

E151 Lecture 9 – Common Emitter with Degeneration

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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.

CE with Degen

- Issue: $V_{SW} \leftrightarrow a_v$ and $r_{in}(V_{SW} \text{ or } A_V) \leftrightarrow r_{out}$

$$V_{OMAX} - V_O = I_C R_C$$

$$A_V = g_m R_C = V_{SW} / \phi_{th}$$

$$r_{in} = r_{\pi} = \frac{I_C}{\beta \phi_{th}} \quad \text{Pins } I_C \text{ value}$$

- Issue for another day ... really hard to get small r_{out}
- Can get overconstrained designs, so we need other amplifier types

Trick #1 - Leverage the midband

- works dc, trickier high pass

Just throws away swing

Trick #2 - Emitter degeneration

no cap!

same large signal that we're used to

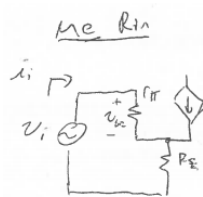
- crazy new small signal

- ignoring to for now, you'll add it back in on your HW

Trick #3: Active loads!

CE with Degen

- Find r_{in} , r_{out} , a_v



- Note $V_{in} \neq V_{be}$

- leads to feedback (could do fun (or stupid))

$$V_{be} = i_i r_{\pi}$$

$$V_E = (g_m r_{\pi} i_i + i_i) R_E$$

$$V_i = V_E + V_{be} = i_i (r_{\pi} + R_E + \beta R_E)$$

really big!

You Try A_v

$$V_{be} = r_{\pi} v_i / R_{in}$$

$$V_o = -g_m (r_{\pi} v_i / R_{in}) R_L$$

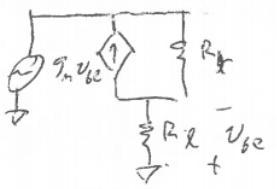
$$= \frac{-g_m r_{\pi} R_L}{r_{\pi} + R_E + \beta R_E} v_i$$

$$A_v = \frac{-\beta R_L}{r_{\pi} + (\beta + 1) R_E} \approx -\frac{R_L}{R_E}$$

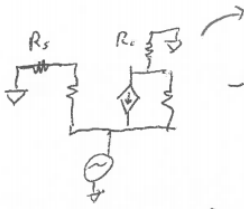
- $r_{out} = R_L$ if r_o presumed infinite, you will do more on your HW

Small Signal Patterns

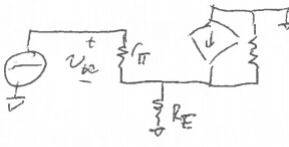
- We've just seen two common small signal models that are used a lot
- Here are more, can analyze fast if you understand / memorize
 - Thevenize aggressively, can remove from circuit
- Watch for variations: dividers to vbe, parallel stuff, ro, care w/ signs.



$$R_{in} = R_L \parallel R_T + g_m R_L R_T$$



$$R_{in} = r_{\pi} \parallel \frac{1}{g_m} + \frac{R_C}{\beta} + \frac{R_S}{\beta}$$



You try

$$R_{in} = R_C (\beta + 1) + r_{\pi}$$

These are Rth and not rin