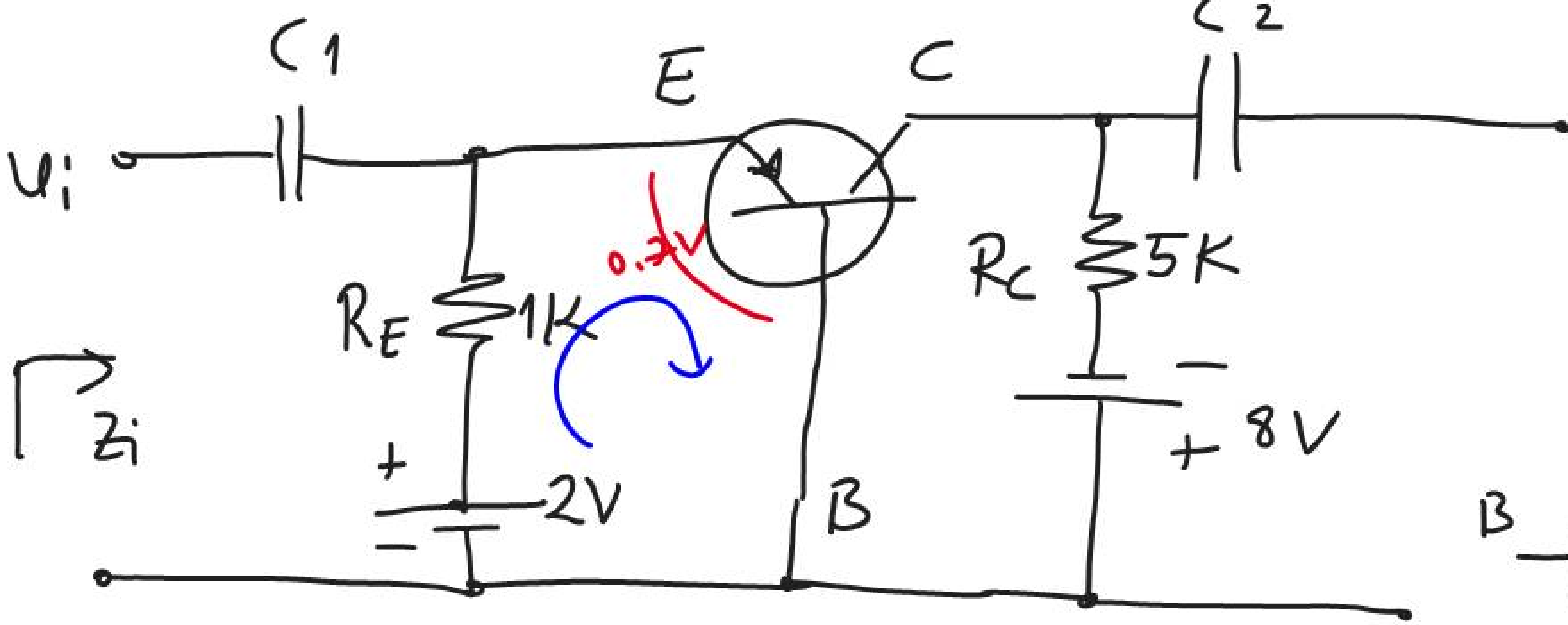
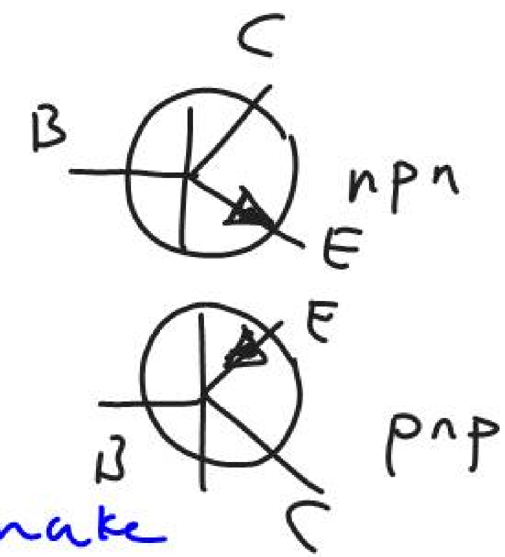
Common-Base Configuration

21.05.2011 ©





$\alpha = 0.98$

$$\alpha = \frac{I_C}{I_E} = \frac{I_C}{I_B} \cdot \frac{I_B}{I_E} = \beta \cdot \frac{1}{\beta+1} = \frac{\beta}{\beta+1}$$

$$I_E = I_B + I_C$$

$$\beta = \frac{I_C}{I_B}$$

a) to find re we make DC analysis:

input KVL:

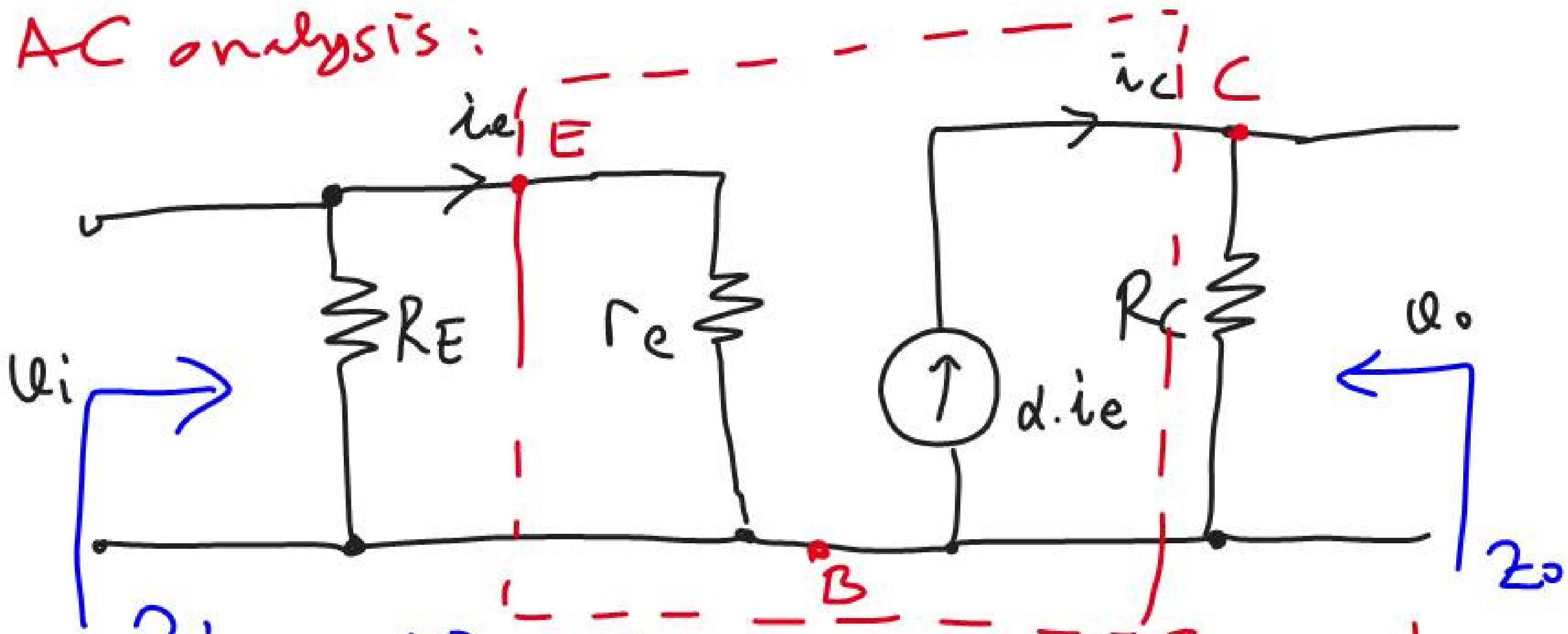
$$2V - I_E \cdot R_E - V_{EB} = 0$$

$$I_E = \frac{2-0.7}{1K} = \frac{1.3}{10^3}$$

$$I_E = 1.3\,mA$$

$$r_e = \frac{26 \times 10^{-3}}{1.3 \times 10^{-3}} = 20\,\Omega$$

AC analysis:



$Z_o \approx R_C$

$i_c = \alpha \cdot i_e$

$\alpha = \frac{i_c}{i_e}$

$Z_i = r_e // R_E \approx r_e$

Common-base transistor small signal equivalent circuit.

$v_o = i_c \cdot R_C$

$v_i = i_e \cdot r_e$

$v_i \cong i_c \cdot r_e \Rightarrow i_c \cong \frac{v_i}{r_e}$

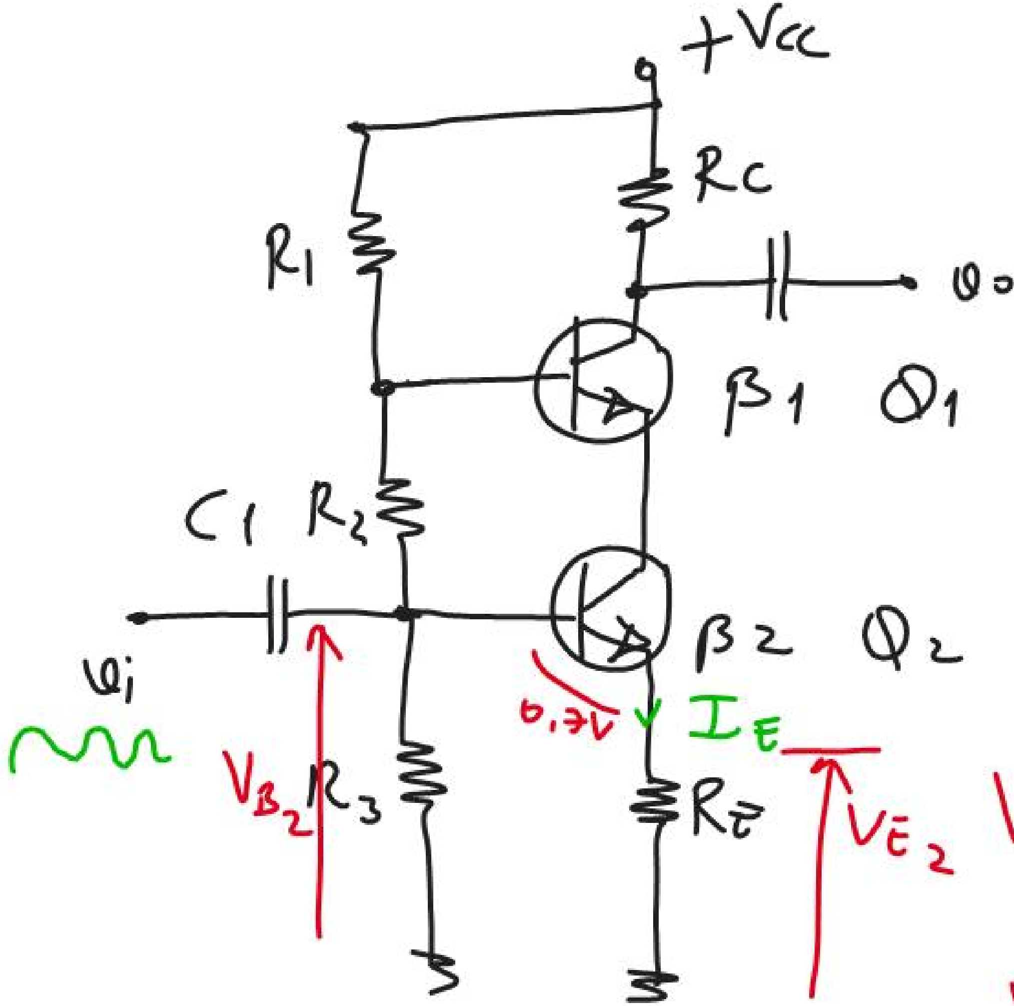
$v_o \cong \frac{v_i}{r_e} \cdot R_C \Longrightarrow$ $\boxed{A_v = \frac{v_o}{v_i} = \frac{R_C}{r_e}}$

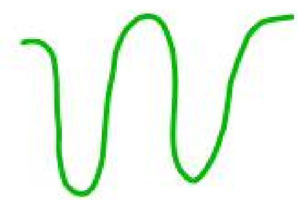
↑ 0° phase shift in voltage gain!

$A_v \cong \frac{5 \times 10^3}{20} = \frac{50 \times 10^2}{20}$

$A_v \cong 250$

ex Cascode Configuration





$$A_v = \frac{v_o}{v_i}$$

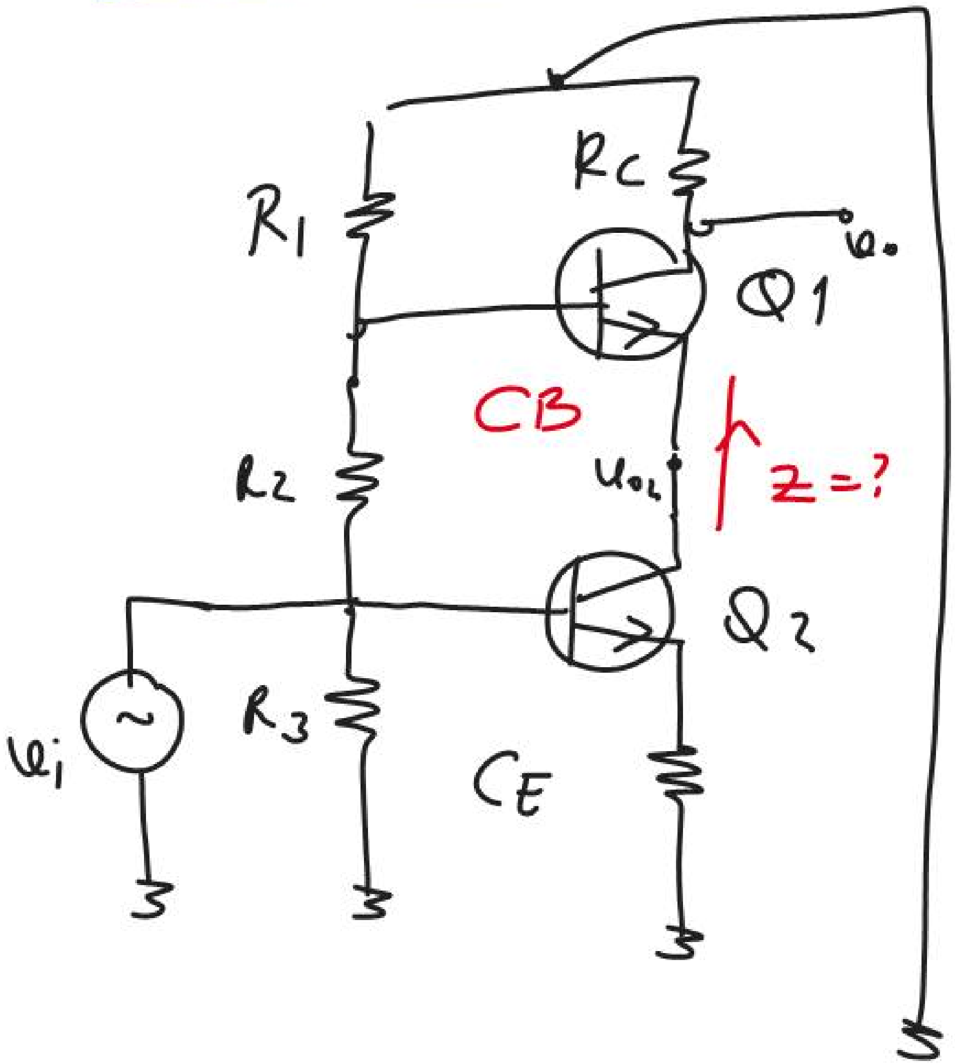
DC analysis:

$$V_{B2} \cong \frac{V_{CC}}{R_1+R_2+R_3} \cdot R_3$$

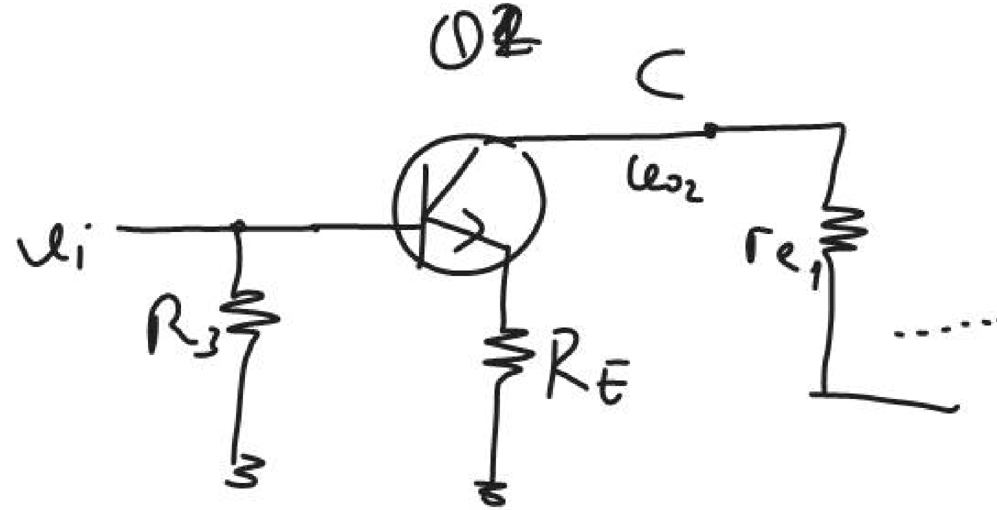
$$V_{B2} - 0{,}7V = V_{E2}$$

$$I_E = \frac{V_{E2}}{R_E} \qquad r_e = \frac{V_T}{I_E} \checkmark$$

AC Analysis:



Q2



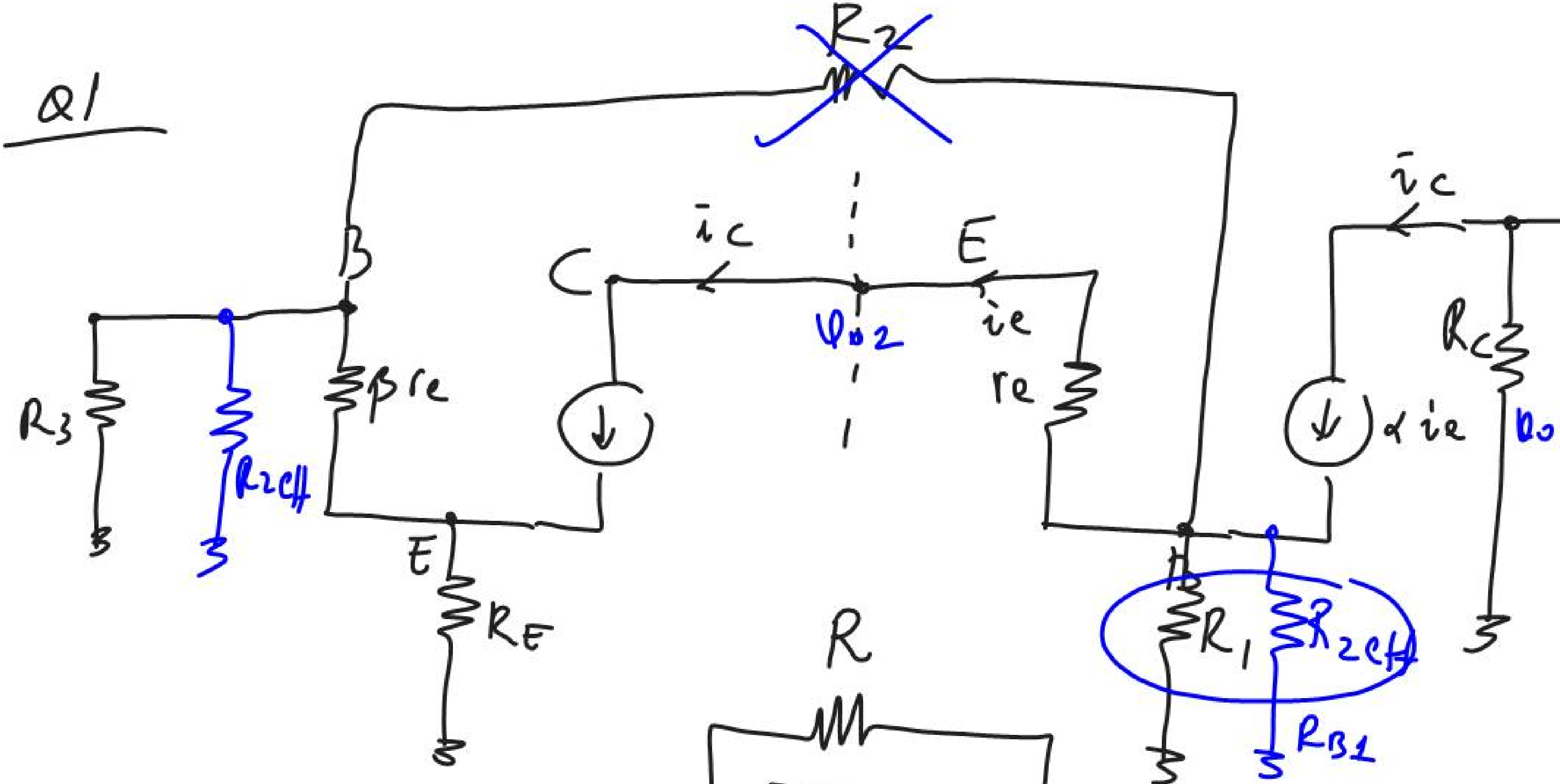
CE with R_E (not bypassed)

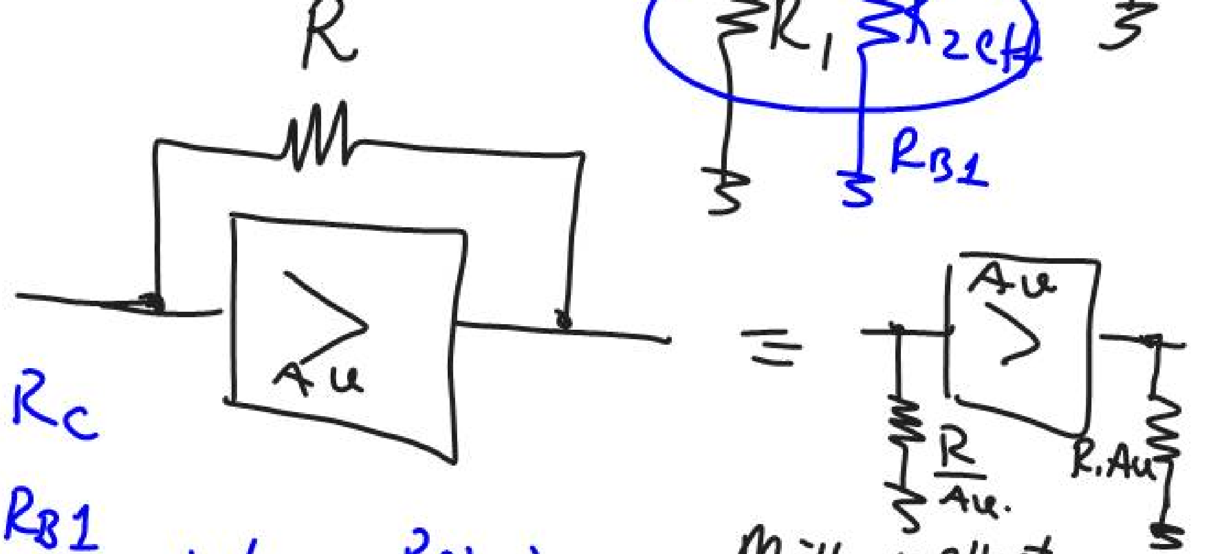
$$A_v = -\frac{R_C}{r_e + R_E} = -\frac{(r_{e1})}{r_{e2} + R_E} = -\frac{r_e}{r_e + R_E}$$

$$I_{E_1} = I_{E_2} = I_E \Rightarrow r_{e1} = r_{e2} = r_e$$

$$\boxed{\frac{v_{o2}}{v_i} = -\frac{r_e}{r_e + R_E}}$$

Q1





Miller's effect

$$v_o = -i_c \cdot R_c \cong -i_e \cdot R_c$$

$$v_{o2} = -i_e \cdot r_e - i_b \cdot R_{B1}$$

$$= -i_e \cdot r_e - \frac{i_e}{\beta+1} \cdot R_{B1} = -i_e\left(r_e + \frac{R_{B1}}{\beta+1}\right)$$

$$i_e = -v_{o2} \Big/ \left(r_e + \frac{R_{B1}}{\beta+1}\right)$$

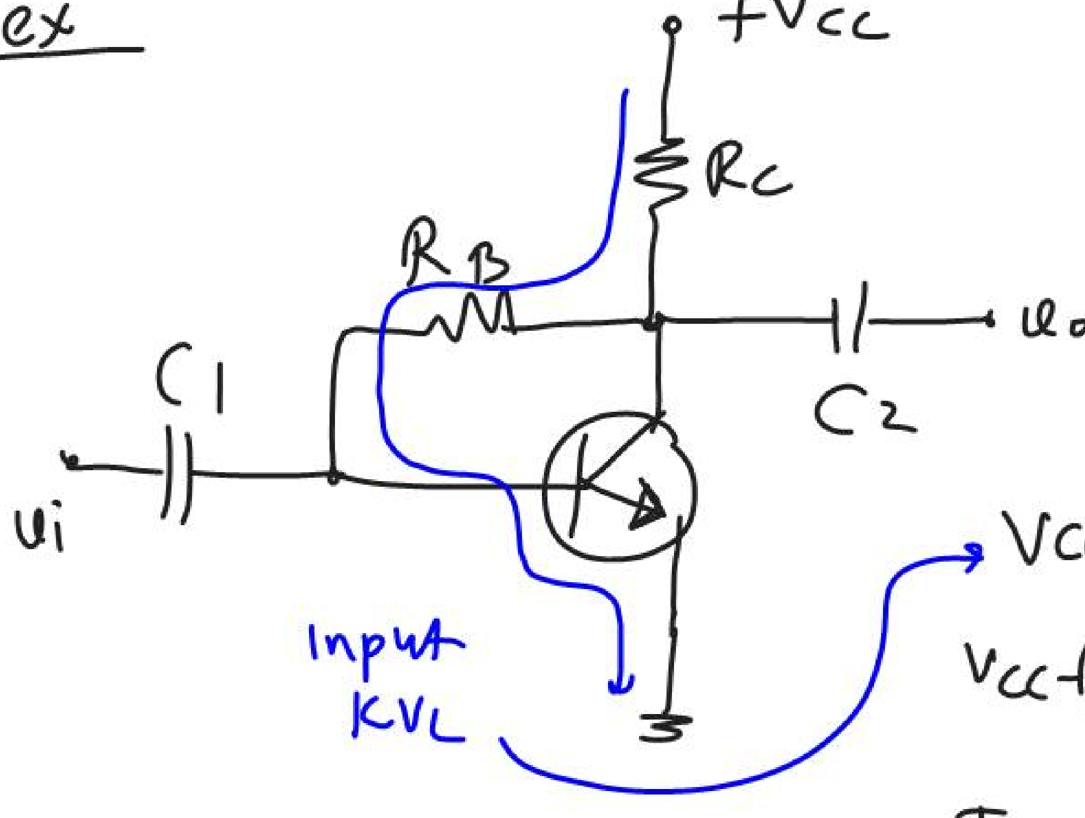
$$\frac{u_o}{u_{o2}} = \frac{R_C}{r_e + \frac{R_{B1}}{\beta+1}} \rightarrow u_o = + \frac{R_C}{r_e + \frac{R_{B1}}{\beta+1}} \cdot u_{o2}$$

$$u_{o2} = - \frac{r_e}{r_e + R_E} \cdot u_i$$

$$u_o = + \frac{R_C}{r_e + \frac{R_{B1}}{\beta+1}} \cdot \left(- \frac{r_e}{r_e + R_E} \right) u_i$$

$$A_{uT} = \frac{u_o}{u_i} = - \frac{R_C \cdot r_e}{\left(r_e + \frac{R_{B1}}{\beta+1} \right) \left(r_e + R_E \right)}$$

ex



Common-emitter

DC analysis

$$V_{CC} - I_E R_C - I_B \cdot R_B - V_{BE} = 0$$

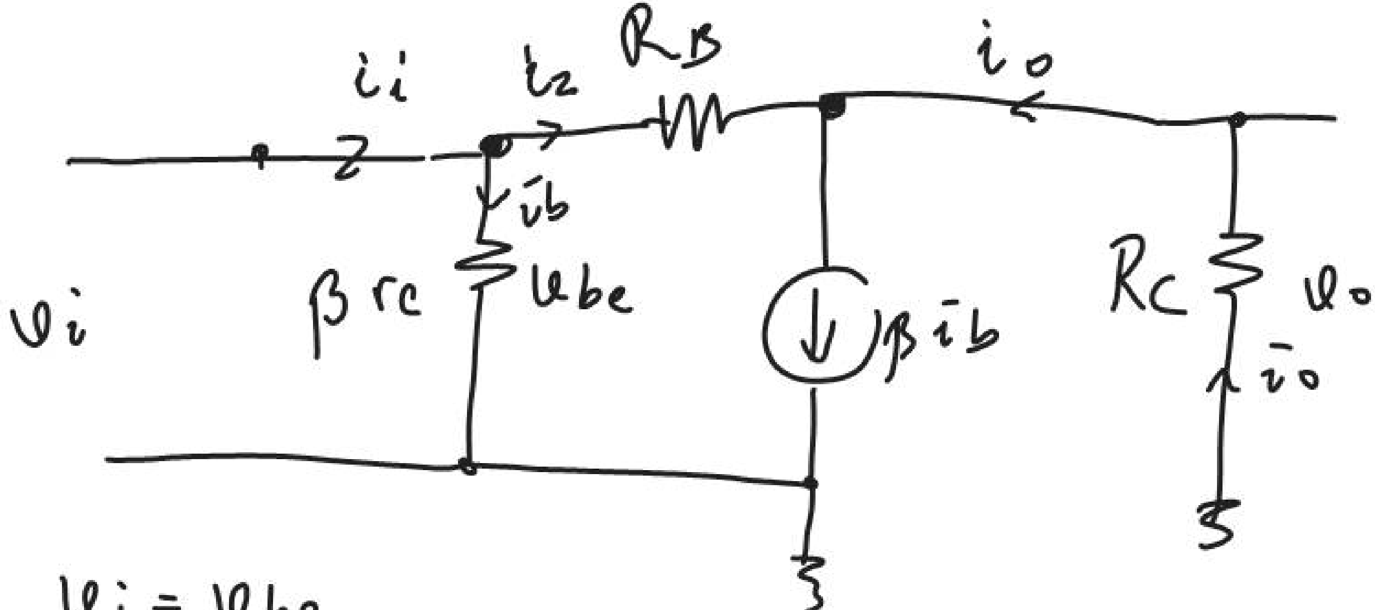
$$V_{CC} - (\beta+1) \cdot I_B R_C - I_B R_B - V_{BE} = 0$$

$$I_B = \frac{V_{CC} - V_{BE}}{R_B + (\beta+1) \cdot R_C}$$

$$I_E = (\beta+1) I_B$$

$$r_e = \frac{V_T}{I_E}$$

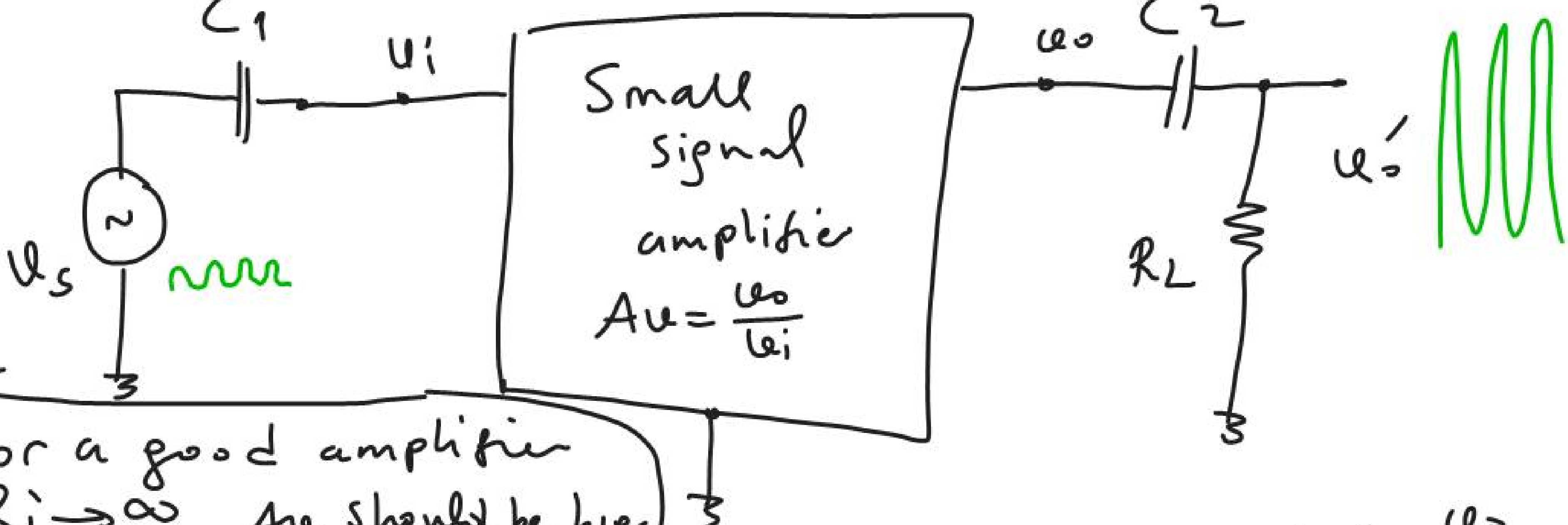
A C analysis



$r_o >> R_C$

$v_i = v_{be}$

Calculate Z_i, Z_o, and $A_v = \frac{v_o}{v_i}$

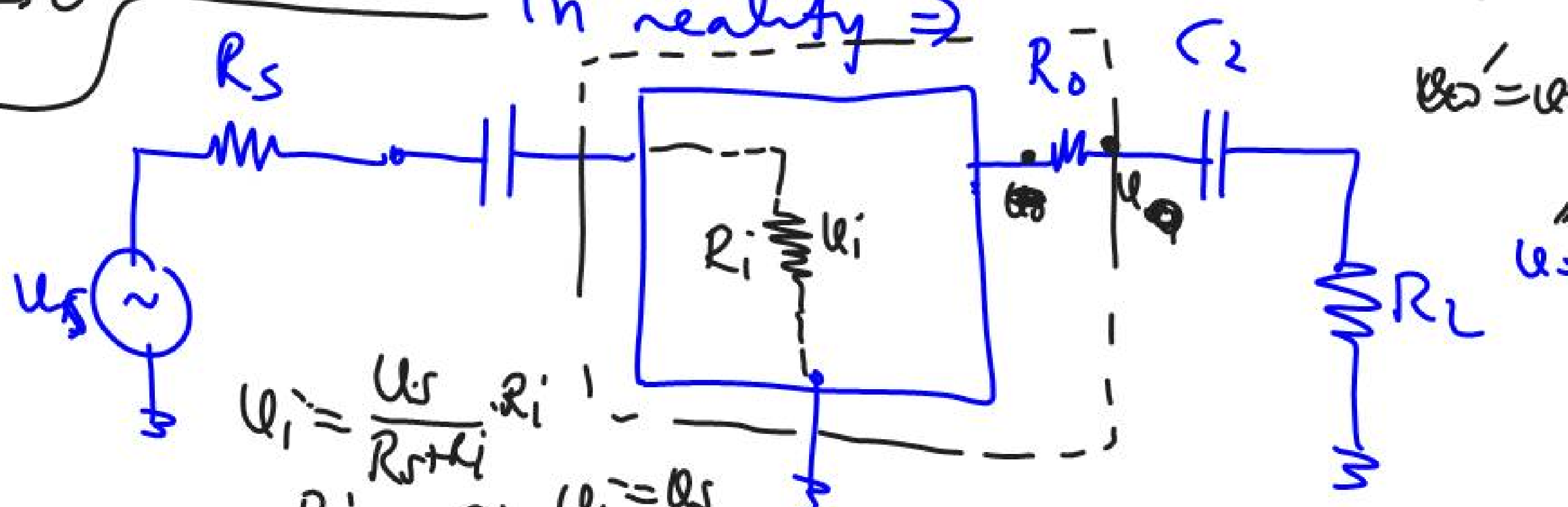


* For a good amplifier

$R_i \to \infty$ A_v should be big.

$R_o \to 0$

In reality ⇒



$$u_o' = \frac{u_o}{R_o+R_L}\cdot R_L$$

$$u_o' = u_o \Rightarrow R_o \to 0$$

$$u_i = \frac{u_s}{R_s+R_i}\cdot R_i$$

$R_i \to \infty$ $u_i = u_s$