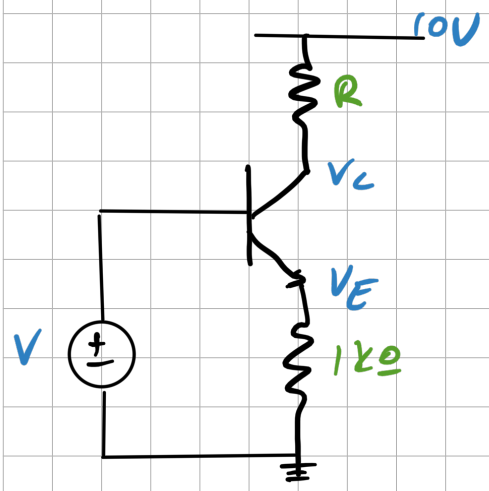
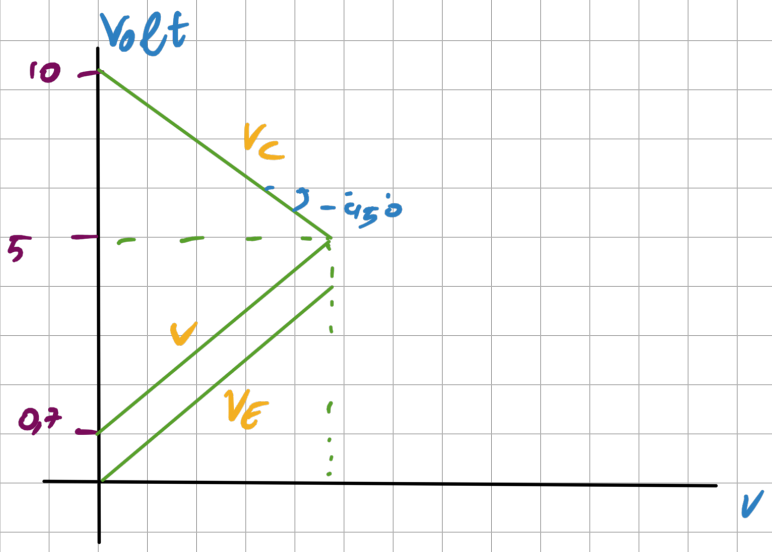
# 05.05.22



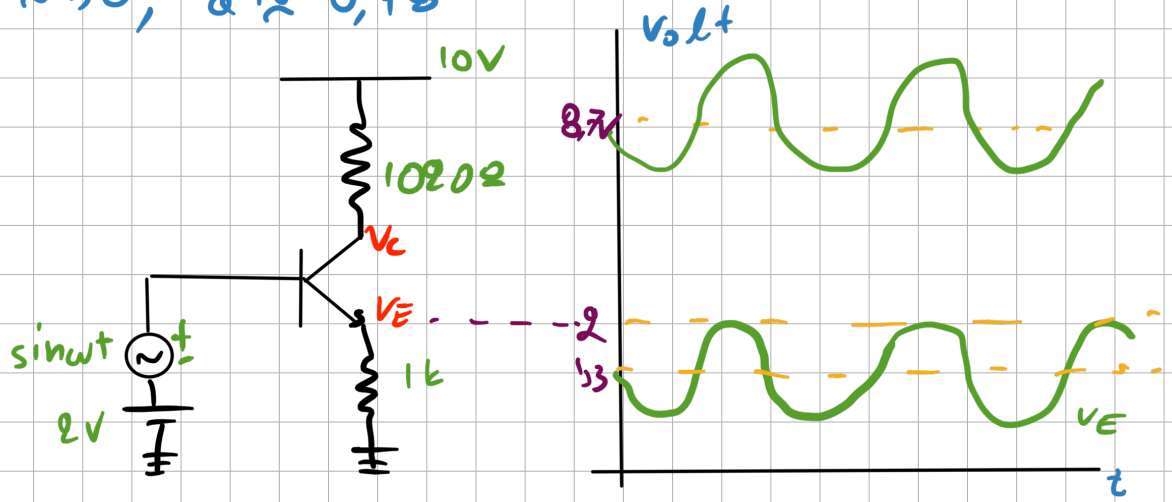




$$i_E = \frac{V - 0{,}7}{1k\Omega}, \quad i_C = \frac{\beta}{\beta+1} i_E$$

$$V_C = 10V - \frac{V - 0{,}7V}{1k} \cdot aR$$

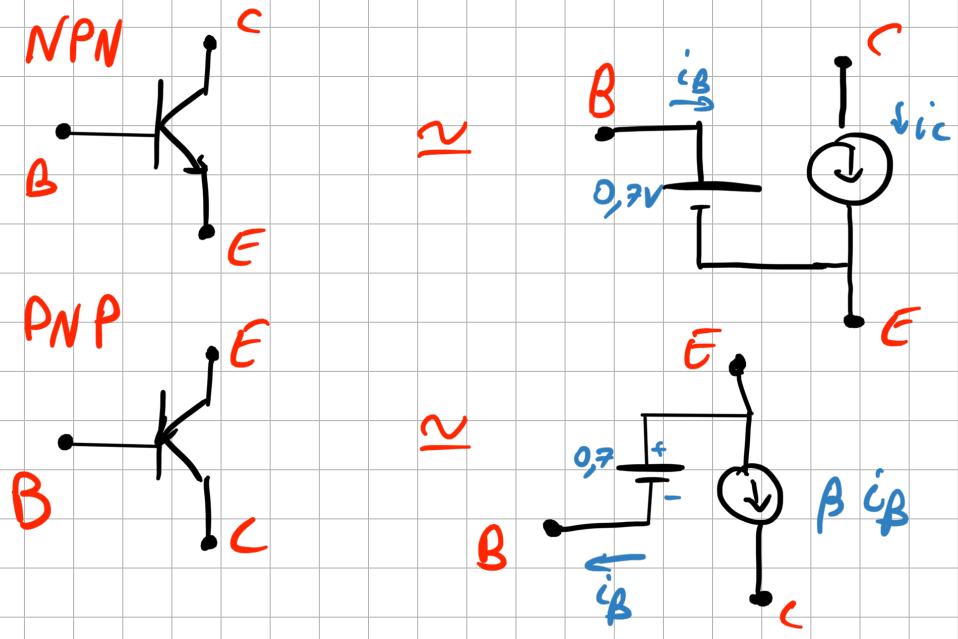
$$\frac{aR}{1k} = 1 \Rightarrow R = \frac{1k}{a} \Rightarrow a = 0{,}98 \Rightarrow R \approx 1020\,\Omega$$

$\beta \approx 50, \quad a \approx 0{,}98$

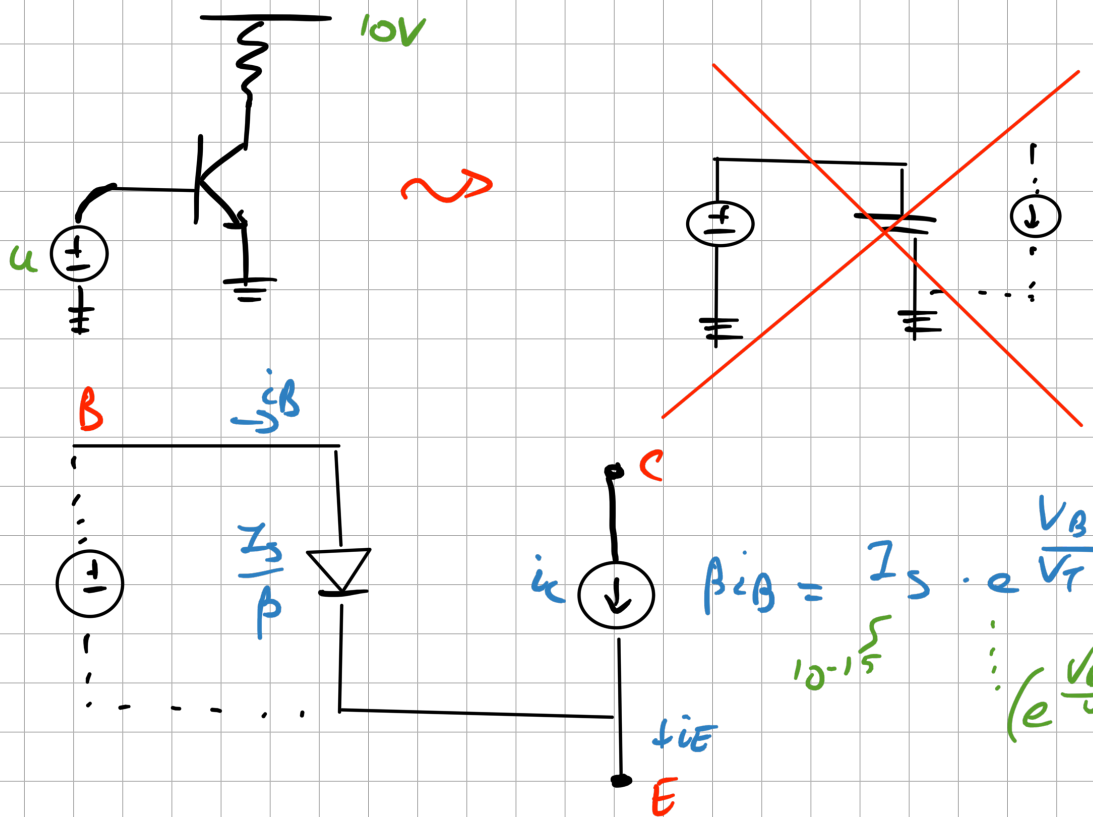



$V_C = 10\,V - (u - 0{,}7V) = 9$
$= 10{,}7V - u$

$V_E = u - 0{,}7V$




$V_{BE} \simeq 0{,}7\,V$ , $i_C = \beta \cdot i_B$




$i_C = \beta\, i_B$ , $i_E = i_B + i_C = (\beta+1)\, i_B$

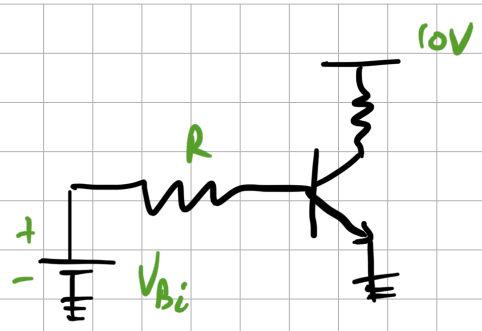
$\frac{I_S}{\beta} e^{V_{BE}/V_T}$

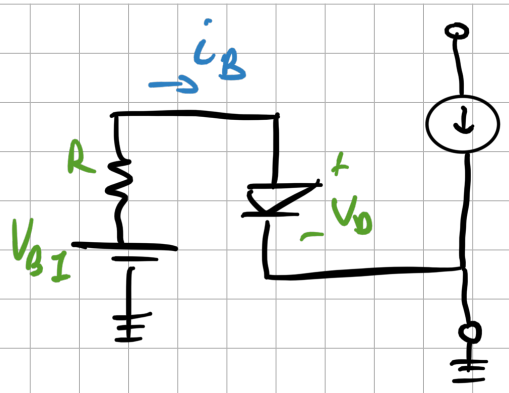
$I_S = I_{SO} \cdot A_E$

$10^{-13}A - 10^{-19}A$

εξαρτάται από το T

$V_T = \frac{kT}{q} \simeq 25mV$ (300K)



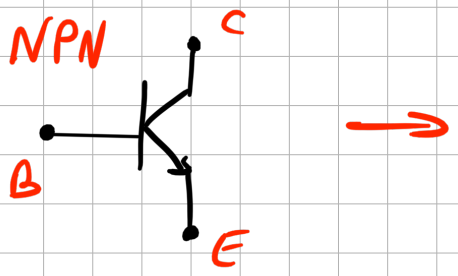



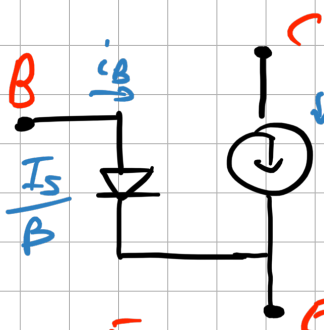

$$V_{BI} - R i_B - V_D = 0$$

$$i_B = \frac{I_S}{\beta} e^{V_D/V_T} \Rightarrow V_B = V_T \ln\left(\frac{\beta i_B}{I_S}\right)$$

$$V_{BI} - R i_B - V_T \ln\left(\frac{\beta i_B}{I_S}\right) = 0$$

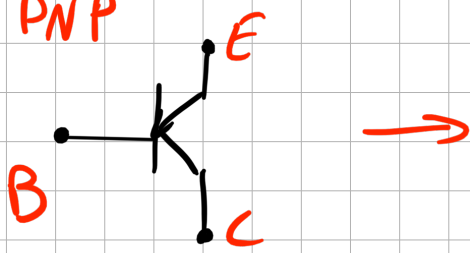
NPN

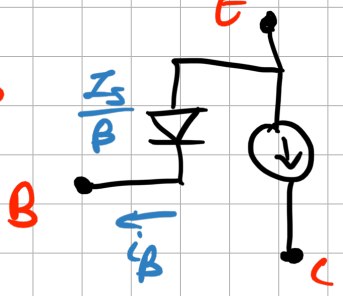


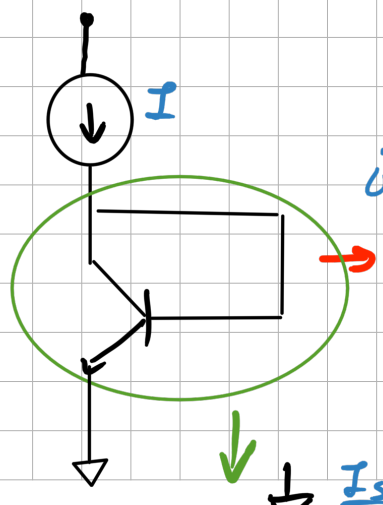

$$i_B \cdot \beta = I_B e^{\frac{V_{BE}}{V_T}}$$

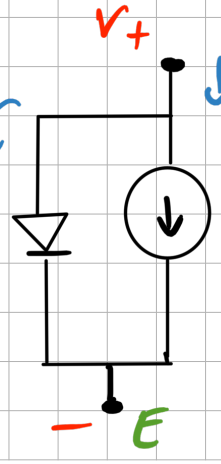
PNP




$$\beta i_B = I_S e^{\frac{V_{EB}}{V_T}}$$



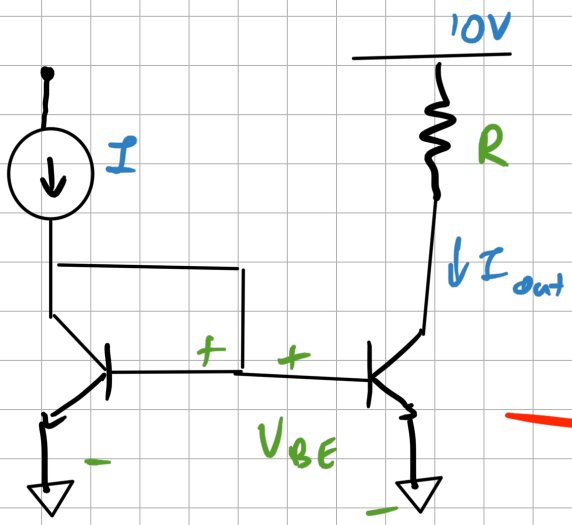




$$I = i_B + i_C = \beta i_B =$$

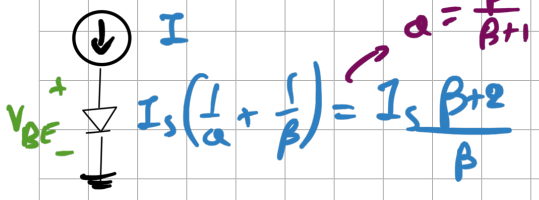
$$= (1+\beta) i_B =$$

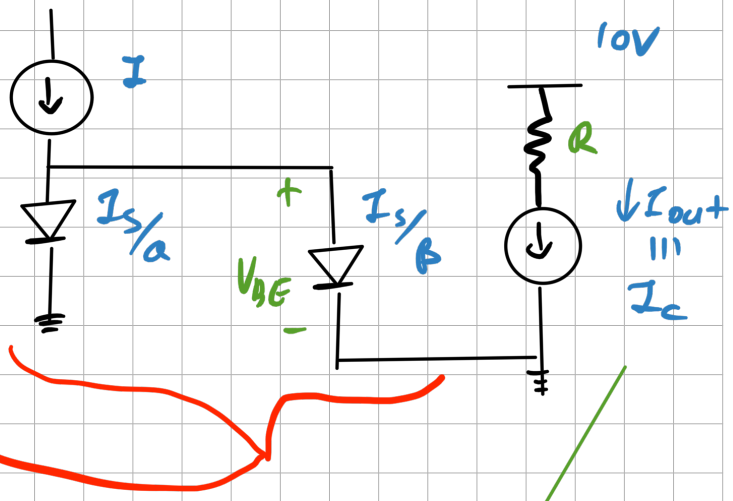
$$= (1+\beta) \frac{I_S}{\beta} e^{V/V_T} =$$

$$= \frac{I_S}{a} e^{V/V_T}$$




$I \Rightarrow V_{BE} \Rightarrow I_{out}$

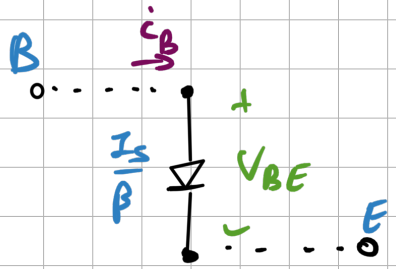


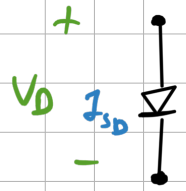




$$I = \frac{\beta+2}{\beta} I_S e^{V_{BE}/V_T}$$

$$I_C = I_S e^{V_{BE}/V_T} = I \cdot \frac{\beta}{\beta+2}$$

$$\boxed{V_{BE} = V_T \ln\left(\frac{I}{I_S} \cdot \frac{\beta}{\beta+2}\right)}$$

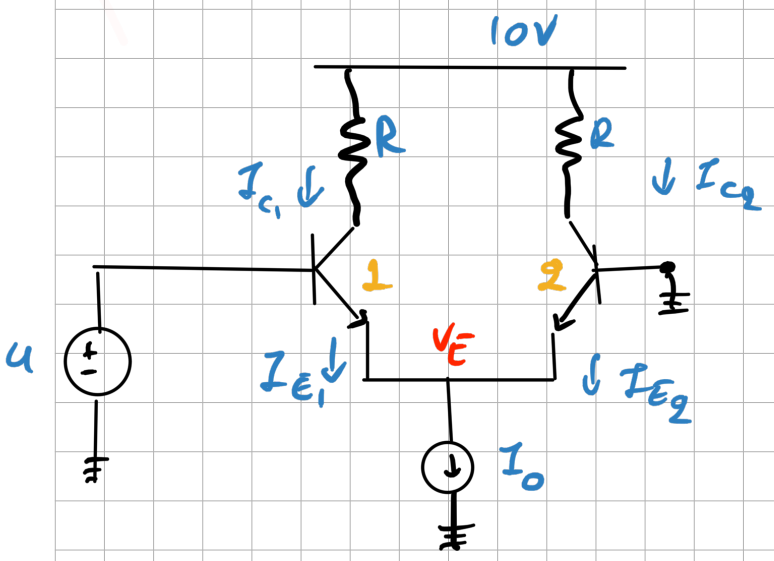



$$i_B = \frac{I_S}{\beta} e^{V_{BE}/V_T}$$

$$I_D = I_{SD} \cdot e^{V_D/n \cdot V_T}$$

$n = 1$ o $2$




$I_{C_1}$ ?

$I_{C_2}$ ?

$$I_0 = I_{E_1} + I_{E_2}$$