E151 Lecture 6 – BJTs in Circuits & PNP

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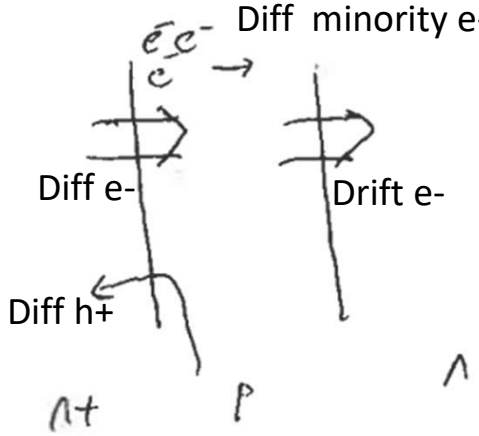
ENGR151

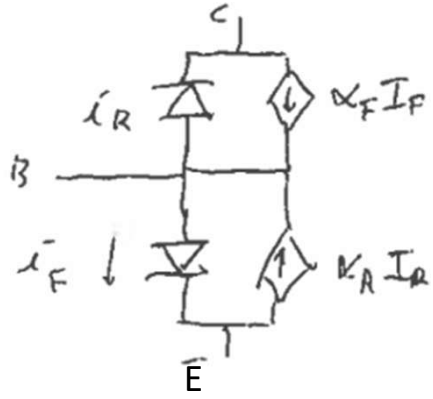
Disclaimer

These are note for Prof. Spencer to give the lecture, they were not intended as a reference for students. Students asked for them anyway, so I'm putting them up as a courtesy. Remember that they are not intended as a substitute for lecture.

Introduced BJTs Last Time

- Like two diodes, but short base region steals current sometimes
- Started with device picture → Ebers-Moll (computer) model
- Now, go from Ebers-Moll to useful models:
  - Picture
  - Equivalent circuits
  - Small signal models





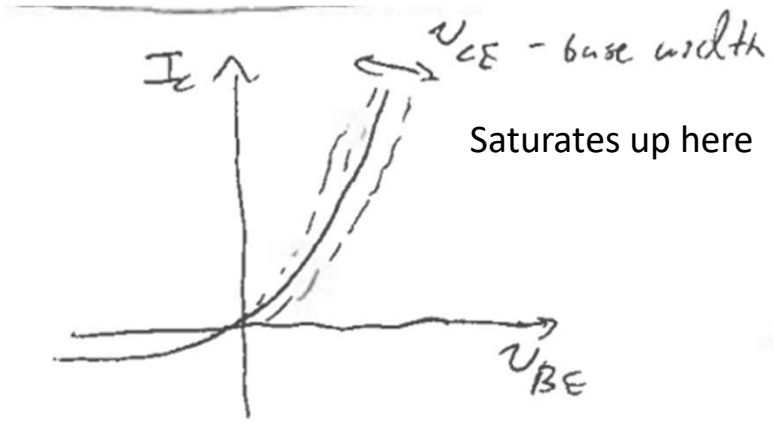
$$I_C = I_S\left(e^{v_{BC}/\phi_{TH}} - 1\right) - \frac{I_S}{\alpha_R}\left(e^{v_{BC}/\phi_{TH}} - 1\right)$$

$$I_E = I_S\left(e^{v_{BC}/\phi_{TH}} - 1\right) - \frac{I_S}{\alpha_F}\left(e^{v_{BE}/\phi_{TH}} - 1\right)$$

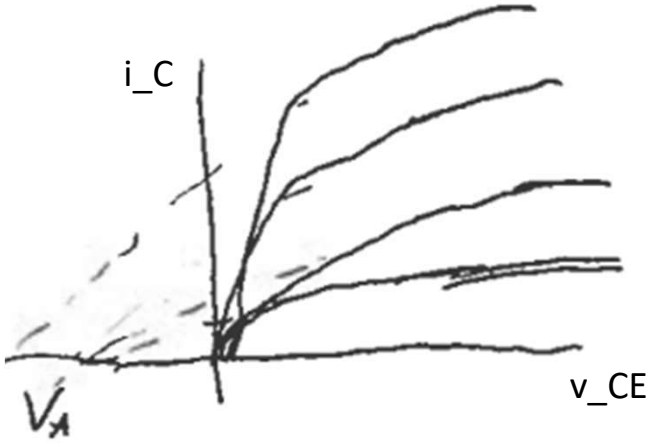
Note: I_ES = alpha*I_CS, simplify to onè I_S

Pictures – iC-vBE, iC-vCE

- Two different ways to look at things
- Omitting breakdown on these graphs
- i_B-v_BE is identical to i_C-v_BE



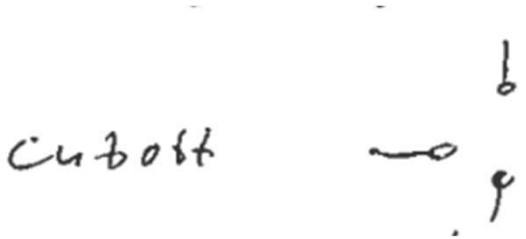
Saturates up here

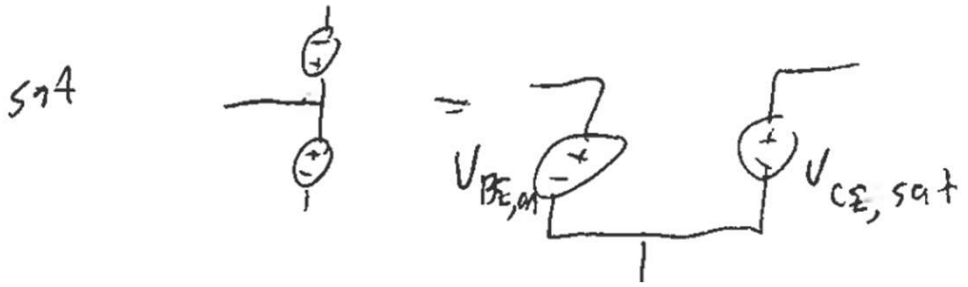


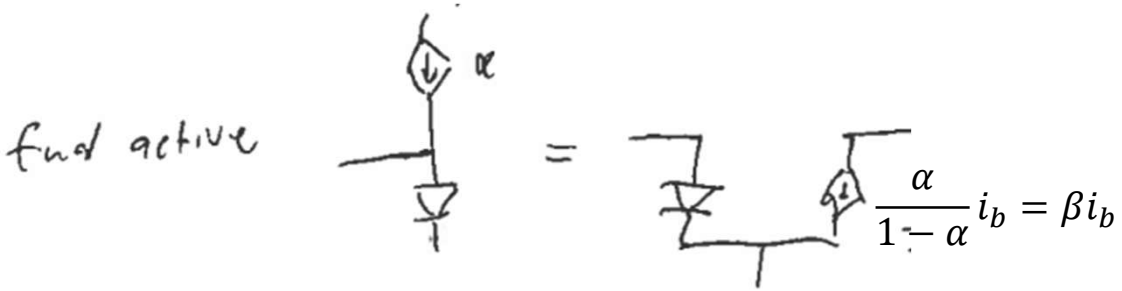
– don't forget base modulation – V_A

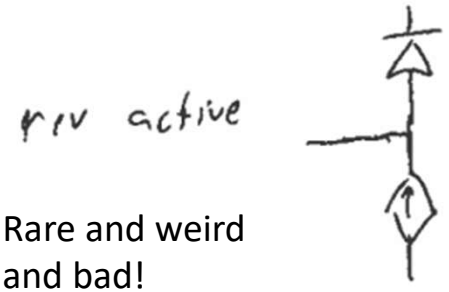
Circuit Models in Regions of Operation

- Specify each region in terms of BE jn on/off and BE jn on/off
- Link to what is on in Ebers-Moll, clarify hitting V_CE,SAT → saturated









Rare and weird and bad!

Exercise: finding regions of operation

- Basically a CE configuration w/ impractical bias
  - E=0V,
  - B=100k+V_B,
  - C= 1k+V_C,
  - beta=100,
  - V_CESAT=0.1V,
  - VBE_ON=0.7V
- Find IC if V_B = {0.6V, 3.2V, 5.7V} and V_C = 5V
- Possible to saturate yourself!