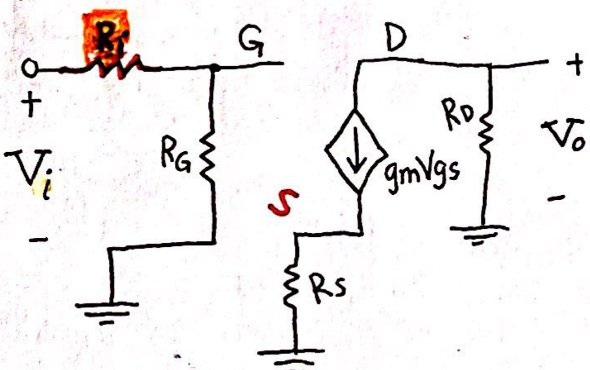
L16 : Part 2 : FET ac analysis ⇨

Common Sourse (CS) Self Bias Effect of Ri



here $V_g = \frac{R_G}{R_G + R_i} \cdot V_i$

$V_{gs} = V_g - V_s$

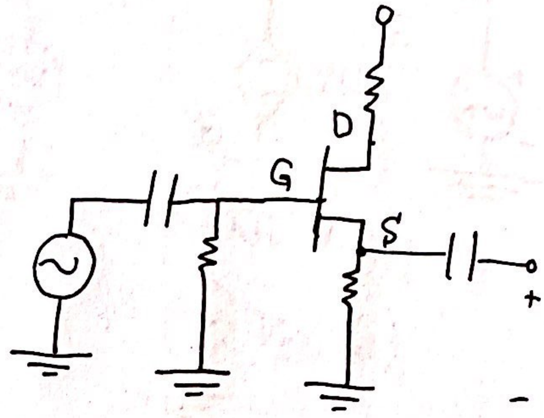
$V_{gs} = \frac{R_G}{R_G + R_i} \cdot V_i - g_m V_{gs} R_s$

$V_i = V_{gs}(1 + g_m R_s) \frac{R_G + R_i}{R_G}$

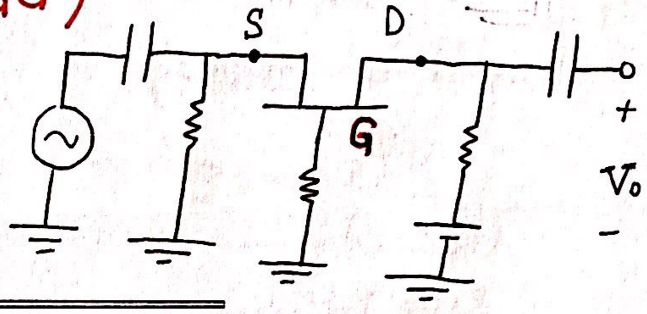
$V_o = -g_m V_{gs} R_D$

$A_V = \frac{V_o}{V_i} = \frac{-g_m R_D}{1 + g_m R_S} \cdot \boxed{\frac{R_G}{R_G + R_i}}$ AV is reduced Further due to Ri

[2] Common drain (CD)



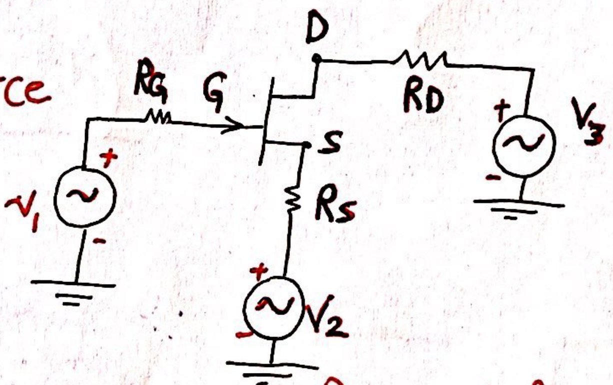
[3] Common Gate (CG)

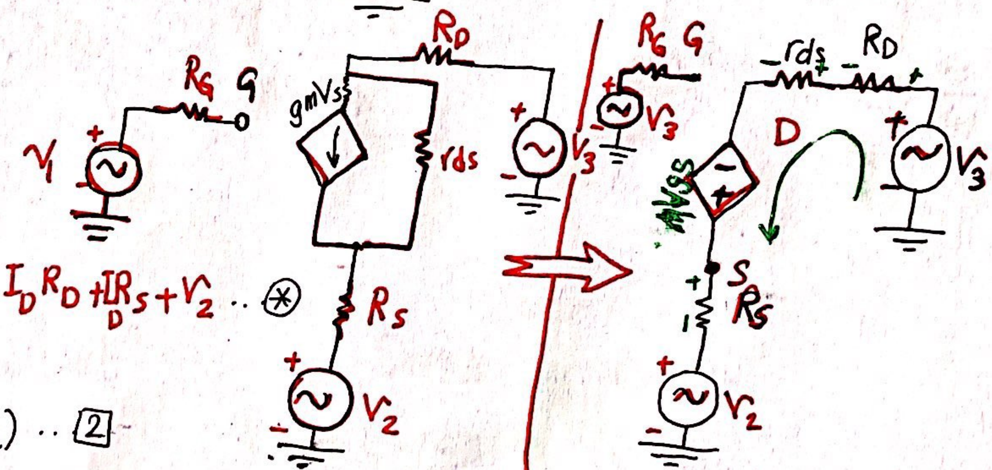


Impedence Reflection

Drain ⟷ Source

[Rs]





KVL :

$V_3 + \mu V_{gs} = I_D r_{ds} + I_D R_D + I_D R_S + V_2$ .. (*)

$V_{gs} = V_g - V_s$ ... [1]

$\quad = V_g - (i_D R_S + V_2)$ .. [2]

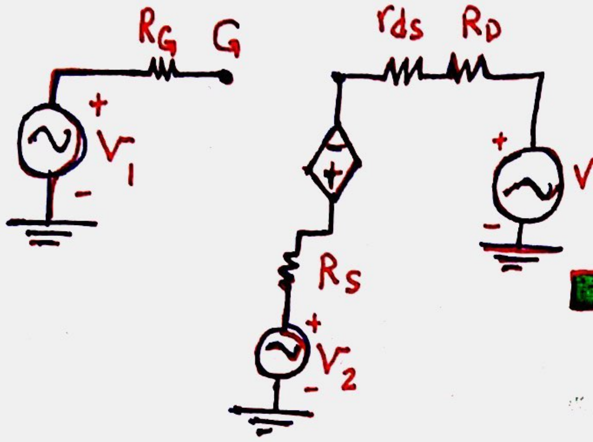
$V_s = I_D R_S + V_2$ ... → at [1]

نعوض [2] في (*)

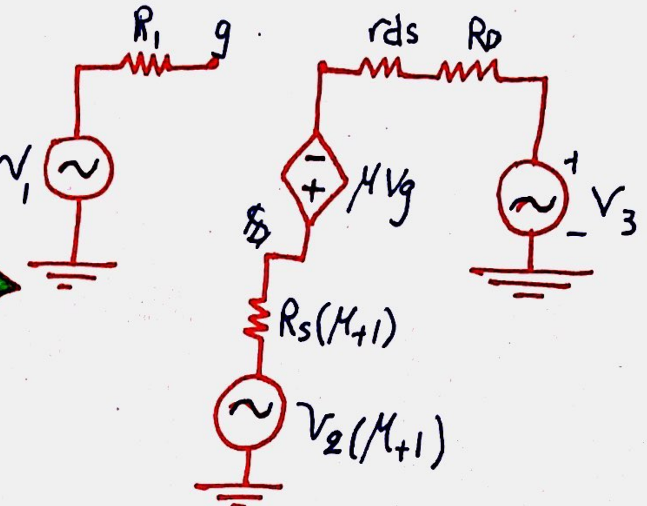
$V_3 + \mu(V_g - (i_D R_S + V_2)) = I_D(r_{ds} + R_D + R_S)$

$$i_D = \frac{V_3 + \mu V_g - V_2(\mu+1)}{R_D + r_{ds} + R_S(\mu+1)}$$

$$i = \frac{\Delta V}{\Sigma R}$$



Original Circuit



Drain Equ. Circuit
(Source to Drain)

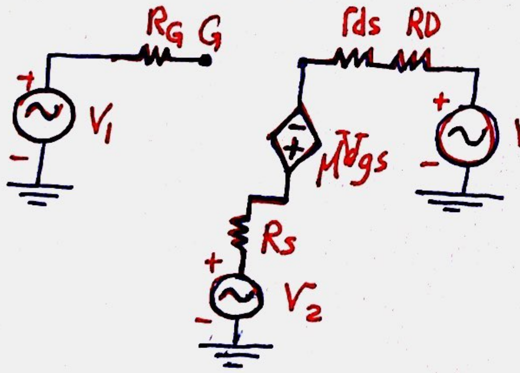
$\mu V_{gs} \longrightarrow \mu V_g$

$R_s \longrightarrow R_s(\mu+1)$

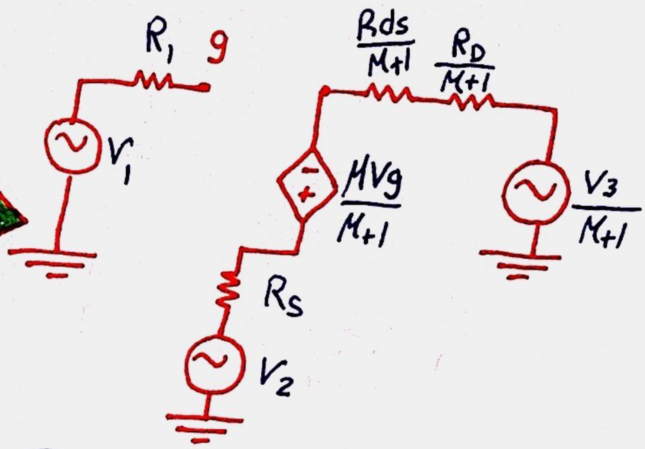
$V_2 \longrightarrow V_2(\mu+1)$

تعويض على M+1

$$i_D = \frac{\frac{V_3}{\mu+1} + \frac{\mu V_g}{\mu+1} + -V_2}{\frac{R_D}{\mu+1} + \frac{r_{ds}}{\mu+1} + R_S}$$



Original circuit



Source Eq. Circuit
(Drain to Source)

$\mu V_{gs} \longrightarrow \frac{\mu V_g}{\mu+1}$ $\quad R_D \rightarrow \frac{R_D}{\mu+1}$

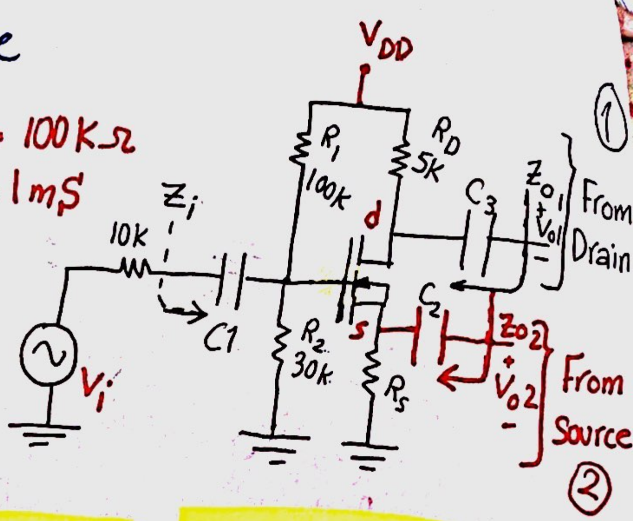
$V_3 \rightarrow \frac{V_3}{\mu+1}$ $\quad R_{ds} \rightarrow \frac{R_{ds}}{\mu+1}$

Example : Phase splitting Circuit

Two outputs : treated one @ time

Find $A_{V_1}, A_{V_2}, Z_i, Z_{o_1}, Z_{o_2}$

$r_{ds} = 100k\Omega$
$g_m = 1mS$

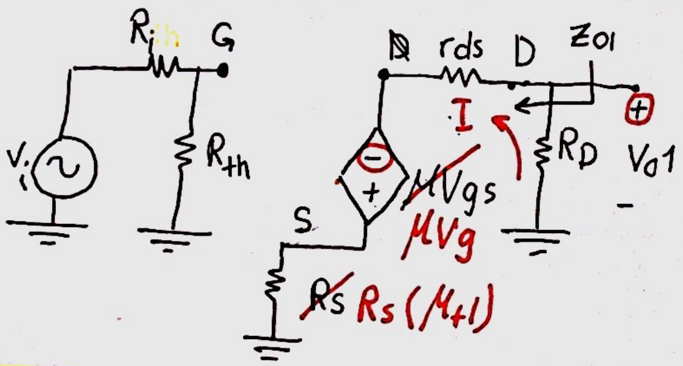


Two outputs :

V_{o1} : Drain

V_{o2} : Source .

1



(تحول الـ D) From S to D

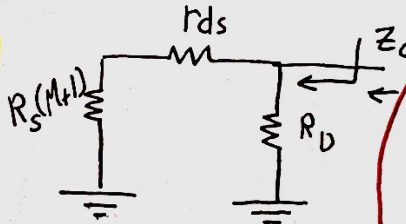
$$V_{o1} = \frac{R_D}{R_D + r_{ds} + R_s(\mu+1)} \cdot (-\mu V_g)$$

$$V_g = \frac{R_{th}}{R_{th} + R_i} \cdot V_i$$

$$A_{V_1} = \frac{V_{o1}}{V_g} \cdot \frac{V_g}{V_i} = \checkmark$$

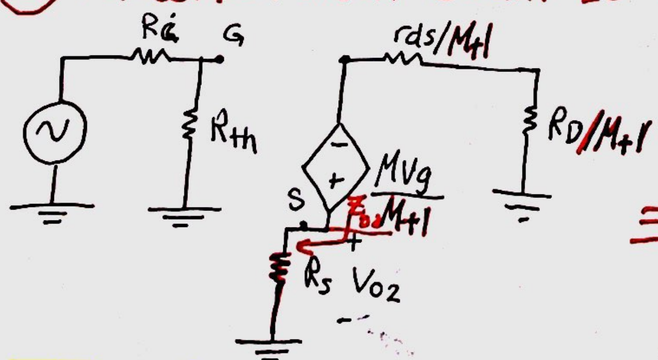
$$Z_{o1} = R_D \,//\, (r_{ds} + R_s(\mu+1))$$

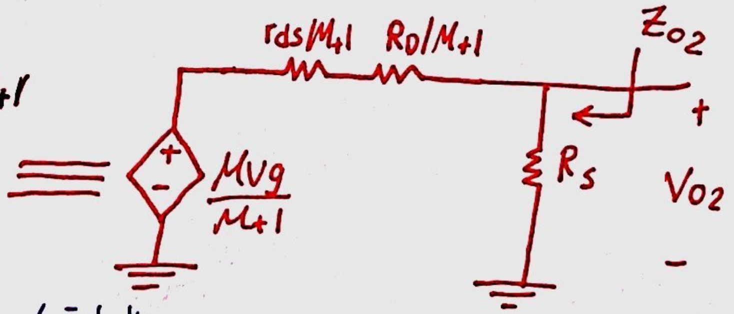
$V_i \sim 0 \Rightarrow V_g = 0 \Rightarrow \mu V_g = 0$



$$Z_i = R_{th}$$

2 reflection from Drain to Source





$$V_{o2} = \frac{R_s}{R_s + \frac{r_{ds} + R_D}{\mu+1}} \cdot \frac{\mu V_g}{\mu+1}$$

من السابق

$$V_g = \frac{R_{th}}{R_{th} + R_i} \cdot V_i$$

$$Z_{o2} = R_s \,//\, \left(\frac{r_{ds} + R_D}{\mu+1}\right)$$

$V_i = 0 \Rightarrow V_g = 0$

.8. Back $\Rightarrow$ $r_{ds} \to \infty$ "فرضا"

$$\mu = g_m r_{ds}$$

$$Z_{o_2} = R_S \,//\, \left(\frac{r_{ds} + R_D}{(\mu + 1)} \right), \quad r_{ds} \to \infty$$

$$\left. \frac{r_{ds} + R_D}{\mu + 1} \right|_{r_{ds} \to \infty} = \frac{r_{ds} + R_D}{g_m r_{ds} + 1}$$

$$\lim \frac{1 + R_D/r_{ds}}{g_m + 1/r_{ds}} = \frac{1}{g_m} \quad (R_D/r_{ds} \to 0,\ 1/r_{ds} \to 0)$$

$$\left. Z_{o_2} \right|_{r_{ds} \to \infty} = R_S \,//\, \left. \frac{1}{g_m} \right|_{r_{ds} \to \infty}$$