

E151 Lecture 9 – Common Emitter with Degeneration

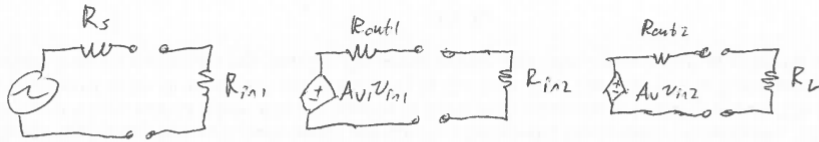
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Disclaimer

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.

Multistage Picture and 2 Ports

- Large signal notes: separate bias points with AC coupling
- $r_{in_tot} = r_{in_1}$, $r_{out_tot} = r_{out_3}$,
- $V_{SW,tot} = \min VSW \leftarrow$ Use FFT/THD to tell if you violate VSW



- Capture interstage loading w/ voltage div b/w R_{in} & R_{out} !

$$A_{V,tot} = A_{V1} A_{V2} \frac{R_{in1}}{R_{in1} + R_{s}} \cdot \frac{R_{in2}}{R_{out1} + R_{in2}} \cdot \frac{R_L}{R_{out2} + R_L}$$

- R_L & R_S represent rest of world

CE with Degen

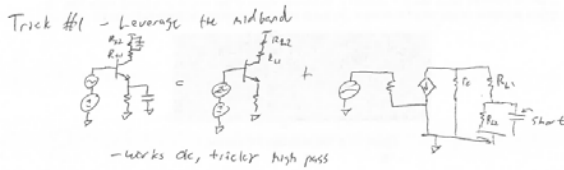
- Issue: $V_{SW} \leftrightarrow a_v$ and $r_{in} + (V_{SW} \text{ or } A_V) \leftrightarrow r_{out}$

$$V_{O,MAX} - V_O = I_C R_C$$

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

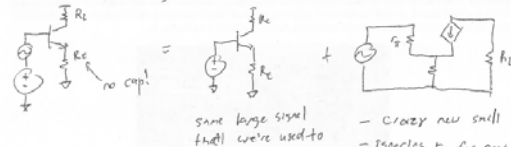
$$r_{in} = r_{\pi} = \frac{I_C}{\beta \phi_{th}} \quad \text{Pins } I_C \text{ value}$$

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



Just throws away swing

Trick #2 - Emitter degeneration

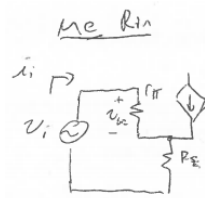


- crazy new small signal
- ignoring r_o for now, you'll add it back in anyway tho

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 fin (or shunt))

$$v_{be} = i_i \cdot r_{\pi}$$

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

$$v_i = v_E + v_{be} = i_i (r_{\pi} + R_E + \beta R_E)$$

really big!

You Try Av

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

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

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

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

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