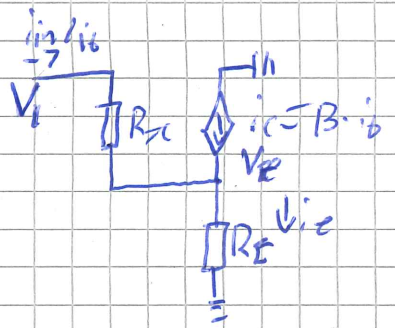
Den interne motstanden ~~inngangsmotstanden~~ er gitt som

$$R_{in} = \frac{V_i}{i_i} = \frac{V_1}{i_b}$$



Vi vet at $V_1 = V_{R\pi} + \cancel{V_E}\, V_e$

$V_{R\pi}$ er gitt som $V_{R\pi} = i_b \cdot R_\pi$

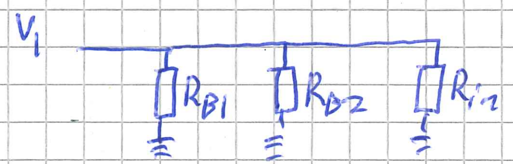
V_e er gitt som $V_e = i_e \cdot R_E$

$$= i_b(\beta+1)R_E$$

Som gir oss

$$R_{in} = \frac{V_1}{i_b} = \frac{\cancel{i_b}(R_\pi + (\beta+1)R_E)}{\cancel{i_b}} = R_\pi + (\beta+1)R_E$$

Vi tegner en modell for inngangen



Vi ser at den totale inngangsmotstanden R_i er

$$R_i = (R_{B1} \| R_{B2}) \| (R_\pi + (\beta+1)R_E)$$

Vi forenkler:

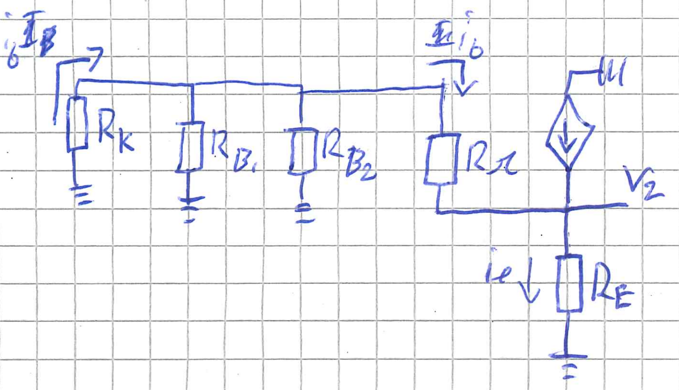
$\beta \gg 1$
$R_E\beta \gg R_\pi$

$$\Rightarrow R_i \approx \underline{\underline{R_{B1} \| R_{B2} \| R_E\beta}}$$

Krav:

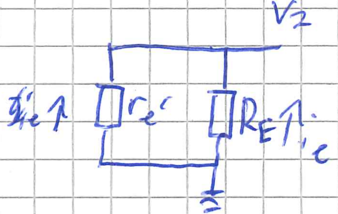
$\beta \gg 1$

$R_E\beta \gg R_\pi$



Vi ignorerer R_{B1} og R_{B2} siden $R_K \ll R_{B1} \wedge R_{B2}$ slik at $R_K \| R_{B1} \| R_{B2} \approx R_K$

Siden det går strøm dannes en reflektert motstand r_e' med strøm i_e igjennom seg



slik at $R_o = r_e' \| R_E$.

$$V_2 = V_{r_e'}$$
$$V_2 = i_e \cdot r_e'$$
$$V_2 = r_e' \cdot (\beta+1) i_b$$
$$\cancel{V_2} = r_e' \cdot (\beta+1) \cdot \frac{\cancel{V_2}}{R_K + R_\pi}$$
$$\Rightarrow \quad r_e' = \frac{R_K + R_\pi}{\beta+1}$$

$$i_e = (\beta+1) i_b$$
$$i_b = \frac{V_2}{R_K + R_\pi}$$

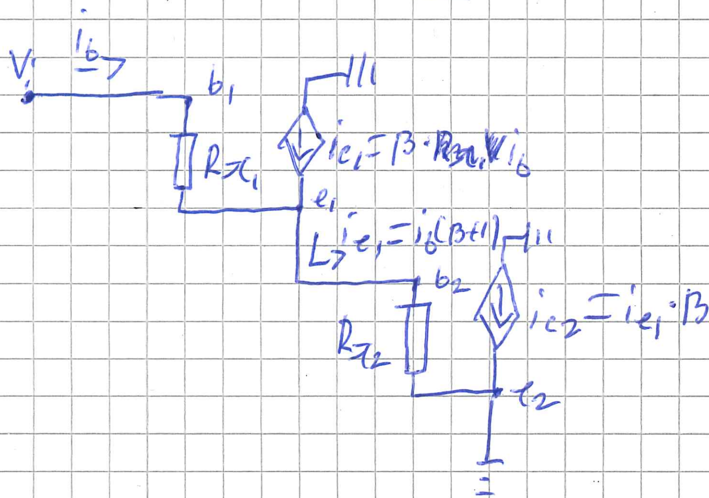
$$R_o = R_E \,\|\, \frac{R_K + R_\pi}{\beta+1}$$

Krav:

$R_K \ll R_{B_1} \wedge R_{B2}$

Håkon K. Mikalsen

Motstand ~~Rπ~~ $R_{D\pi}$ i



R_π i en transistor er definert som

$$R_\pi = \frac{V_{in}}{i_{in}} = \frac{V_i}{i_b}$$

V_i er summen av spenningene over $R_{\pi 1}$ og $R_{\pi 2}$ gitt ved $V_i = V_{be_1} + V_{be2}$.

V_{be1} er gitt ved $V_{be1} = i_b \cdot R_{\pi 1}$. dette gir $i_{e1} = \cancel{(\beta)\, i_b}$ $(\beta+1)\cdot i_b$ som går igjennom $R_{\pi 2}$. Dette gir at $V_{be2} = R_{\pi 2} \cdot i_{e1} = R_{\pi 2}(\beta+1)\cdot i_b$ V_i blir da:

$V_i = V_{be1} + V_{be2} = R_{\pi 1} \cdot i_b + R_{\pi 2}(\beta+1) i_b$. $R_{\pi 1} = R_{\pi 2} = R_\pi$ noe som gir $V_i = R_\pi \cdot i_b(\beta+2)$. Fra dette ser vi at

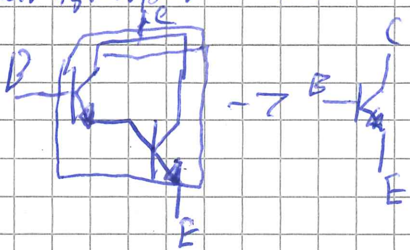
$$R_{D\pi} = \cancel{R_\pi i_b(\beta+2)} = \frac{V_i}{i_i} = \frac{V_i}{i_b} = \frac{R_\pi \cdot \cancel{i_b}(\beta+2)}{\cancel{i_b}} = R_\pi(\beta+2)$$

Siden $\beta >> 2$ så får vi

$$\underline{R_{D\pi} \approx R_\pi \cdot \beta}$$

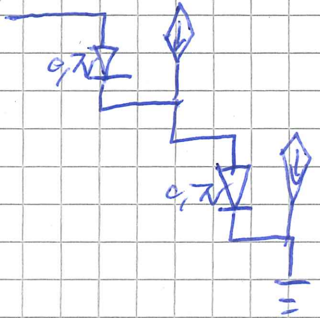
Håkon K. Mikalsen

Vi ønsker å forenkle et darlistorpar til modell med en transistor

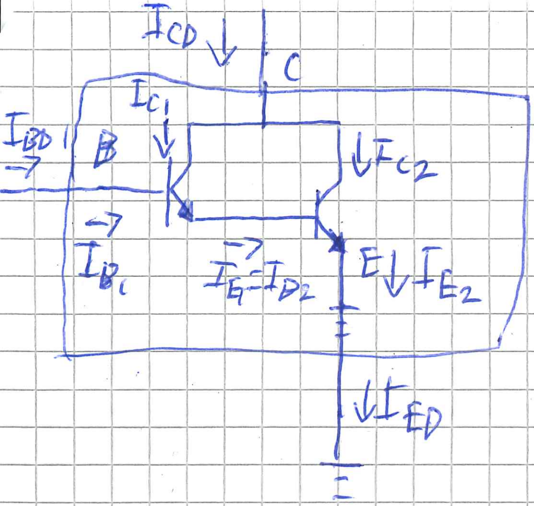


Spenningsfall:

Vi starter med spenningsfallet over base emitter



Fra en (stor) forenkling ser vi at spenningsfallet er ca. 1,4V gitt 0,7V spenningsfall per hver av transistorene



Forsterkning β_D:

$$\beta_D = \frac{I_{CD}}{I_{BD}} \qquad I_{BD} = I_{B1}$$

$$I_{CD} = I_{C1} + I_{C2}$$

$$I_{B2} = I_{E1} = (\beta+1) I_{B1}$$

$$I_{C1} = I_{B1} \cdot \beta$$

$$I_{C2} = I_{B2} \cdot \beta = (\beta+1) \cdot I_{B1} \cdot \beta$$

$$I_{CD} = I_{C1} + I_{C2} = I_{B1} \cdot \beta + I_{B1} \cdot \beta \cdot (\beta + 1)$$

$$\cancel{= I_{B1} 2\beta}$$

$$= I_{B1} \cdot \beta + I_{B1} \beta^2 + I_{B1} \cdot \beta$$

$$= I_{B1} (\beta^2 + 2\beta)$$

$$\beta_D = \frac{I_{CD}}{I_{BD}} = \frac{\cancel{I_{B1}}(\beta^2 + 2\beta)}{\cancel{I_{B1}}} = \beta^2 + 2\beta$$

siden $\beta^2 >> 2\beta$

$$\Rightarrow \underline{\underline{\beta_D \simeq \beta^2}}$$

Håken K. Mikalsen