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: $V_{SW} \leftrightarrow av$ and $\text{rin+}(V_{SW} \text{ or } A_V) \leftrightarrow rout$

  \[
  V_{OMAX} - V_O = I_C R_C \\
  A_V = g_m R_C = V_{SW} / \phi_{th}
  \]

  \[
  r_{in} = r_{\pi} = \frac{I_C}{\beta \phi_{th}}
  \]

  Pins ic value

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

Trick #3: Active loads!

Just throws away swing

CE with Degen

- Find rin, rout, av

\[
\begin{align*}
  V_{be} &= \frac{V_{1} - \frac{\beta}{\beta + 1}}{r_\pi + R_{E} + \beta R_{E}} \\
  V_{be} &= \frac{V_{1} - \frac{\beta}{\beta + 1}}{r_\pi + R_{E} + \beta R_{E}}
\end{align*}
\]

\[
A_v = \frac{\frac{\beta R_{E}}{R_{E} + (\beta + 1) R_{E}}}{r_\pi + R_{E}}
\]

- rout = $R_L$ if ro 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.

\[
R_{in} = R_{1} \cdot R_{2} + R_{3} \cdot R_{4} + R_{5}
\]

\[
R_{in} = \frac{R_{1} \cdot R_{2} \cdot R_{3} \cdot R_{4}}{R_{5}}
\]

These are Rth and not rin