

E151 Lecture 7

Common Emitter Amplifier and Biasing BJTs

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Disclaimer

These are notes 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 attending lecture.

Small Signal Derivation

- Graphical, Ebers-Moll Equation Based, Diode argument, i_c linear i_b !

) small signal model review in FAR

Don't forget to show $g_m \cdot r_p = \beta$

$i_c = \beta i_b$
 $i_e = i_c + i_b$
 $i_b = I_{ES} (e^{v_{BE}/\phi_{th}} - 1)$ ← on i_b → function of v_{BE}
 $i_c = \beta I_{ES} (e^{v_{BE}/\phi_{th}} - 1) (1 + \frac{v_{CE}}{V_A})$ ← $\frac{\partial i_c}{\partial v_{BE}} = \frac{I_C}{\phi_{th}} \approx g_m$
 we've been ignoring V_A in calc, but slowing on large signal plots
 $\frac{\partial i_c}{\partial v_{BE}} = \frac{I_C}{V_A}$ ← conductance
 $r_o = \frac{V_A}{I_C}$

conductance, $g_m = \frac{\phi_{th}}{I_B} \approx \frac{\beta}{g_m}$
 $\frac{\partial i_b}{\partial v_{BE}} = \frac{I_B}{\phi_{th}}$

What About PNP? Large signal negative

- Backwards from NPN, diodes point IN! (care w/ i direction)
- Region of operation table to emphasize
- Small signal is identical by diode/graphical argument

PNP $-I_E$, $+I_B$, $+I_C$
 BE BC
 off off cut-off
 fwd off FAR
 off fwd RAR
 fwd fwd SAT
 -Again, same as NPN but upside down
 -Same! Good small signal model

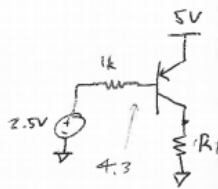
PNP Exercise for Class

- Have them work example

— Recall that I find this all confusing. Just think of PNP

(in a circuit (or as junctions))

You guys



① — Find I_c

— For PNP, if we have emitter to supply & recall stuff turns on below supply it makes sense

$$V_R = 1.8V \rightarrow I_b = 1.8mA \rightarrow I_c = 90mA \quad (V_{CE} = 0.2V)$$

$$|V_{BE,ON}| = 0.7V$$

② — What is max R_1 before we enter SAT? $V_{CE,SAT} = 0.1V$

$$V_{CE} = 5V - 90mA \cdot R_1 \quad V_C = 90mA \cdot R_1 \text{ can't be } < 4.9V$$

$$R_1 < \sim 55\Omega$$