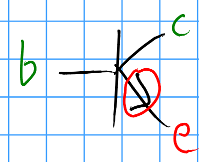
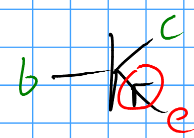
ST1-Tutorium Blatt 7, 15.12.09

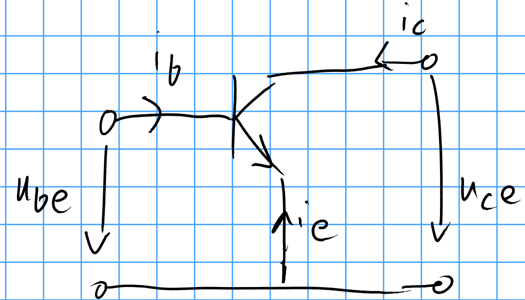
Bipolar-Transistoren: → npn-Typ



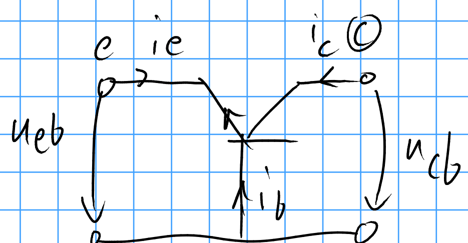
→ pnp-Typ



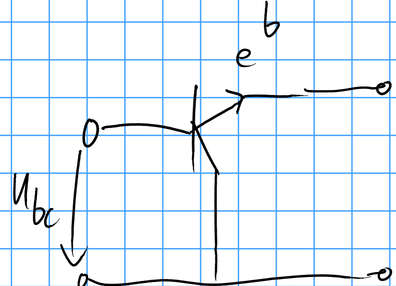
- Emitterschaltung:



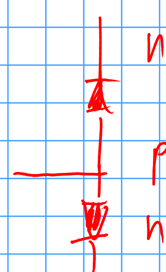
- Basisschaltung:



- Kollektorschaltung

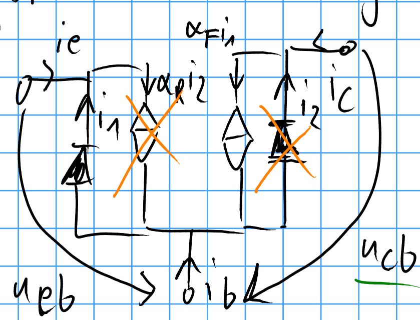


pn-Diode



Schaltungstechnischer Ausgangspunkt:

Ebers-Moll-Modell

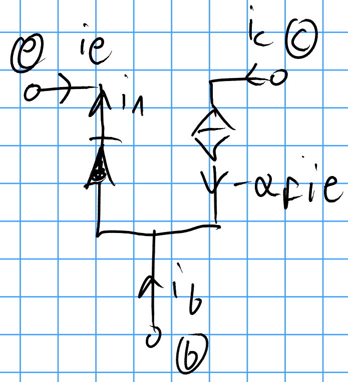


$i_2 = 0A$

Vorwärtsbetrieb: → Kollektorbasis-Diode sperrt: $u_{cb} \geq 0$

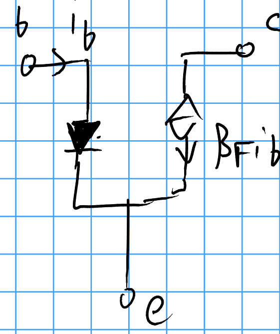
→ Basis-Emitter-Diode leitet: $u_{eb} < 0$ bzw. $u_{be} \geq 0$

=> neues ESB:



$i_1 = -i_e$

=>

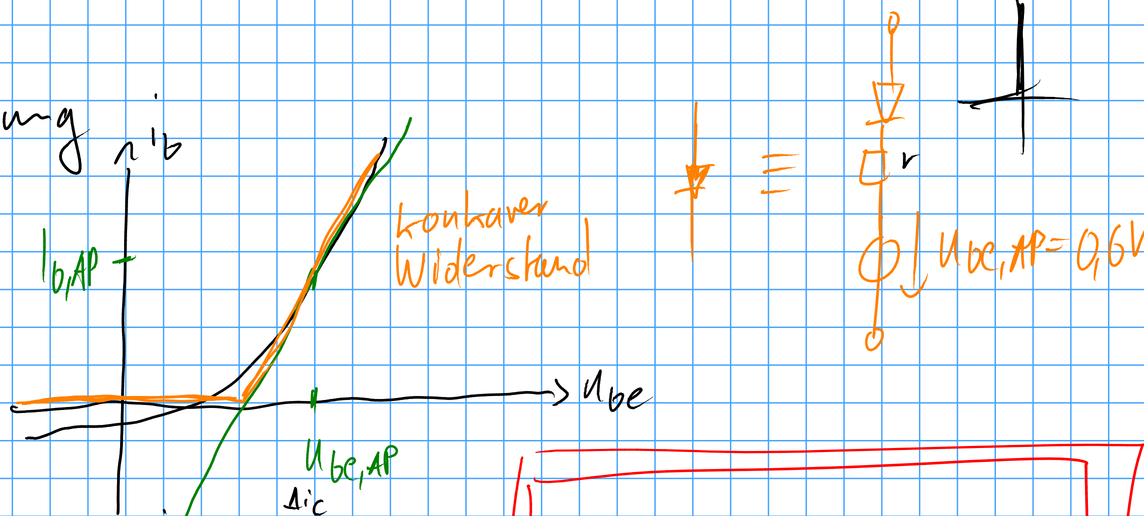


Emitter-schaltung

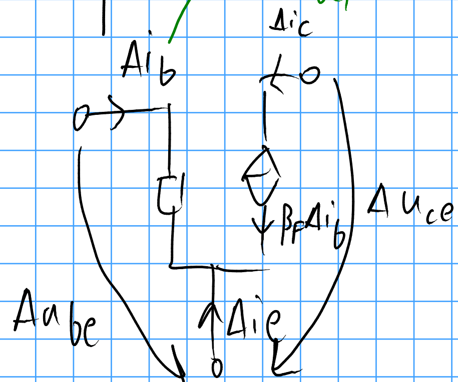
↳ Großsignal

-> Linearisierung

$$g = \frac{1}{r} = \frac{\partial i_b}{\partial u_{be}}$$

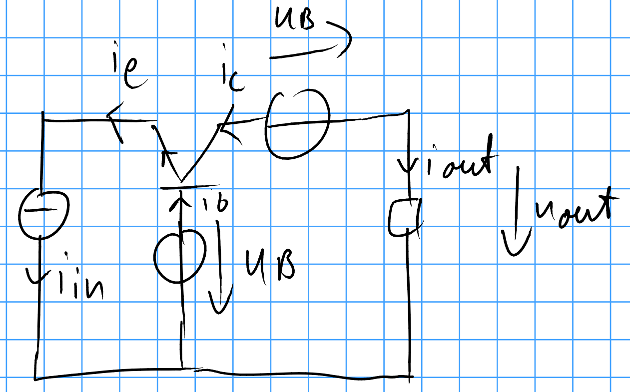


Kleinsignal:



für npn+pnp Typ gleich

Aufgabe 1



a) ges: $I_{b,AP}$

Lös: $i_{in} = I_{in} \mid \Delta i_{in} = 0$ (AP)

KCL: $i_e = i_b + i_c = i_b + \beta i_b = \boxed{i_b(\beta+1)}$

$i_e = i_{in} \Rightarrow i_b = \frac{i_n}{(\beta+1)} = \frac{10{,}1\,mA}{101} = 0{,}1\,mA$

b) u_{out}

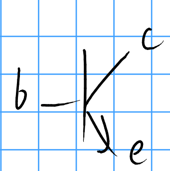
$u_{out} = R_L i_{out}$; $i_{out} = -i_c = -\beta i_b = -100 \cdot 0{,}1\,mA = -10\,mA$

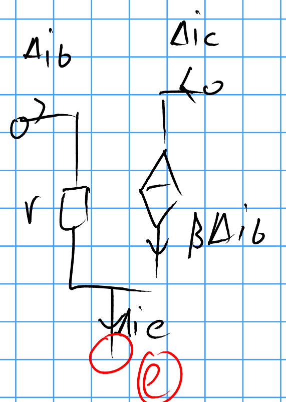
$= \cdot R_L 10\,mA$

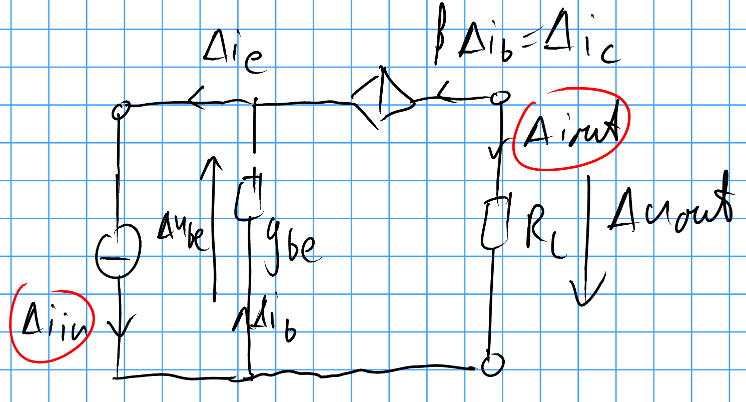
c) npn-Transistor: $u_{cb} > 0V$ Kollektor-Basis sperrt

$u_{be} > 0V$ Emitter-Basis in Durchlassrichtung

d) KS-ESB:







e) $v_i = \frac{\Delta i_{in}}{\Delta i_{out}}$ $\qquad \Delta i_{in} = \Delta i_e = \Delta i_b(\beta+1)$

$\Delta i_{out} = -\Delta i_c = -\beta \Delta i_b$

$$v_i = \frac{+\Delta i_b(\beta+1)}{-\beta \Delta i_b} = -\frac{\beta+1}{\beta} = \Big|_{\beta=100} = \ldots$$

f) $R_{in} = \frac{\Delta u_{be}}{\Delta i_{in}}$ $\qquad \Delta u_{be} = \frac{1}{g_{be}} \cdot \Delta i_b$

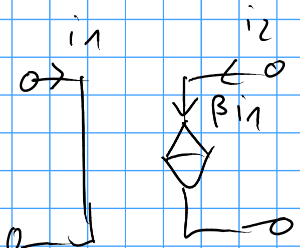
$$\Delta i_{in} = \Delta i_b(\beta+1)$$

$$\Rightarrow R_{in} = \frac{\Delta i_b}{g_{be}(\beta+1)\Delta i_b} = \frac{1}{g_{be}(\beta+1)}$$

g) $\lim\limits_{\beta\to\infty} -\frac{\beta+1}{\beta} = -1$ $\qquad \lim\limits_{\beta\to\infty} \frac{1}{g_{be}(\beta+1)} = \underline{0}$

$v_i = \frac{\Delta i_{in}}{\Delta i_{out}} = -1$ $\qquad R_{in} = 0\,\Omega$ (KS)

$\Delta i_{out} = -\Delta i_{in}$

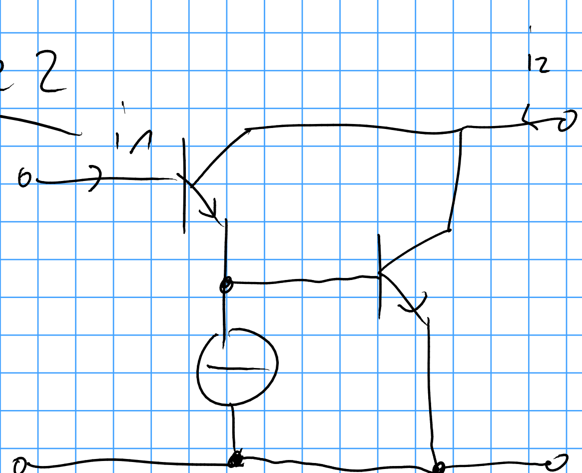


$\beta = v_i = -1$

$\Rightarrow$ ISI

Aufgabe 2

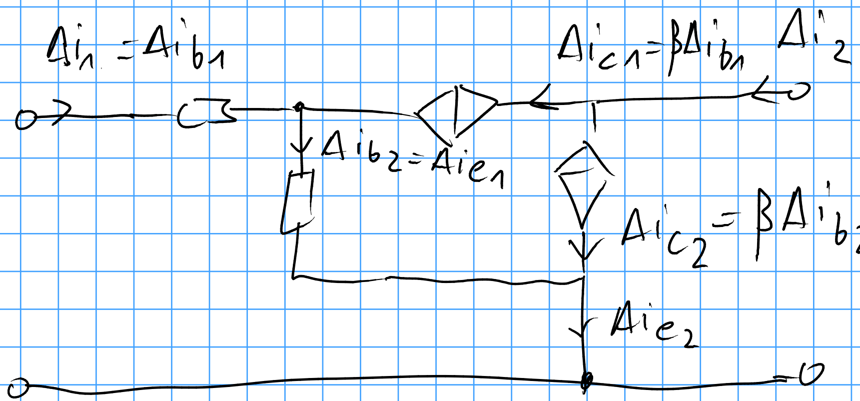
geg:



1\. ges: Kleinsignal-ESB

Vorgehen: - Weglassen konst. Quellen (hier Stromquelle → LL)

- Einbau des KS-Transistor ESB



2\. ges: $\beta_D = \frac{\Delta i_2}{\Delta i_1}$

Lös: $\Delta i_2 = \Delta i_{c1} + \Delta i_{c2} = \beta \Delta i_{b1} + \beta \Delta i_{b2}$ 2

$\Rightarrow \Delta i_{b2} = \Delta i_{e1} = \Delta i_{b1} + \Delta i_{c1} = \Delta i_{b1} + \beta \Delta i_{b1} = \Delta i_{b1}(\beta+1)$

$\Rightarrow \Delta i_2 = \beta \Delta i_{b1} + \Delta i_{b1}\beta(\beta+1) = \Delta i_{b1}\beta(1+\beta+1) =$
$= \Delta i_{b1}\beta(\beta+2) = \Delta i_{b1}(\beta^2+2\beta)$

$\Rightarrow \beta_D = \frac{\Delta i_{b1}(\beta^2+2\beta)}{\Delta i_{b1}} = \underline{\underline{\beta^2+2\beta}}$