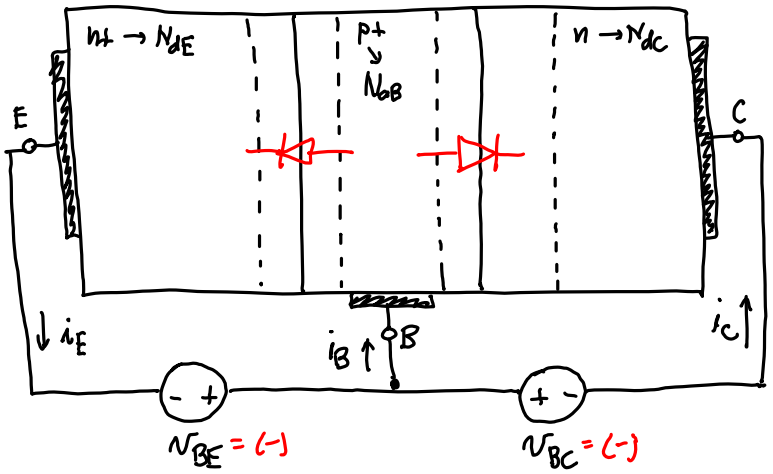
F ← forward bias, R ← reverse bias

EBJ	CBJ	Mode
R	R	Cutoff (both diodes off)
F	R	Forward Active (widely used in analog amplifiers)
R	F	Reverse Active
F	F	Saturation

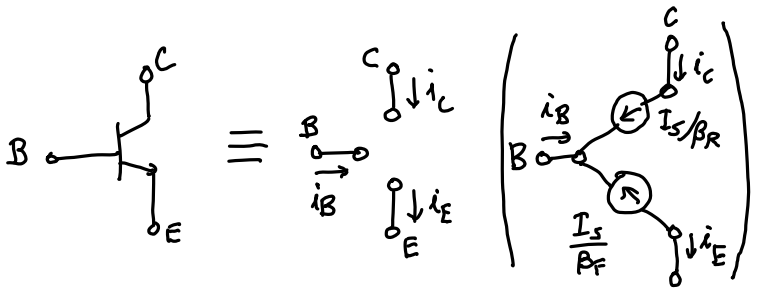
⇒ Or graphically:



① Cutoff Region: (npn transistor)



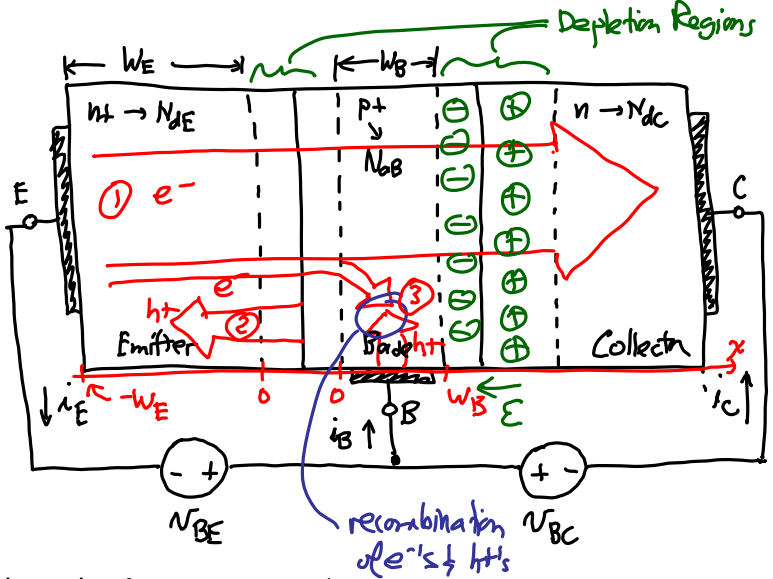
⇒ Both diodes reverse-biased
↳ No current flows.
$i_B = 0,\ i_C = 0,\ i_E = 0$



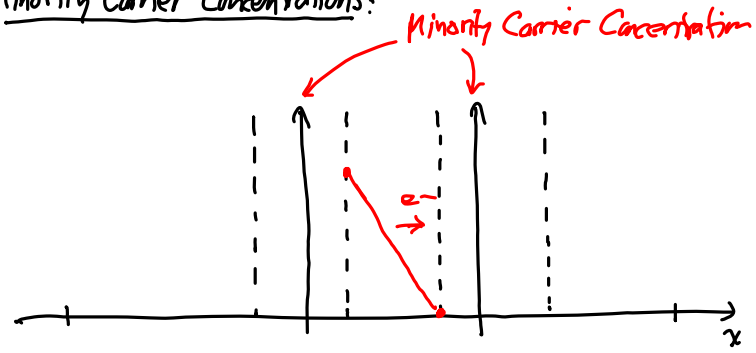
② Forward-Active Region: (npn transistor)

BEJ forward-biased (i.e., diode on)

BCJ reverse-biased (i.e., diode off)



Minority Carrier Concentrations:



BEJ Forward-Biased:

⇒ get diffusion current as in diode

⇒ forward-biasing of a BJT → three current components:

① e^-'s injected from emitter to base:

$$I_{nB} = -A J_{nB}^{diff}$$

② h^+s injected from base to emitter:

$$I_{pE} = -A J_{pE}^{diff}$$

③ recombination of e^-'s & h^+'s in the base

$$I_{rB} \propto \exp\left(\frac{V_{BE}}{V_T}\right)$$

$i_C = I_{nB} = ①$

$i_E = I_{nB} + I_{pE} + I_{rB} = ① + ② + ③$

$i_B = I_{pE} + I_{rB} = ② + ③$