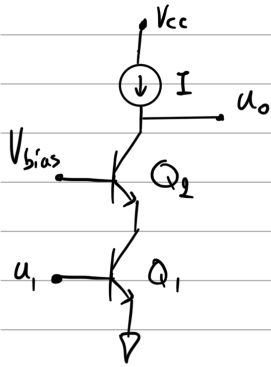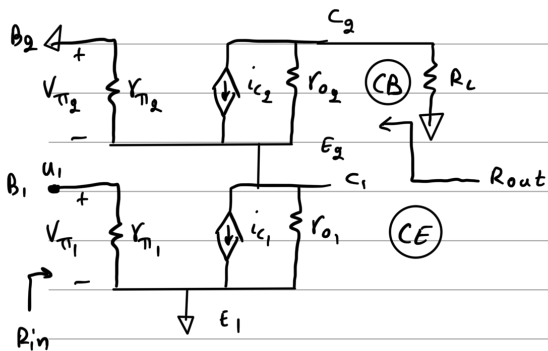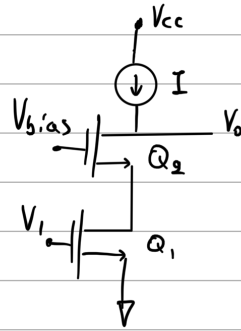# Cascode: Κυκλωματική τοπολογία 2 σταδίων

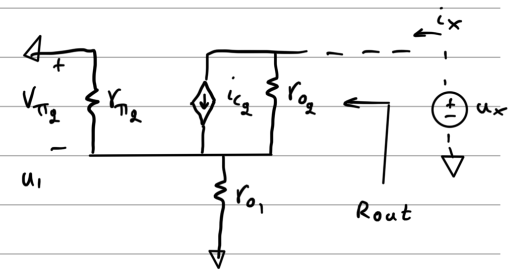## CB - CE   ή   CG - CS

$R_{in} = r_{\pi_1}$

$R_{out} = \dfrac{u_x}{i_x}\Big|_{\substack{u_i = 0 \\ R_L \to \infty}}$
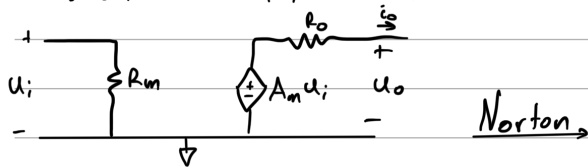

Έστω $\beta_1 = \beta_2$: $R_{out} = \beta \cdot r_o$ $\left(g_{m_1} = g_{m_2}, \quad r_{o_1} = r_{o_2}, \quad r_{\pi_1} = r_{\pi_2} \right)$
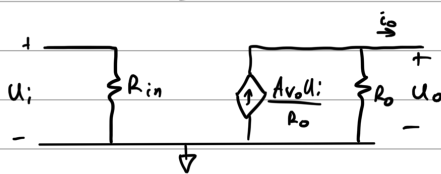
$$\hookrightarrow R_{out} = \left[\dfrac{1 + g_{m_2} r_{o_1}}{1 + \dfrac{g_{m_2} r_{o_1}}{\beta}} \right] r_{o_2} = \beta r_{o_2}$$

Διαγωγιμότητα Βραχυκυκλώματος G_m
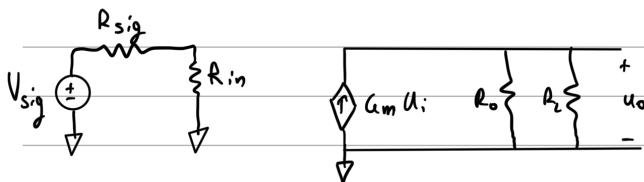
$G_m = \dfrac{i_o}{u_i}\Big|_{R_L = 0}$

Norton $\rightarrow$

$\dfrac{A_{vo} u_i}{R_o} = G_m u_i$

$\downarrow$

$$\boxed{G_m = \dfrac{A_{vo}}{R_o}}$$

$\dfrac{u_o}{u_{sig}} = \dfrac{R_{in}}{R_{in} + R_{sig}} G_m \cdot (R_o /\!/ R_L)$

Ενισχυτές BJT 2 σταδίων

1ο στάδιο	2ο στάδιο	
CE	CE	Ενισχ. τάσης (υψηλό κέρδος τάσης)
CE	CB	Μεγάλο εύρος ζώνης (cascode)
CE	CC	Τελ. ενισχυτής (υψηλά Z_{in}, Z_{out})
CB	CE	Current buffer
CB	CB	Current buffer
CB	CC	Δεν χρησιμοποιείται
CC	CE	Δεν χρησιμοποιείται, Υψηλό Z_{in}
CC	CB	Διαφορικός ενισχ., υψηλά Z_{in}, Z_{out}
CC	CC	Darlington: Υψηλό A_i
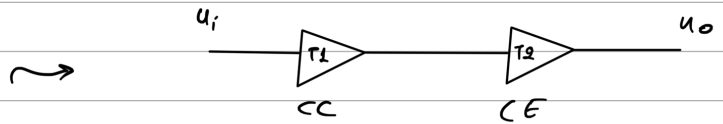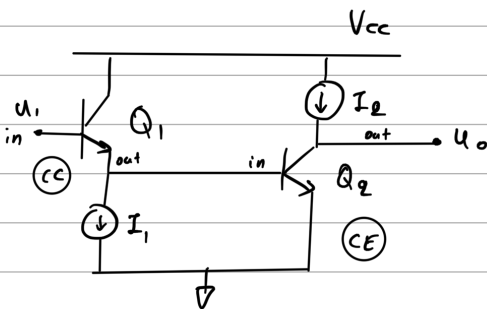
$$A_v \quad R_i^{buffer} \gg \quad \text{και} \quad R_o^{buffer} \ll$$
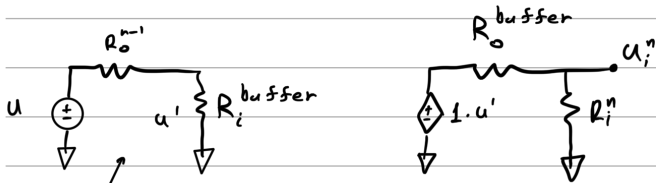
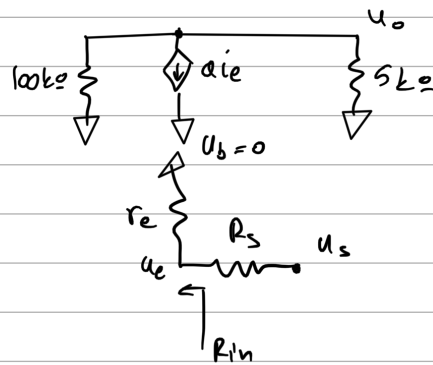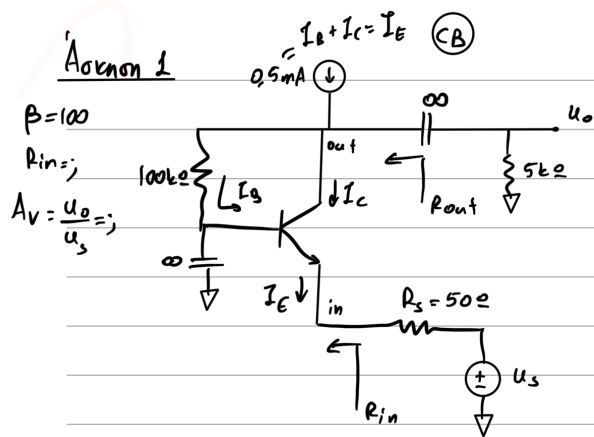$$u' = \frac{R_i^{buffer}}{R_i^{buffer} + R_o^{n-1}} \, u \quad \simeq u$$

$$u_i^n = \frac{R^n}{R_i^n + R_o^{buffer}} \, u' \quad \simeq u'$$

Ισοδύναμο κύκλωμα του σταδίου n-1 και των προηγουμένων

Πραγματικός ενισχυτής CC-CE

Äovnon 1

$\beta = 100$

$R_{in} = ;$

$A_v = \dfrac{u_o}{u_s} = ;$

Circuit labels: $I_b + I_c = I_E$ (CB), $0.5mA$, ∞, u_o, out, ∞, $100k\Omega$, I_B, dI_c, R_{out}, $5k\Omega$, I_E, in, $R_s = 50\Omega$, R_{in}, $\pm\ u_s$

Small-signal equivalent: u_o, $100k\Omega$, aie, $5k\Omega$, $u_b = 0$, r_e, u_e, R_s, u_s, R'_{in}
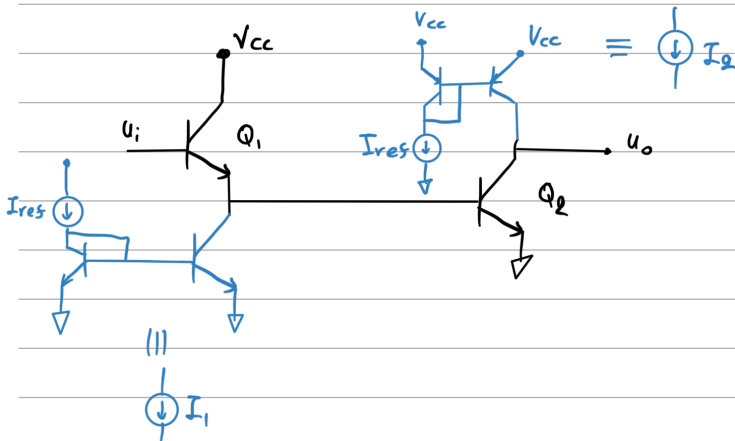
$$R_{in} = r_e = \frac{V_T}{I_E} = \frac{25m}{0.5m} = 50\Omega$$

$$aie = g_m\, u_\pi = g_m(u_b - u_e) = -g_m u_e = -(100k\,/\!/\,5k)\,u_o \quad\to\quad \frac{I_c}{V_T}\,\frac{r_e}{r_e + R_s}\, u_s = (100k\,/\!/\,5k)\,u_o \to$$

$$\to\quad \frac{u_o}{u_s} = \frac{\beta}{\beta+1}\, I_E \cdot \frac{1}{V_T} \cdot \frac{r_e}{r_e + R_s} \cdot \frac{1}{(100k\,/\!/\,5k)} = 47.6\ V/V$$