E151 Lecture 10 – Emitter Follower and Multistage

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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 Patterns – repeat just in case

• 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.

Emitter Follower (Common Collector)

• We don’t yet have the ability to generate a small rout
• Need a new amplifier topology. I do rin, they do av, I do rout
• rin follows same patterns as CE w/ degen, rout is a new pattern (1/gm)
rin

• Same pattern as CE with degen

\[ V_{be} = I_b \frac{r_i}{r_{bb}} \]
\[ I_c = \frac{V_{ce}}{r_e} + \frac{V_{ce}}{r} - 2 \times V_{ce} \]
\[ = V_{ce} \left( \frac{1}{r_e} + \frac{1}{r} \right) - 2 \times V_{ce} \]
\[ I_c (\beta+1) = \frac{V_{be}}{r_{eb} R_0} \]
\[ V_{be} = \frac{I_c (\beta+1) r_{eb} R_0}{\beta R_b} \]
\[ R_{in} = \frac{r_i (\beta+1) r_{eb} R_0}{\beta R_b} \]

Exercise: you find \( av \)

• Gain of 1 isn’t very high, level shift is nice interpretation

\[ v_o = u_v (\beta+1) (R_{eb} || r_o) \text{ from above} \]
\[ A_v = \frac{(\beta+1) (R_{eb} || r_o)}{r_i + (\beta+1) (R_{eb} || r_o)} \]
\[ \rightarrow A_v = 1 \]

Let’s look at large signal to check this

- Gain is 1 late shifted down
- Use to set DC voltages right
- \( V_{be} \) steps \(-0.7\) small and captures changes
rout – a new small signal pattern (1/gm)

- Need to include Rs b/c not pure 1 directional
- Breaks our 2 port model a bit

Multistage Picture and 2 Ports

- Large signal notes: separate bias points with AC coupling
- rin_tot = rin_1, rout_tot = rout_3,
- V_SW,tot = min VSW \leftarrow Need to use FFT to tell if you violate VSW