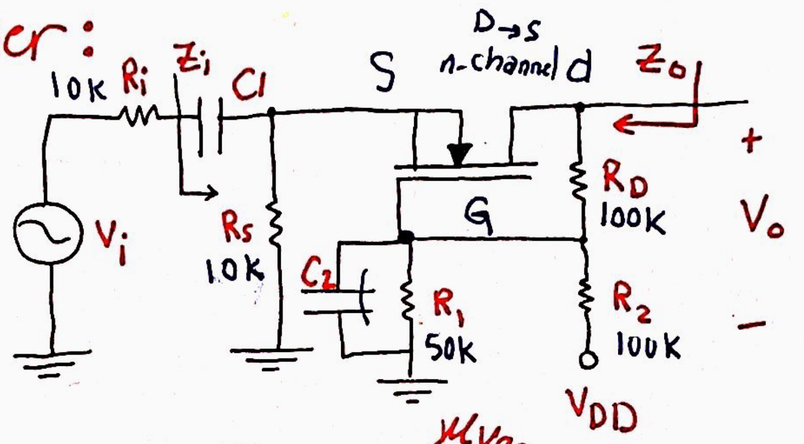
Electronics : ENEE236 → L17 FET Design

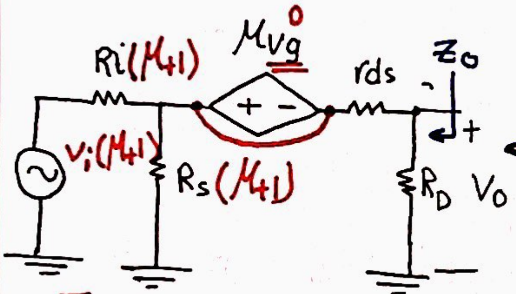
Comon Gate Amplifier :

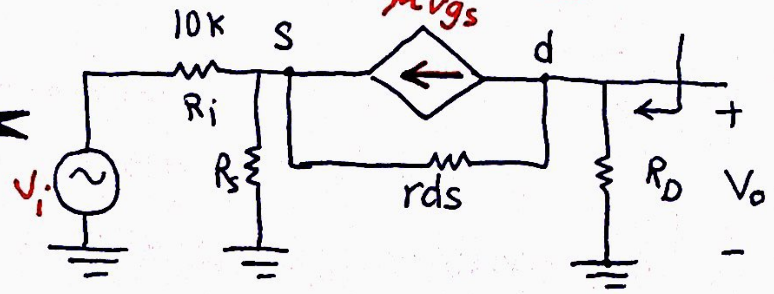
Z_i, Z_o, A_v

Short "C"

$V_{DD} \rightarrow$ ⏚

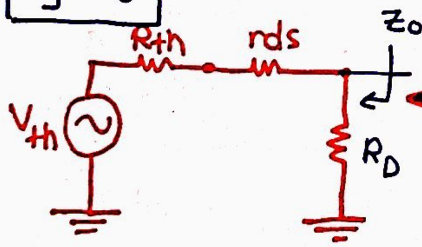


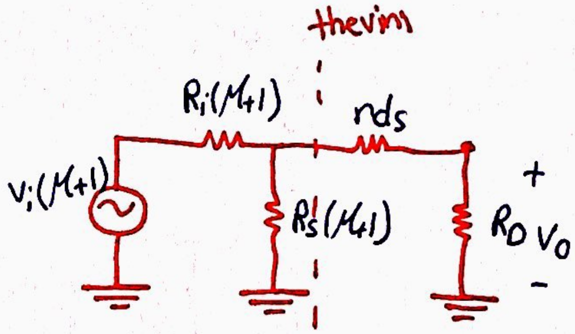




[Drain Eq. Circuit]

$\boxed{V_g = 0}$





" special case "

$$R_{th} = 5K(\mu+1) = R_i(\mu+1)/2$$

, $V_{th} = \frac{1}{2} V_i(\mu+1)$ لانو $R_s = R_i$ في الجهد عليها بنقسم للنص في كل وحدة بتوخذ $\frac{(\mu+1)V_i}{2}$

$$V_o = \frac{R_D}{R_D + rds + R_{th}} \cdot V_{th}$$

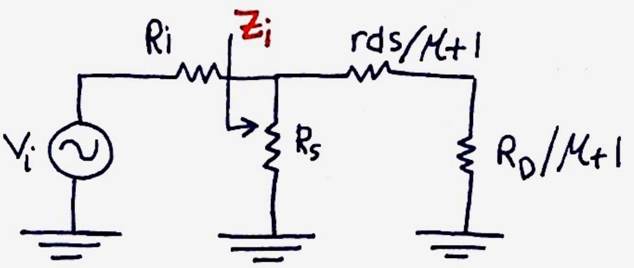
$$V_o = \frac{R_D}{R_D + rds + R_{th}} \cdot \frac{(\mu+1)V_i}{2}$$

$$\boxed{\therefore A_V = \frac{R_D(\mu+1)}{2\left[R_D + rds + \frac{R_i(\mu+1)}{2}\right]}}$$

$$Z_o\Big|_{V_{th}=0} = R_D \,//\, (R_{th} + rds) = R_D \,//\, \left(rds + \frac{5K(\mu+1)}{2}\right)$$

when $rds \approx \infty$ $\quad Z_o = R_D$

to Find $Z_i \longrightarrow$ Source Eq. is needed



$$Z_i = R_S \,//\, \left(\frac{r_{ds} + R_D}{\mu + 1} \right)$$

$$Z_i \Big|_{r_{ds} \to \infty} = R_S \,//\, \frac{1}{g_m}$$

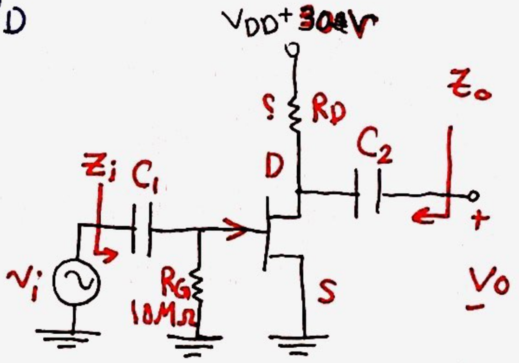
FET Amplifier Design "Important"

- Design a fixed Bias network such that the ac voltage gain $|A_V| = 10$, i.e. find value of R_D

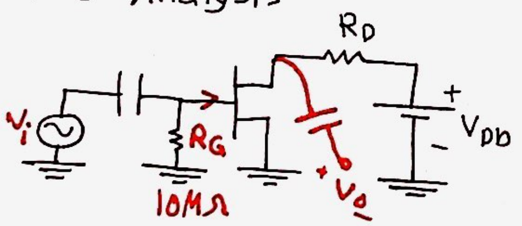
$V_P = -4V$

$I_{DSS} = 10\,mA$

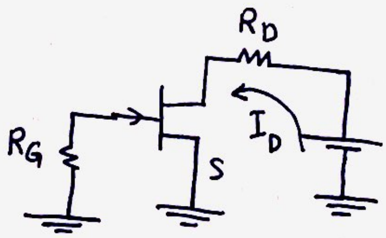
$r_{ds} = 50K\Omega$



After Analysis



$\Rightarrow$



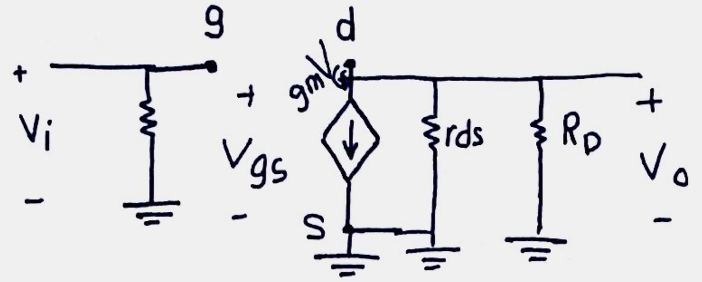
$V_{GS} = V_G - V_S$ "DC Analysis"

$= 0 - 0 = 0$

$$I_D = I_{DSS} \left(1 - \frac{V_{GS}}{V_P} \right)^2$$

$= 10\,mA$

$$g_m = \frac{2 I_{DSS}}{|V_P|} \left(1 - \frac{\overset{0}{V_{GS}}}{V_P} \right) = \frac{2 \times 10\,mA}{4} = 5\,mS$$



Ac Analysis

$v_o = -V_{gs} g_m (R_D // rds)$

$v_{gs} = V_i$

$|A_v| = \frac{V_o}{V_i} = |-g_m(R_D // rds)| = 10$

$rds // Rd = \frac{10}{5m} = 2K\Omega$

$\frac{\cancel{rds}^{50} \times Rd}{\cancel{rds}^{50} + Rd} = 2k \Rightarrow \boxed{R_D = 2.08\,K\Omega}$

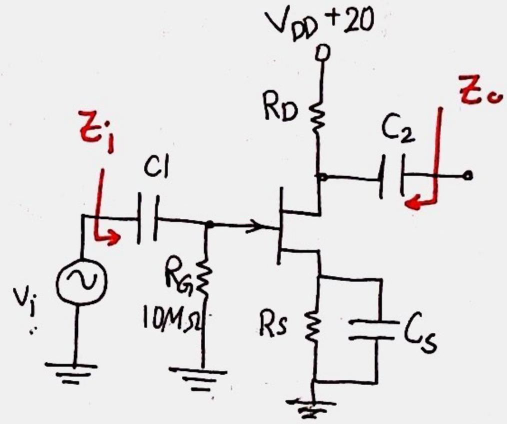
Design Example 2 "Important"

Choose the value of R_D & R_S that will result in voltage gain $|A_v| = 8$, Using the value of g_m defind by $V_{GSQ} = \frac{1}{4} V_p$

$V_p = -4 \Rightarrow V_{GSQ} = -1$

$I_{DSS} = 10mA$

$r_{ds} = 50K$



at dc → C → "open"
at AC → C → short

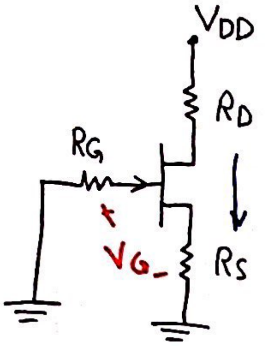
زي اللي مرقت بال A.C.A

$|A_v| = |-g_m(R_D // rds)|$

$g_m = \frac{2 \times 10mA}{4}\left(1 - \frac{-1}{-4}\right) = 5m\,S \times 0.75 = 3.75\,S$

$\frac{8}{3.75} = \frac{R_D \times 50k}{50K + R_D} \Rightarrow R_d = 2.133k\Omega$

DC Analysis



$V_{GSQ} = \frac{1}{4} V_p = -1$

$= \cancel{V_G} - V_S$, $V_G = 0$, $V_S = I_D R_S$

$-1 = -I_D R_S$

$1 = I_D R_S \Rightarrow R_S = \frac{1}{5.625m} = \cancel{1.77}\ 177.7\Omega$

Use Standard Value! 180Ω

$I_D = I_{DSS}\left(1 - \frac{V_{GS}}{V_p}\right)^2$

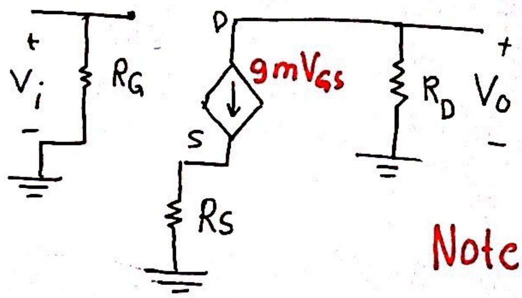
$= 10mA\left(1 - \frac{1}{4}\right)^2 = 5.625mA$

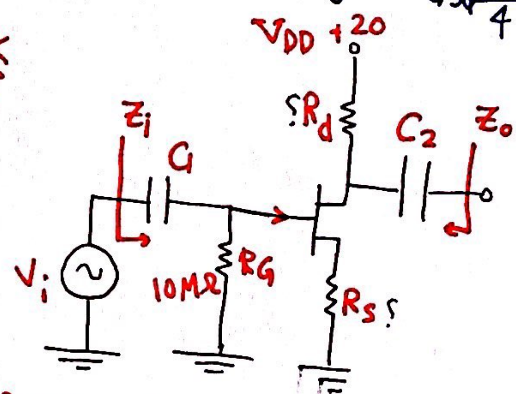
Design Example 3

Choose the value of R_D & R_S that will result in $|A_V| = 8$, using the value of g_m def. by: $V_{GSQ} = \frac{1}{4} V_p$

$V_p = -4$, $V_{GSQ} = -1$, $I_{DSS} = 10mA$, $r_{ds} = \cancel{50K}\ \infty$

AC SS Eq. Circuit:





Note: This the same Previous Ex. except that no CS Cap.

$g_m = 3.75$ (from Previous Ex)

$A_V = \frac{V_o}{V_i}$

$V_o = -g_m V_{GS}(R_D \parallel r_{ds})$

$V_{GS} = V_G - V_S = V_G - g_m V_{gs} R_s$

$V_g = V_i \Rightarrow V_{gs} = V_i - g_m V_{gs} R_s$

$V_i = V_{gs} - g_m V_{gs} R_s$

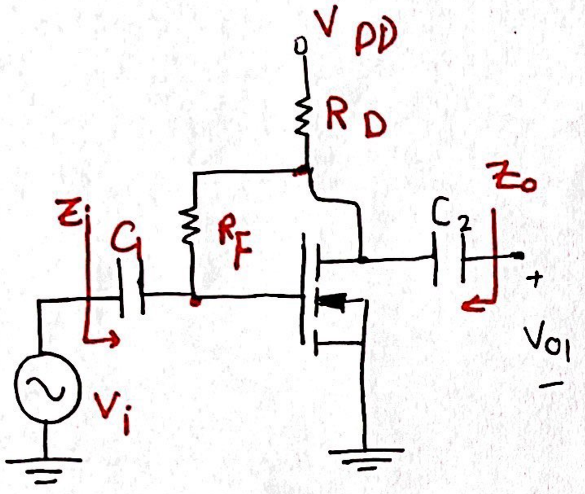
$V_o = \frac{-g_m V_{gs}(R_D)}{V_{GS} + g_m V_{gs} R_s} = \frac{-g_m R_D}{1 + g_m R_s}$

$|A_V| = \left|\frac{-g_m R_D}{1 + g_m R_s}\right| = 8 \Rightarrow R_s = 177.7 \approx 180$

$R_D = 3.573k\Omega$

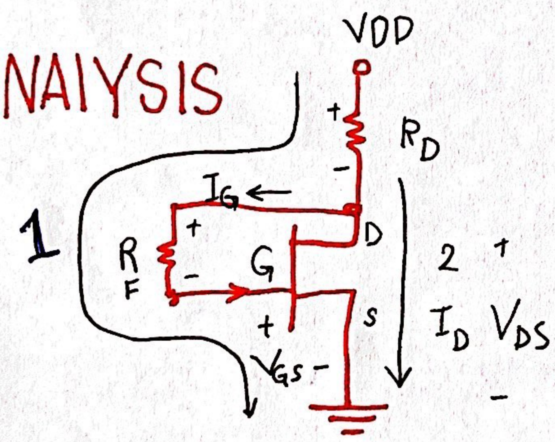
4.

Drain Feedback Configaration



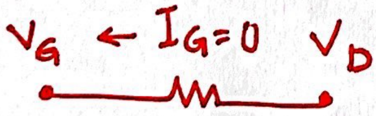
Just DC Analysis

DC ANAIYSIS



① $V_{DD} = I_D R_D + \cancel{I_G}^{0} R_F + V_{GS} \ldots \longrightarrow V_{GS} = V_{DD} - I_D R_D$

② $V_{DD} = I_D R_D + V_{DS} \longrightarrow V_{DS} = V_{DD} - I_D R_D$



$V_D = V_G$

$V_{DS} = V_{GS}$