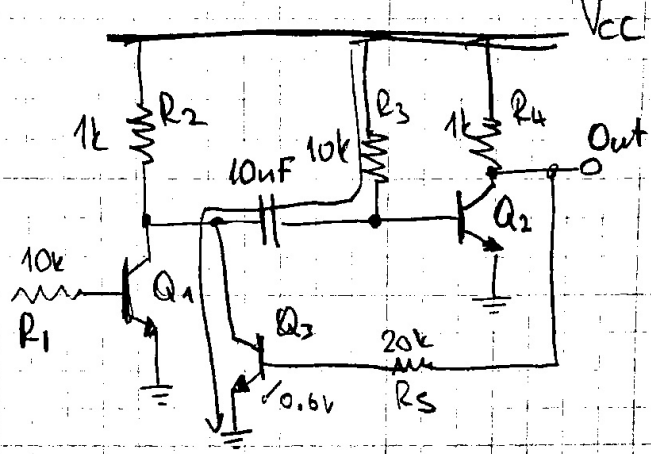
Ex 2.3



- Output reduced due to R_4-R_S voltage divider:

$$V_{out,max} = \frac{R_S}{R_4+R_S}(V_{CC} - 0.6) \approx 0{,}95(V_{CC}-0{,}6)$$
$$= 4{,}18V$$

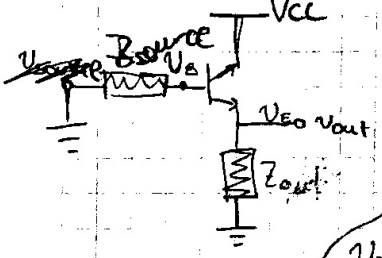
- min β_3 to ensure saturation?

We need at least 0,5mA for I_{C_3} (due to $\frac{V_{CC}-0.6}{R_3 \| R_2}$) $\Rightarrow \frac{I_{C\,min}}{I_B}$

$$= \frac{0{,}5mA}{(0{,}95V_{CC}-0.6V)/R_S} = \frac{0{,}5mA}{0{,}2075mA} = 2{,}75 \text{ (correct?)}$$

$\Rightarrow \beta_3 > 2{,}75$ for saturation

Ex 2.4



$$Z_{out} = \frac{v_E}{i_E} = \frac{v_B}{i_E}$$

(Bonus)

$$i_E = \frac{v_E}{Z_{out}} \qquad i_E = i_B + i_C \qquad Z_{in} = ? = \frac{v_B}{i_B}$$

$$v_E = v_B \qquad i_C = h_{fe} \cdot i_B \Rightarrow \frac{v_B}{Z} = h_{fe} \cdot i_B$$

$$\Rightarrow i_E - i_B = h_{fe} \cdot i_B \Leftrightarrow i_E = (\beta+1) i_B$$

$$v_E = v_B \Leftrightarrow \frac{v_B}{Z} = (\beta+1) i_B \Leftrightarrow \frac{v_B}{i_B} = (\beta+1) \cdot Z \Rightarrow \boxed{Z_{in} = (\beta+1) Z}$$

$$i_E = i_C + i_B = (\beta+1) i_B = (\beta+1) \frac{v_B - v_{out}}{Z_{source}} \Rightarrow Z_{out} = \frac{v_B}{(\beta+1) \cdot \frac{v_B}{Z_{src}}} = \frac{Z_{source}}{\beta+1}$$

q.e.d