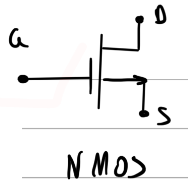
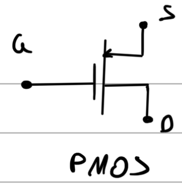
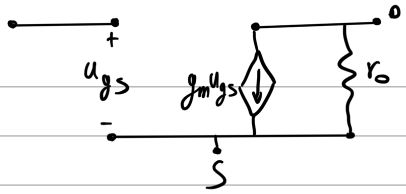


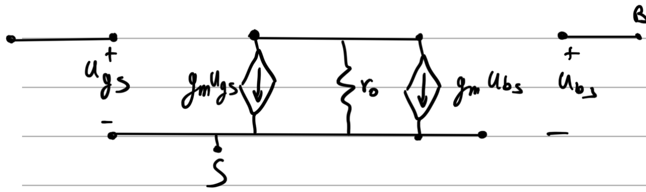




$r_o = \frac{V_A}{I_D}$ , $V_A = \frac{1}{\lambda}$ , $I_D = \frac{1}{2}\underbrace{\underbrace{\mu_n C_{ox}}_{k_n'}\left(\frac{W}{L}\right)}_{k_n}\underbrace{(V_{GS}-V_t)^2}_{V_{ov}}$

Για PMOS: $|V_A|$ , $|\lambda|$ , $|V_{ov}|$ , $|V_t|$

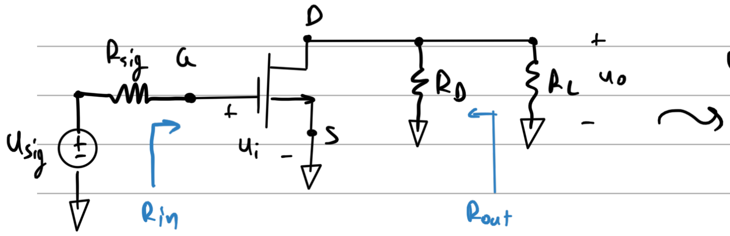
$$g_m = \frac{\partial i_D}{\partial u_{GS}}\bigg|_{u_{GS}=V_{GS}}$$

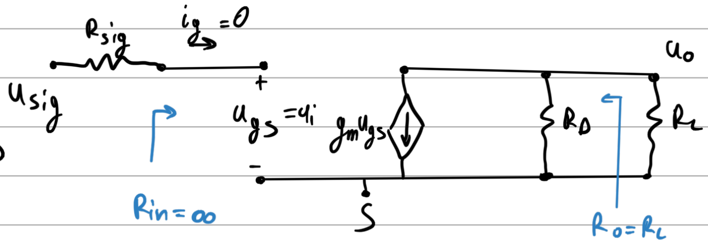
$$g_m = k_n V_{ov} = \mu_n C_{ox}\left(\frac{W}{L}\right)(V_{GS}-V_t) = \frac{2 I_D}{V_{ov}} = \sqrt{2\mu_n C_{ox}\left(\frac{W}{L}\right) I_D}$$




(B. body)

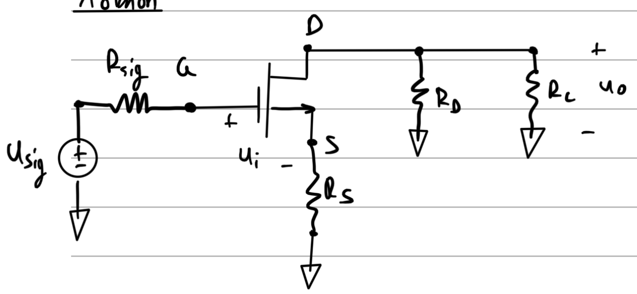
## Ενισχυτής Κοινής Πηγής (CS)

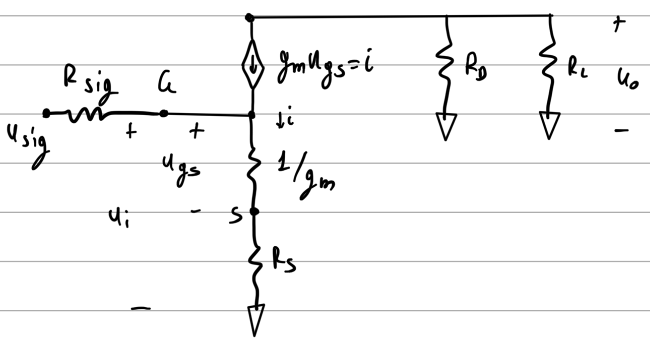



$$\frac{u_o}{u_{sig}} = \frac{-g_m u_{gs}(R_D // R_L)}{u_{sig}} \xrightarrow{u_{gs} = u_i = u_{sig}} \frac{u_o}{u_{sig}} = -g_m (R_D // R_L)$$

### Άσκηση

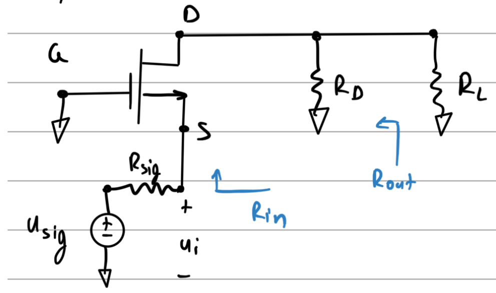


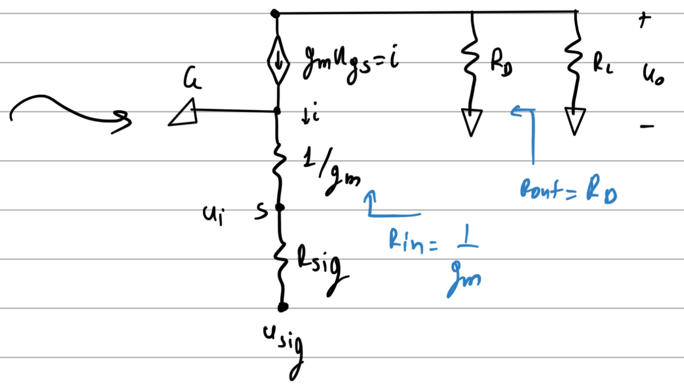




$$\left.\begin{aligned} u_o &= -g_m u_{gs}(R_D//R_L) = -i(R_D//R_L) \\ i &= \frac{u_i}{\frac{1}{g_m}+R_s} \end{aligned}\right\} \xrightarrow{u_i = u_{sig}} \frac{u_o}{u_{sig}} = -\frac{R_D // R_L}{\frac{1}{g_m}+R_s}$$

$$\boxed{A_{v_{G\to D}} = \frac{u_o}{u_{sig}} = -\frac{R_{o\lambda,D}}{R_{o\lambda,S}}}$$

## Ενισχυτής Κοινής Πύλης (CG) $\sim$ αντίστοιχος του CB

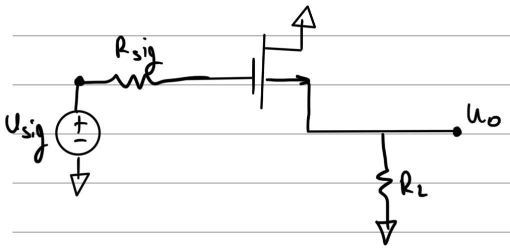


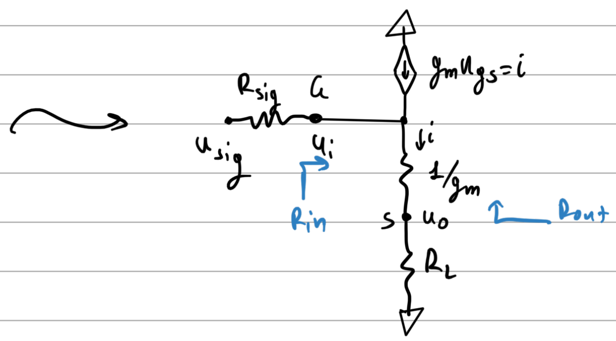




$$\left.\begin{aligned} u_o &= -i\,(R_D /\!/ R_L) \\ i &= \frac{-u_i}{1/g_m} \end{aligned}\right\} \rightarrow u_o = \frac{u_i\,(R_D /\!/ R_L)}{1/g_m} \rightarrow \left.\begin{aligned} \frac{u_o}{u_i} &= g_m\,(R_D /\!/ R_L) \\ u_i &= \frac{1/g_m}{1/g_m + R_{sig}}\,u_{sig} \end{aligned}\right\} \rightarrow \frac{u_o}{u_{sig}} = \frac{R_D /\!/ R_L}{R_{sig} + 1/g_m}$$

$$A_{v,\,S\to D} = \frac{u_o}{u_{sig}} = \frac{R_{ολ,D}}{R_{ολ,S}}$$

## Ενισχυτής Κοινής Υποδοχής (CD) $\sim$ αντίστοιχος του CC (ή ακολ. εκπομπού)
## ή Ακολουθητής Πηγής



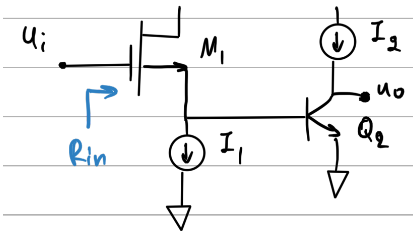

$$R_o = \frac{u_x}{i_x}\Bigg|_{\substack{u_{sig}=0 \\ R_L\to\infty}} = \frac{1}{g_m}$$

$R_{in} = \infty$, $u_{sig} = u_i$, $u_o = \frac{R_L}{R_L + R_{sig}}\,u_{sig} \rightarrow \frac{u_o}{u_{sig}} = \frac{R_L}{R_L + 1/g_m} < 1$

Επειδή $1/g_m \ll R_L \leadsto \frac{u_o}{u_{sig}} \simeq 1$

$$\left.\begin{aligned} R_{in} &= \infty \\ R_o &= \frac{1}{g_m} \ll 1 \\ \frac{u_o}{u_{sig}} &\simeq 1 \end{aligned}\right\} \rightarrow$$ απομονωτής τάσης (buffer)
στάδιο εξόδου σε ενισχυτή πολλών σταδίων

# Άσκηση: Ενισχυτής CD-CE




$V_T = 25mV$, $\beta_2 = 100$, $k_{n1} = 8mA/V^2$

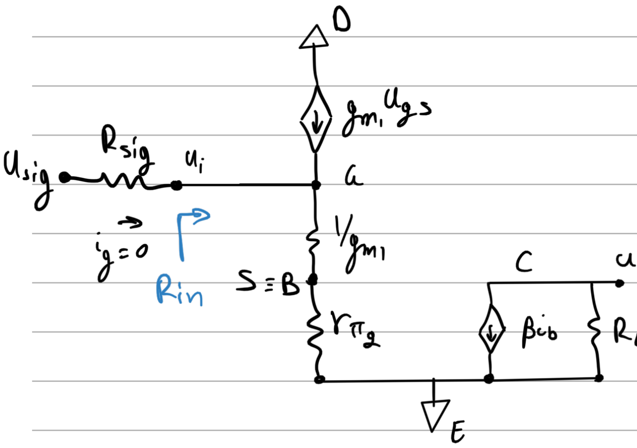
$I_1 = I_2 = 1mA$

Αγνοήστε φαιν. σώματος στο $M_1$, φαιν. Early στα $M_1, Q_2$.

a) $R_{in} = ?$ , $R_{sig} = 4k\Omega$

β) $u_o/u_{sig}$ ? , $R_{sig} = 4k\Omega$

και αν $R_{sig} = 400k\Omega$?




- $R_{in} = \infty$ , $\forall R_{sig}$
- $u_o = -\beta i_b R_L$
- $i_b = \dfrac{u_i}{\frac{1}{g_{m1}} + r_{\pi_2}}$
- $u_i = u_{sig}$

$\longrightarrow$

$$\frac{u_o}{u_{sig}} = \frac{-\beta R_L}{\frac{1}{g_{m1}} + r_{\pi_2}} \not\propto R_{sig} = -145,5 \ V/V$$

$g_{m1} = \sqrt{2k_n I_0} = 4mS$ , $g_{m2} = \dfrac{I_C}{V_T} = 40mS$ , $r_{\pi 2} = \dfrac{\beta}{g_{m2}} = 2,5k\Omega$