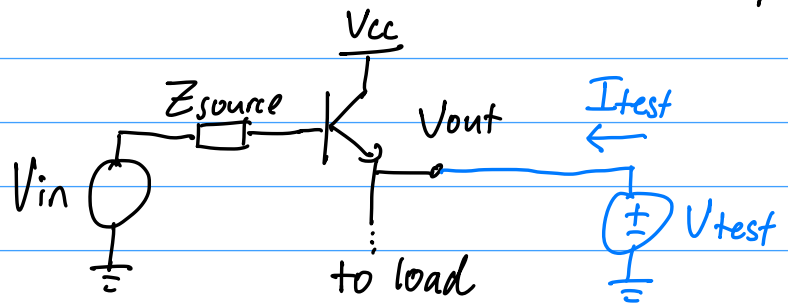
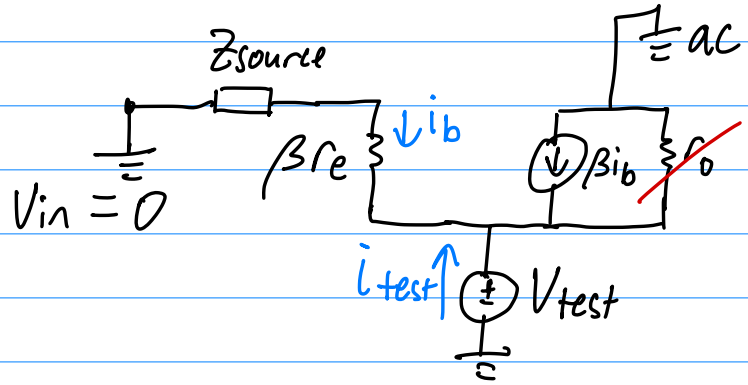
AoE Ex 2.4

Consider the follower and prove $Z_{out} \approx \frac{Z_{source}}{\beta+1}$



Draw the small signal model. Use current version since the statement we're proving uses β.



$$r_e = \frac{1}{g_m} = \frac{V_T}{I_C}$$
$$r_o = \frac{V_A}{I_C}$$

Neglect the Early effect $\therefore r_o \to \infty$

Analyse the circuit.

$$i_b = \frac{-V_{test}}{Z_{source} + \beta r_e}$$

$$i_{test} = -i_B - \beta i_B = -(1+\beta) i_B = \frac{(1+\beta) V_{test}}{Z_{source} + \beta r_e}$$

$$\therefore Z_{out} = \frac{V_{test}}{i_{test}} = \frac{Z_{source} + \beta r_e}{1+\beta} \approx \frac{Z_{source}}{1+\beta}$$

Note: neglecting the second term is arguable but notice r_e is small. Example: $I_C = 1\,mA \Rightarrow r_e = 26\,\Omega$. It's a nice approximation to see the impedance transforming property of a follower.