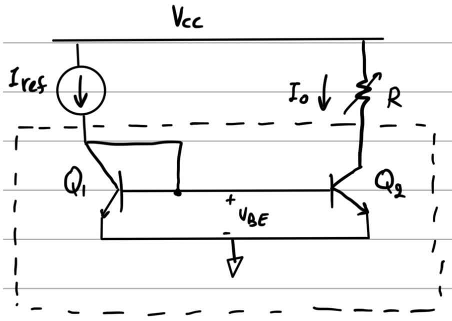
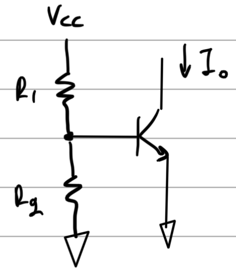


καθρέπτης ρεύματος



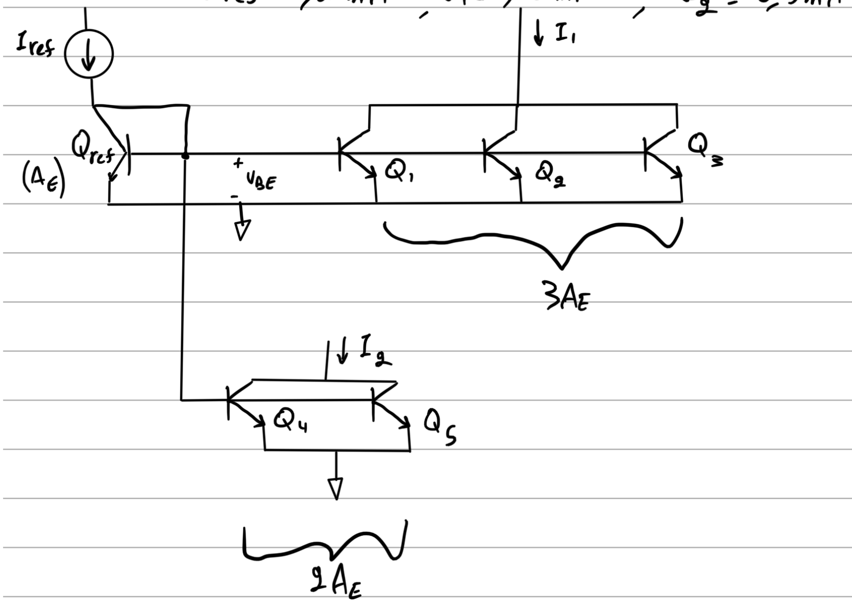
$$\left.\begin{aligned} V_{BE} &= \frac{R_2}{R_1+R_2} V_{cc} \\ I_c &= I_s \cdot e^{V_{BE}/V_T} \end{aligned}\right\} \rightarrow$$

$$\rightarrow \frac{R_2}{R_1+R_2} V_{cc} = V_T \ln \frac{I_o}{I_s}, \quad V_T = \frac{kT}{q}$$

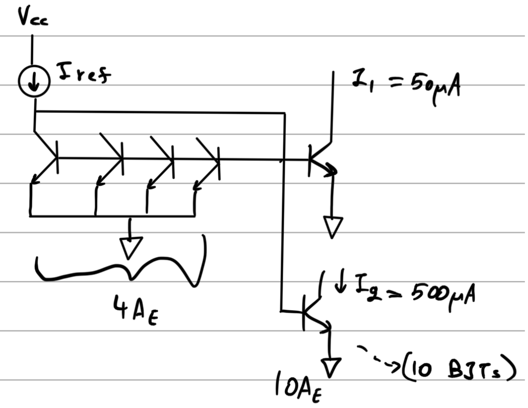
I_s εξαρτάται από T

Παράδειγμα

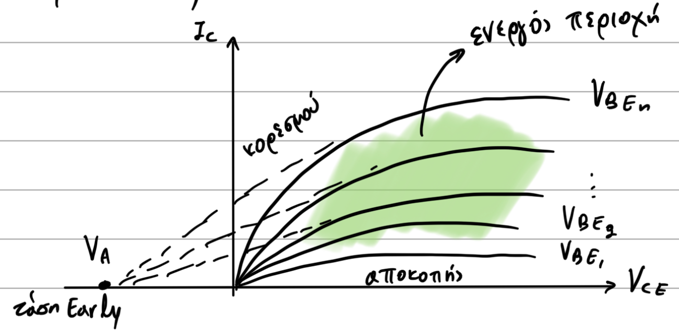
$I_{ref} = 0{,}25mA$, $I_1 = 0{,}75mA$, $I_2 = 0{,}5mA$

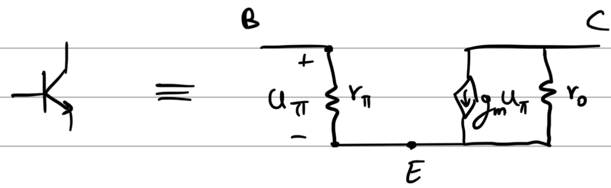


$I_{ref} = 200\mu A \rightarrow 4A_E$
$I_1 = 50\mu A \rightarrow A_E$
$I_2 = 500\mu A \rightarrow 10A_E$



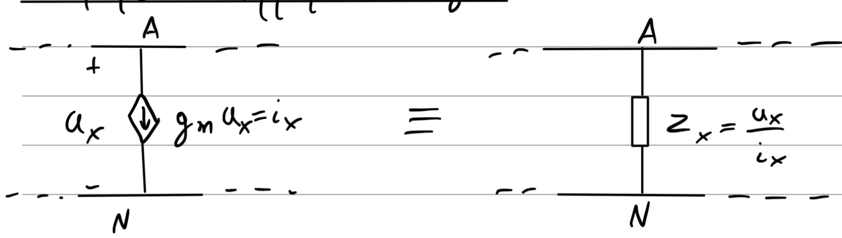
Φαινόμενο Early

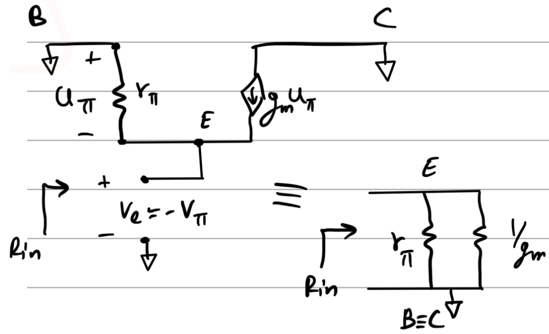




$$r_o = \frac{V_A}{I_c}$$

Θεώρημα απορρόφησης πηγής

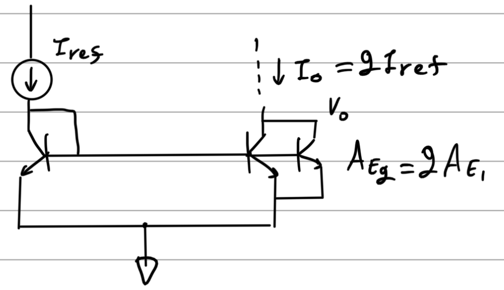




$R_{in} = r_\pi \,//\, (1/g_m)$

Δες προηγούμενο μάθημα:

$$\frac{I_o}{I_{ref}} = \frac{A_{E_2}}{A_{E_1}}$$



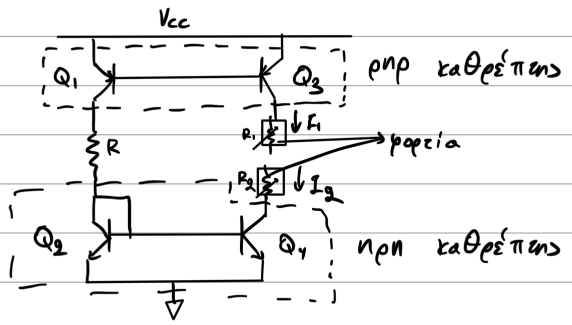
Για m ... BJTs

$$\frac{I_o}{I_{ref}} = \frac{m}{1+\frac{m+1}{\beta}} \xrightarrow{\beta >>} \simeq m$$

↳ σε περίπτωση που έχουμε m BJTs με Early:

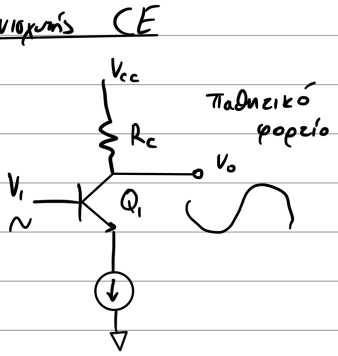
$$I_o = I_{ref}\left(\frac{m}{1+\frac{m+1}{\beta}}\right)\left(1+\frac{V_o - V_{BE}}{V_A}\right)$$

Συνολική οδήγηση ρεύματος



$$I_{ref} = \frac{V_{cc} - V_{EB_1} - V_{BE_2}}{R}$$

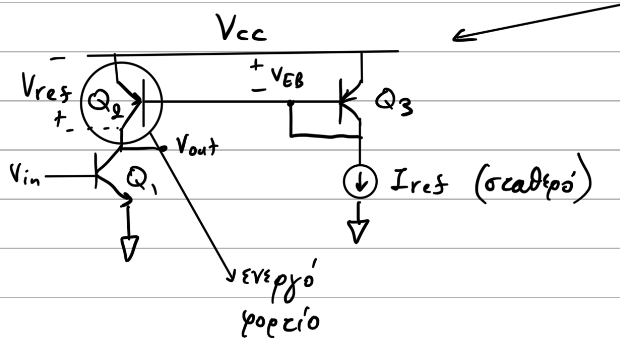
Ενισχυτής CE



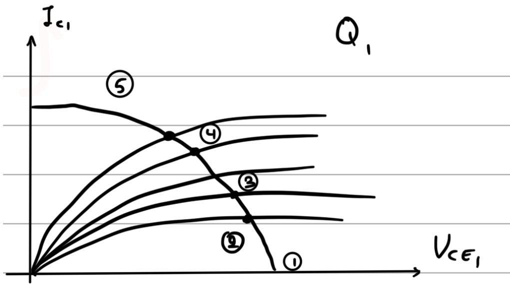
$A_o \simeq -g_m R_c$

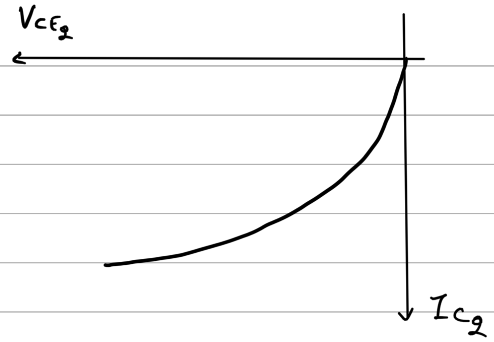
$A_o \uparrow \Rightarrow R_c \uparrow$ ⟶ μειονέκτημα γιατί Rc σημαίνει μεγάλο εμβαδό στην επιφάνεια S_i →

→ μεγάλο κόστος $\xrightarrow{\text{ΛΥΣΗ}}$ Αντίσταση παθητικού φορτίου με ενεργό BJT



I_{C_1} καθορίζει το $g_m = \frac{I_C}{V_T}$



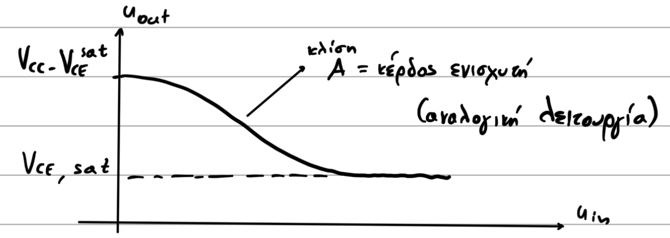


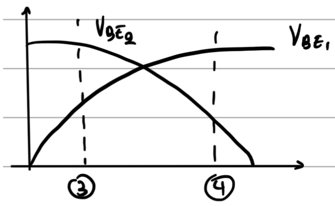
① $u_1 = 0$ Q_1 cut off , Q_2 saturation

② $u_1 \uparrow$ Q_1 on , Q_2 saturation

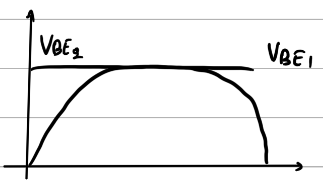
③ - ④ $u_1 \uparrow\uparrow$ Q_1, Q_2 on , ενεργός

⑤ $u_1 \uparrow\uparrow\uparrow$ Q_1 saturation





με Φ. Early

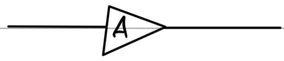


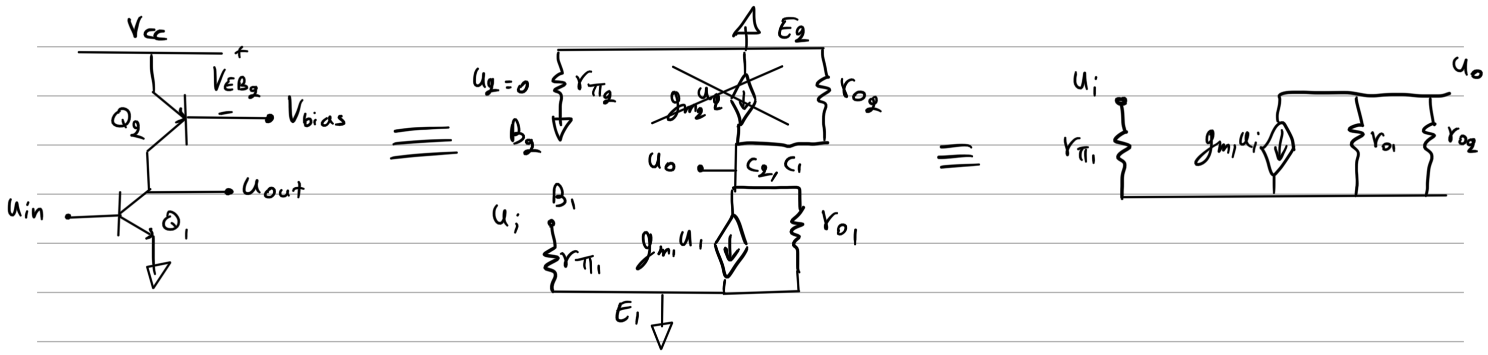
χωρίς Φ. Early

CC ακόλουθος εκπομπού

CE ενισχυτής τάσης

CB απομονωτής ρεύματος

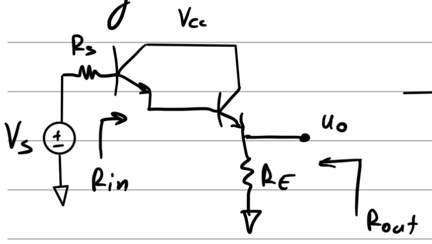


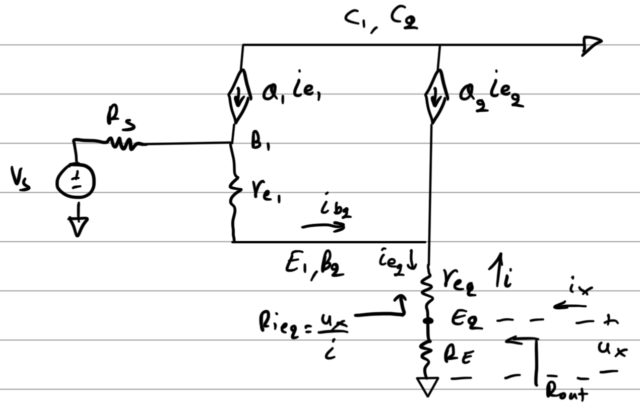


$$A_V = \frac{u_o}{u_i} = -g_m \left(r_{o_1} // r_{o_2}\right) \frac{r_o = \frac{V_A}{I_C}}{g_m = \frac{I_C}{V_T}} - \frac{I_C}{V_T} \frac{\left(\frac{V_A}{I_C}\right)^2}{2\frac{V_A}{I_C}} = -\frac{V_A}{2V_T}$$

$\rightsquigarrow$ όχι εξάρτηση από I_C και $A_V \gg$

Darlington





$$R_{out} \equiv \left.\frac{u_x}{i_x}\right|_{\substack{u_s=0\\ R_L\to\infty}} = R_E \,//\, R_{ieq}$$

$$\left.\begin{aligned} i &= -i_{e_2} = -(\beta_2+1)\, i_{b_2} \\ i_{b_2} &= i_{e_1} = (\beta_1+1)\, i_{b_1} \end{aligned}\right\} \rightarrow i = -(\beta_1+1)(\beta_2+1)\, i_{b_1}$$

$$u_x = -i_{b_1} R_s - i_{e_1} r_{e_1} - i_{e_2} r_{e_2} = -\left[R_s + (\beta_1+1) r_{e_1} + (\beta_1+1)(\beta_2+1) r_{e_2} \right] i_{b_1}$$

$$R_{ie_2} = \frac{u_x}{i}$$

$$\rightarrow R_{out} = R_E \,//\, \left[r_{e_2} + \frac{r_{e_1} + \frac{R_s}{\beta_1+1}}{\beta_2+1} \right]$$