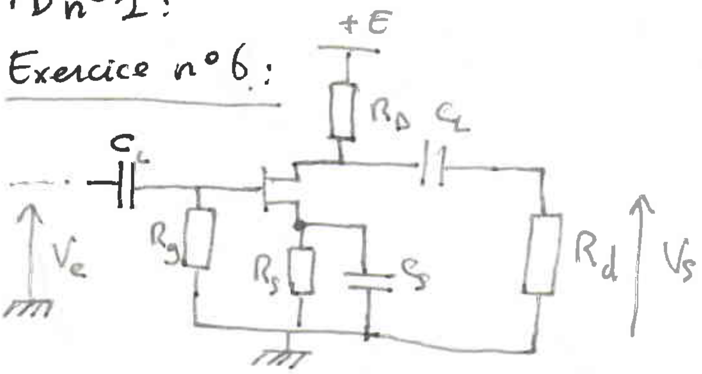
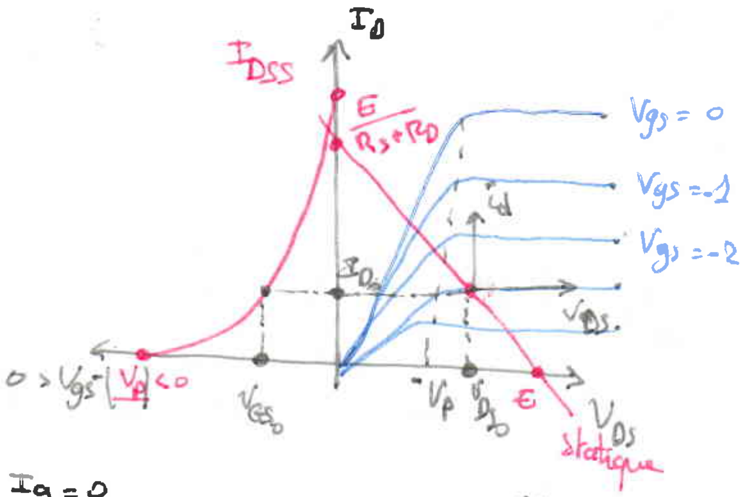
TD n°1 :

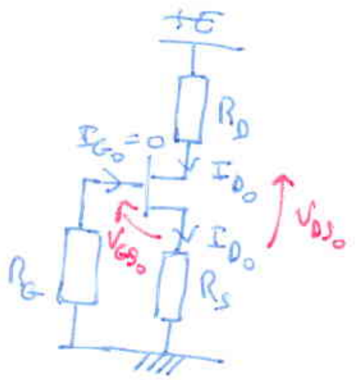
Exercice n°6 :





1- point de polarisation:

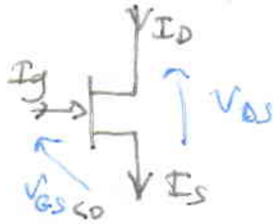
Modèle statique : $-||- \equiv$ –o⁄ o–



$I_g = 0$

$I_D = I_S$

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



=> Dans un JFET, $I_G = 0$

(1) $E = R_S I_{D_0} + R_D I_{D_0} + V_{DS_0}$

(2) $0 = R_S I_{D_0} + V_{GS_0} + \underbrace{R_G I_{G_0}}_{=0 \text{ car } I_{G_0}=0}$

(3) $I_{D_0} = \underset{\text{cste}}{I_{DSS}}\left(1 - \frac{V_{gs}}{|V_p| \leftarrow \text{cste}}\right)^2$

3 équations 3 inconnues à calculer

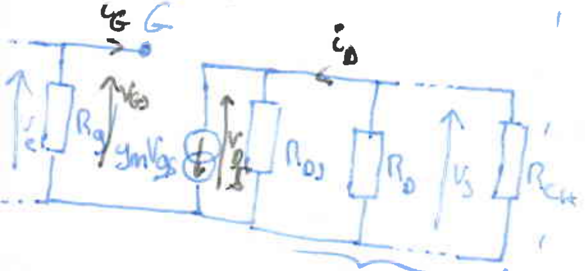
(2) $V_{GS_0} = -R_S I_{D_0} \Rightarrow$ (3) $I_{D_0} = I_{DSS}\left(1 + \frac{R_S I_{D_0}}{|V_p|}\right)^2$

1 équation 1 inconnue (I_{D_0})

$\Delta = b^2 - 4ac$

Injection dans (1) et (2)

2) Donner le gain en tension



$(R_{DS} // R_D) // R_{CH}$

Fonction de transfert :

$V_s = -g_m V_{gs} (R_{DS} // R_D) // R_{CH}$

$V_e = V_{gs}$

$\frac{V_s}{V_e} = -g_m (r_{DS} // R_D // R_{CH}) = G_V = A_{V_0}$

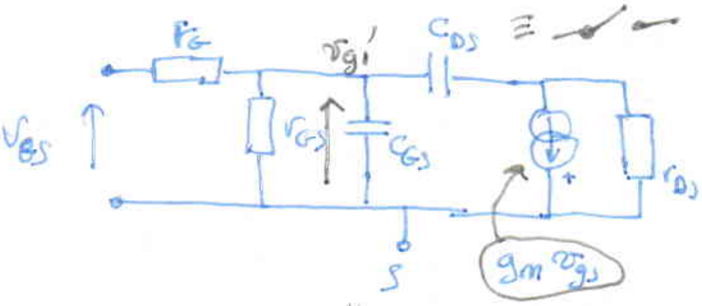
Gain dynamique.

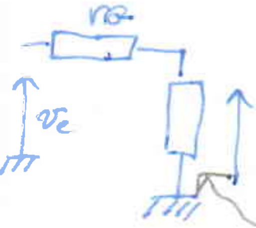
Trouver la tension à vide : $R_{CH} \to +\infty$.

$A_{V_0} = \lim_{R_{CH} \to +\infty} A_V = -g_m (r_{ds} // R_D)$

$A_V = \frac{V_S}{V_e} = -g_m(r_{DS} // R_D // R_{CH})$

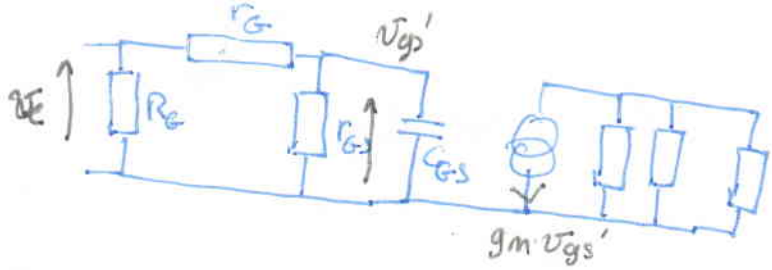
$v_s = -g_m v_{gs}'(r_{DS} // R_D // R_{CH})$





$$V_{GS}' = v_e \frac{\frac{r_{GS}}{1+jr_{GS}C_{GS}\omega}}{r_g + \frac{r_{gs}}{1+jr_{GS}C_{GS}\omega}}$$

⇓

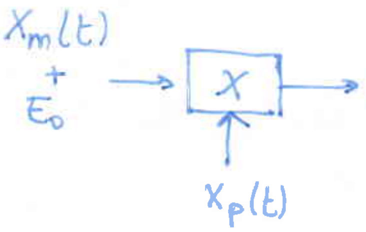


$$V_{GS}' = v_e \frac{r_{GS}}{r_G + r_{GS}} \cdot \frac{1}{1 + j r_G // r_{GS} C_{GS}\omega}$$

$$\frac{v_s}{v_e} = -g_m(r_{DS} // R_D // R_{CH})\left(\frac{r_{gs}}{r_g + r_{GS}}\right)\left(\frac{1}{1 + j r_g // r_{gs} C_{GS}\omega}\right)$$

TD2 :

AM → DBSP
AM → DBPC



$(E_0 + X_m(t))x_p(t) = X_s(t)$

$X_m(t) = A_m\cos(\omega_m t)$

$X_p(t) = A_p\cos(\omega_p t)$

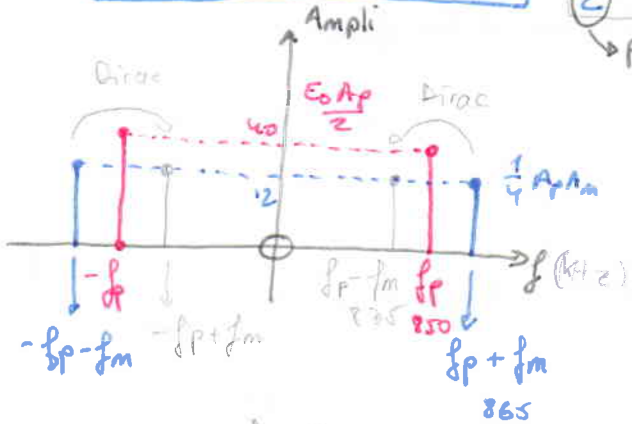
$X_s(t) = (\underset{\text{offset}}{E_0} + A_m\cos(\omega_m t))A_p\cos(\omega_p t)$

$X_s = E_0 A_p\left(1 + \overset{m}{\frac{A_m}{E_0}}\cos(\omega_m t)\right)\cos(\omega_p t) = E_0 A_p\cos(\omega_p t) + A_p A_m\cos(\omega_m t)\cos(\omega_p t)$

$X_s(t) = \underbrace{E_0 A_p\cos(\omega_p t)}_{\text{spectre}} + \frac{1}{2}A_pA_m\cos(\omega_p + \omega_t)t + \frac{1}{2}A_pA_m\cos(\omega_p - \omega_m)t$

→ Formule de Moivre cos → e

2 types d'amplitude :
→ Avec porteuse
→ Sans porteuse



- Sans porteuse, on aurait pas le pic central (celle de la porteuse)
- Fréquence de la porteuse : 850 kHz
- La présence de pic signifie que on a que des cos ou sin.
- Fréquence du modulant : 15 kHz

Porteuse

$P_T = \frac{2}{3}P_T + \underset{USB}{\frac{1}{6}P_T} + \underset{LSB}{\frac{1}{6}P_T}$

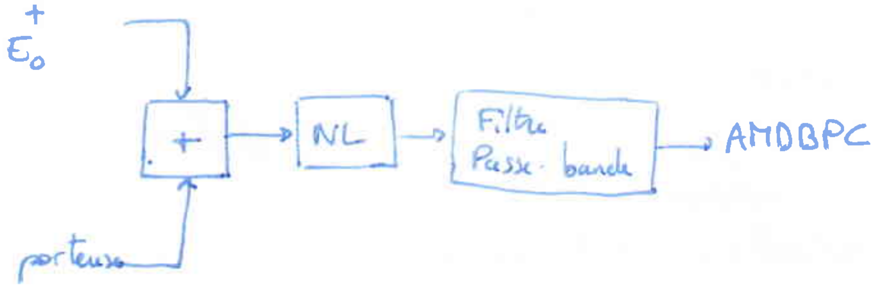
$P_T = \cancel{\frac{2}{3}P_T} + \frac{1}{6}P_T + \frac{1}{6}P_T$

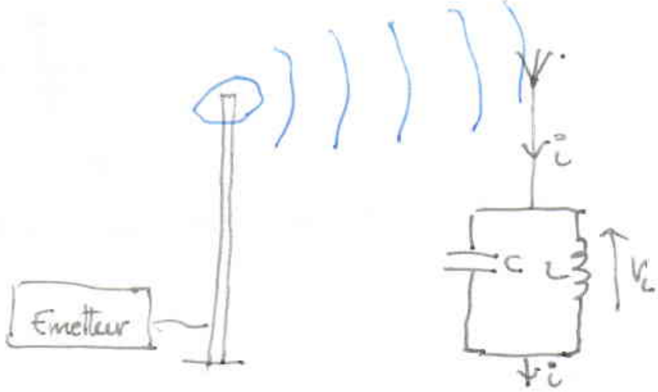
Grande ondes
Avec porteuse

Petites ondes (AM)
Sans porteuse

$$m = \frac{A_m}{E_0} \qquad \frac{40}{12} = \frac{\frac{E_0 A_p}{2}}{\frac{1}{4} A_m A_p} = 2\frac{E_0}{A_m} \qquad f_{m_{max}} = 5\,\text{kHz}$$

$$v = \frac{A_m}{E_0} = \frac{3}{5} = 0{,}6 \quad \text{Indice de modulation}$$





1) Calculer l'équation représentant la tension aux bornes de LC en fonction de i.

$$V_L = i\,\frac{\frac{1}{jC\omega} \times jL\omega}{\frac{1}{jC\omega} + jL\omega} = i\,\frac{jL\omega}{1 - LC\omega^2}$$

2) On suppose que $i = I\cos(2\pi f t)$, avec $f = 220\,\text{kHz}$ et la capacité $C = 410\,\text{pF}$

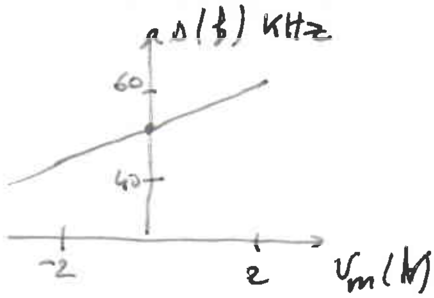
Pour avoir le max il suffit que le dénominateur soit à 0.

$$1 - LC\omega^2 = 0 \iff L = \frac{1}{C\omega^2}$$

Exos : Modulation de fréquence à l'aide d'un VCO. $V_m(t)$ — VCO — $s(t) = 10\cos(\theta(t))$

- Sensibilité du VCO :

$$k = \frac{20 \cdot 10^3}{4} = 5 \cdot 10^3\ \text{Hz/V}.$$



- $v_m(t) = 0{,}6\cos(\underbrace{2\pi\, 2000 t}_{max = 1}) \Rightarrow$ max 0,6 — freq modulant
- $f(t)$? Δf ? $\omega(t)$? $\theta(t)$? β ? $s(t)$?

$f(t) = V_m \times k + 50 \times 10^3$ $(ax+b)$

Si on met 0V, on obtient 50kHz à 10V d'amplitude (20V cac)

$\Delta f = f_{max} - \bar{f} = (0{,}6k + 50 \cdot 10^3) - 50 \cdot 10^3 = 0{,}6k = 3 \cdot 10^3\,\text{Hz}$

$\omega(t) = 2\pi f(t) = 2\pi k V_m + 50 \times 10^3 =$

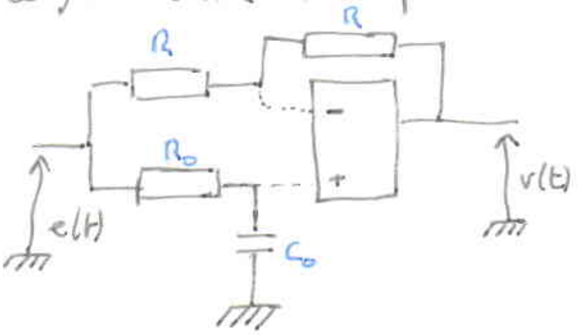
$\frac{d\theta(t)}{dt} = \omega(t) \iff \theta(t) = 2\pi k \int 0{,}6\cos(2\pi\, 2\cdot 10^3 t) + 50 \cdot 10^3 t + \theta_0$ (cste)

$= \frac{0{,}6 \times 2\pi k \sin(2\pi\, 2 \cdot 10^3 t)}{2\pi \cdot 2 \cdot 10^3} + 50 \cdot 10^4 t \quad = \frac{3 \times 10^3}{2 \times 10^3} \sin(2\pi\, 2 \cdot 10^3 t) + C \cdot 10^4 t + \theta_0$

$\beta = \max(\theta(t)) = \theta(0) = \frac{3}{2} \times \sin(0) = \frac{3}{2} = 1{,}5$.

$s(t) = 10 \cos[\theta(t)]$.

Coef de Bessel : $m = \beta$.



Millman :

$V^-\left(\frac{1}{R} + \frac{1}{R}\right) = \frac{e(t)}{R} + \frac{v(t)}{R}$

$V^+\left(\frac{1}{R_0} + jC_0\omega\right) = \frac{e(t)}{R_0} + jC_0\omega$

$V^+ = V^-$

$$\begin{cases} V^+ = \dfrac{e}{1 + jR_0C_0\omega} \\ V^- = \dfrac{e+v}{2} \end{cases} \quad V^+ = V^- \Rightarrow \frac{e+v}{2} = \frac{e}{1+jR_0C_0\omega} \quad \dots \quad \frac{V}{e} = \frac{1-jR_0C_0\omega}{1+jR_0C_0\omega}$$

$e(1+jR_0C_0\omega) + v(1+jR_0C_0\omega) = 2e$

$$V = \left(\frac{1-jR_0C_0\omega}{1+jR_0C_0\omega}\right) e \iff V_m = E_m \times 1$$

$\mathrm{mod}\left(\frac{\bar{z}}{z}\right) = 1$

$\mathrm{Arg}(1 + jR_0C_0\omega) = \arctan(R_0C_0\omega)$

$a + jb = |z| e^{j\theta}$

$\cos(\theta) = \frac{a}{\sqrt{a^2+b^2}}$

$\varphi = -2\arctan(R_0C_0\omega)$

$\alpha = \arctan(-R_0C_0\omega) - \arctan(R_0C_0\omega)$

$u(t) = k\, e(t)\, v(t) = k E_m \cos(\omega t) V_m \cos(\omega t + \varphi) = V_m k E_m \cos(\omega t)\cos(\omega t + \varphi)$

$u(t) = \frac{1}{2} V_m k E_m \cos(2\omega t + \varphi) + \frac{1}{2} k E_m V_m \cos(\varphi)$

$$s(t) \sim \frac{1}{2} k E_m V_m \cos(\varphi) = \frac{1}{2} k E_m V_m \left[\frac{2}{1+\left(\frac{\omega}{\omega_0}\right)^2} - 1\right] = \frac{1}{2} k E_m V_m \frac{1-\left(\frac{\omega}{\omega_0}\right)^2}{1+\left(\frac{\omega}{\omega_0}\right)^2}$$