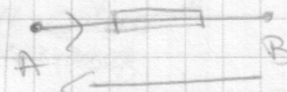
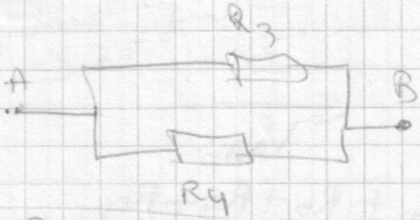
TD électronique

1.1. $\boxed{R_{AB} = R_1 + R_2}$ $R \geq 0$ A.N $R_{AB} \simeq 500\,\Omega$

1.2. 

$U_{AB} = R.I$



$\frac{1}{R_{AB}} = \frac{1}{R_3} + \frac{1}{R_4}$

$\frac{1}{R_{AB}} = \frac{R_4 + R_3}{R_3 . R_4} \rightarrow \boxed{R_{AB} = \frac{R_3 \times R_4}{R_3 + R_4}}$

• si $R3 \ll R4$ $R_{AB} = \frac{R_4 . R_3}{R_4\left(1 + \frac{R_3}{R_4}\right)} = \frac{R_3}{1 + \frac{R_3}{R_4}}$ $\boxed{\frac{R3}{R4} \ll 1 \Rightarrow R_{AB} \sim R_3}$

• A.N : i) $R_{AB} = \frac{100 . 500}{600}$: $= 83\,\Omega$

ii) $R_{AB} \simeq 250\,\Omega$

iii) $R_{AB} \simeq 9,1 \sim R_4$ car $R_4 \ll R_3$

1.3 : → fig 3 : R_{AB} $\frac{1}{R_{AB}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} = \frac{R_1 + R_2}{R_1 R_2} + \frac{1}{R_3}$

$\frac{1}{R_{AB}} = \frac{(R_1 + R_2) . R_3 + R_1 R_2}{R_1 R_2 R_3}$ $R_{AB} = \frac{R_1 R_2 R_3}{(R_1 + R_2) . R_3 + R_1 R_2} = 58,8\,\Omega$

→ fig 4 R $\frac{1}{R_{AB}} = \frac{1}{R_1 + R_2} + \frac{1}{R_3 + R_4} = \frac{1}{400} + \frac{1}{600} = \frac{600 + 400}{400 . 600}$

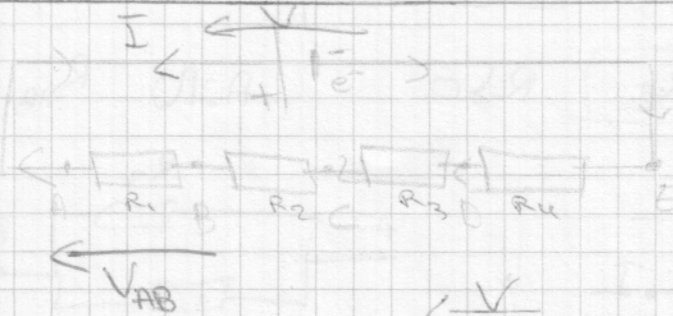
$R_{AB} = 240\,\Omega = \frac{(R_1 + R_2)(R_3 + R_4)}{R_1 + R_2 + R_3 + R_4}$

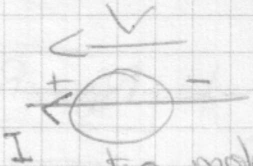
→ fig 5

$R_{AB} = \frac{R_5 . \left[\left(\frac{R_1 . 5}{R_1 + 5}\right) + R_4\right]}{R_5 + \left(\frac{R_1 . 5}{R_1 + 5}\right) + R_4} = 2,93\,\Omega$

2. Schémas Diviseur de Tension et diviseur de courant.

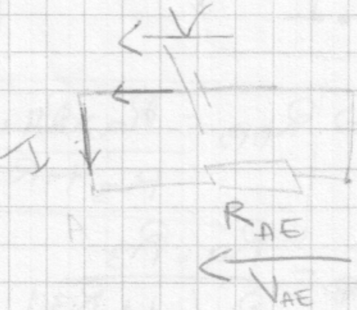
voir fig 6





autre notat° générateur

2.1 $R_{AE} = R_1 + R_2 + R_3 + R_4$



Loi d'ohm

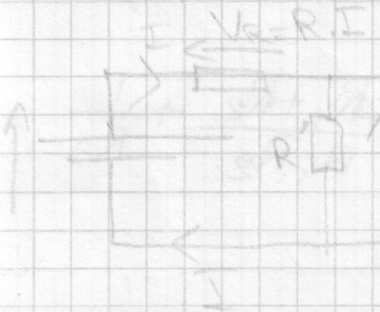
$\rightarrow V_{AE} = R_{AE} \cdot I$

loi des mailles $V = V_{AE}$ $\longrightarrow I = \dfrac{V}{R_{AE}}$

or $V_{AB} = R_1 \cdot I$ $\quad V_{BC} = R_2 \cdot I$ $\quad V_{CD} = R_3 \cdot I$ $\quad V_{DE} = R_4 \cdot I$

$V_{BC} = R_2 \cdot I = \dfrac{R_2}{R_{AE}} V$ $\qquad \boxed{V_{BC} = V \cdot \dfrac{R_2}{R_1 + R_2 + R_3 + R_4}}$ diviseur de tens°

$= \dfrac{V}{R}$ ici $\dfrac{V}{R_{AE}}$

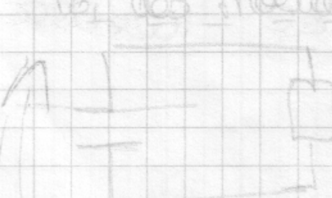


$V = V_R + V_{R'} = RI + R'I = (R + R')I$

$\boxed{V_{R'} = \dfrac{R'}{R + R'} V}$ pont diviseur de tens°

2.2 Diviseur de courant voir fig 7

loi des nœuds $I = I_1 + I_2 + I_3 + I_4$



$R_{eq} = (R_1 // R_2 // R_3 // R_4)$ $\Rightarrow$ loi d'ohm

$V = R_{eq} \cdot I$

$V_{R_2} = R_2 I_2 = V = R_{eq} I$ $\qquad \boxed{I_2 = I \cdot \dfrac{R_{eq}}{R_2}}$

TD Electronique

3) Analyse de réseaux linéaires

3.1) Resolution par le théorème de Thevenin.

1)

a) maille 1 : $E_1 + E_2 = ri_2 + Ri_3 = (r+R)i_3$ (1)

maille 2 = $(R+r)\, i_2 = (r+R)\, i_3$ (2)

loi des noeuds = $i_1 = i_2 + i_3$ (3)

$B/C/A_1\ E_{th} = Ri_2 - ri_3$ (4)

$B/D/A_1 \cdot E_{th} = -ri_2 + Ri_3$ (5)

Determinons Eth

de la ref(2) - $i_2 = i_3$

(1) $i_3 = \dfrac{E_1+E_2}{r+R}$ de (4) $E_{th} = (R-r)i_3 = \dfrac{(R-r)(E_1+E_2)}{(R+r)}$

$R_{AB} = R_{th} = (R//R) + (r//R)$
$= \dfrac{rR}{r+R} + \dfrac{rR}{R+R} = \dfrac{2rR}{r+R}$

$E_{th} = (R_{th}+R)\, i'$

$i' = \dfrac{E_{th}}{R_{th}+R} = \dfrac{(R-r)(E_1+E_2)}{(R+r)\left(R + \dfrac{2rR}{r+R}\right)} = \dfrac{(E_1+E_2)(R-r)}{R^2+3rR}$

A.N : $E_{th} = 33\,V$
$R_{Th} = 16\ \Omega$
$i' = 0{,}25\ A$

Calcul Eth

b) maille 1 : $E_1 = Ri_1 + Ri_3$

maille 2 : $E_2 = Ri_1 + 2ri_2$

loi des Noeuds : $i_1 = i_2 + i_3$

$E_{th} = ri_2$

① $E_1 = R(i_1 + i_3) = R(2i_1 - i_2)$

② $E_2 = Ri_1 + 2ri_2$

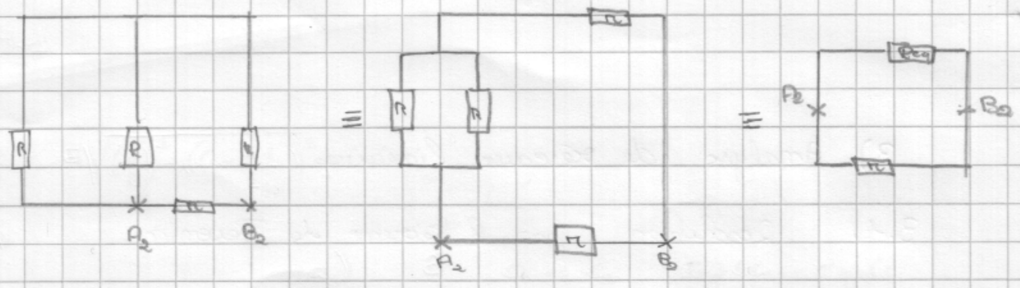
2) $i_1 = \dfrac{E_2 - 2ri_2}{R}$

1) $E_1 = \dfrac{2R(E_2 - 2ri_2) - Ri_2}{R}$

$\iff i_2 = \dfrac{2E_2 - E_1}{4r+R} \iff i_2 = \left(E_2 - \dfrac{E_1}{2}\right)\dfrac{1}{2r+\frac{R}{2}}$

$E_{th} = \left(E_2 - \dfrac{E_1}{2}\right)\dfrac{r}{2r+\frac{R}{2}}$

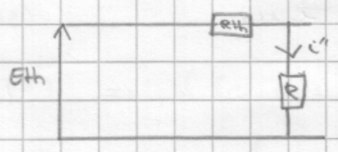
Résistance de Thévenin



$$R_{eq} = r + \frac{R}{2} \qquad R_{th} = \left(\frac{1}{r} + \frac{1}{r+\frac{R}{2}}\right)^{-1} = \left(\frac{2r+\frac{R}{2}}{r^2 + \frac{rR}{2}}\right)^{-1}$$

$$R_{th} = \frac{2r^2 + rR}{4r + R}$$

$$i'' = \frac{E_{th}}{R + R_{th}}$$



A.N $\quad E_{th} = 0{,}33\,V \qquad R_{th} = \frac{8}{3}\left(2^{2/3}\,\Omega\right) \qquad i'' = 0{,}03125\,A$

2) a) $$\frac{di'}{dR} = 0 = \frac{(E_1+E_2)(R^2+3rR) - (E_1+E_2)(R-r)(2R+3r)}{(R^2+3rR)^2}$$

dénominateur $\neq 0$ $\Rightarrow$ numérateur $= 0$

$$\Rightarrow -R^2 + 2rR + 3r^2 = 0$$

$$\Delta = 4r^2 + 12r^2 = 16r^2 = (4r)^2$$

$$R = \frac{-2r \pm 4r}{-2} = \begin{cases} 3r \\ \text{imp} \end{cases} \qquad R = 3r$$

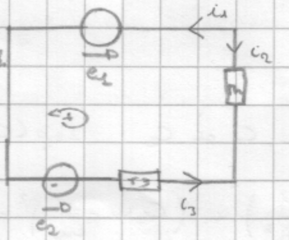
b) $V_2 = Ri''$ $\qquad$ V_2 max quand $\frac{dV_2}{dR} = 0$

On trouve $-R^2 + 2r^2 = 0$ $\qquad R = \sqrt{2}\,r$

3.2 Resolution par 4 methodes.

a) Kirchhoff

Loi des maille.



$e_2 - e_1 = r_3 i_3 - R_2 i_2$

Maille 1 : $-E_1 = -r_1 i_1 - R_2 i_2$ (1)

Maille 2 : $0 = -RI + R_1 i_2 - r_2 i_3$ (2)

Maille 3 : $E_2 = -r_2 i_1 + R_2 i_3$ (3)

A : $i_1 = I + i_2$ (4)

B $I = i_3 + i_1$ (5)

(3) et (5)

$E_2 = R_2 i_3 - r_2 (I - i_3) \iff i_3 = \dfrac{E_2 + r_2 I}{R_2 + r_2}$

(1) et (4)

$-E_1 = -R_1 i_2 - r_1 (I + i_2) \iff i_2 = \dfrac{E_1 - r_1 I}{R_1 + r_1}$

3 ds 2 :

On obtient $I = \dfrac{\dfrac{R_1 E_1}{R_1 + r_1} - \dfrac{R_2 E_2}{R_2 + r_2}}{R + \dfrac{r_1 R_1}{R_1 + r_1} + \dfrac{r_2 R_2}{R_2 + r_2}}$

A.N $I = \dfrac{10}{11} = 0{,}91$ A.

b) Superposition

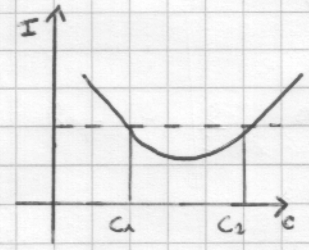
→ On éteind E_2 et donc on a 2 mailles

maille (1) $-E_1 = -r_1 i_1 - R_1 i_2$

IV Mesure d'inductance

4.1 mesure d'inductance

$$I_{eff} = E\sqrt{\left(\frac{1}{R}\right)^2 + \left(C\omega - \frac{1}{L\omega}\right)^2}$$



a) $\hat{c}$. C_1 et C_2 $I_{eff}(C_1) = I_{eff}(C_2)$

$$\cancel{\left(\frac{1}{R^2}\right)^2} + \left(C_1\omega - \frac{1}{L\omega}\right)^2 = \cancel{\left(\frac{1}{R}\right)^2} + \left(C_2\omega - \frac{1}{L\omega}\right)^2$$

$$\Rightarrow \left(C_1\omega - \frac{1}{L\omega}\right)^2 - \left(C_2\omega - \frac{1}{L\omega}\right)^2 = 0 \qquad [A^2 - B^2 = (A-B)(A+B)]$$

$$\Rightarrow \left((C_1+C_2)\omega - \frac{2}{L\omega}\right)\left((C_1 - C_2)\omega\right) = 0$$

$$\hookrightarrow (C_1 + C_2)\omega = \frac{2}{L\omega} \Rightarrow L = \frac{2}{\omega^2 (C_1 + C_2)}$$

b) i minimal pour C_0 donné

$$\min(I_{eff}) \Leftrightarrow \left(C_0\omega - \frac{1}{L\omega}\right) = 0$$

$$C_0 = \frac{1}{L\omega^2} = \frac{1}{0{,}2 \cdot (1000)^2} = 5\,\mu F$$

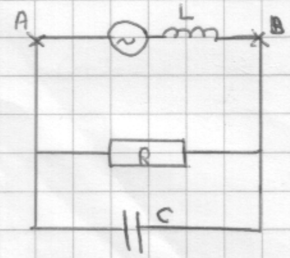
$$I_{eff\,min} = \frac{E}{R} = 0{,}02\,A$$

c) $C_0 = 0{,}02\,A$

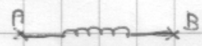
C_1 et C_2 $\quad I_{eff} = E\left(\left(\frac{1}{R}\right)^2 + \left(C_1\omega - \frac{1}{L\omega}\right)^2\right)^{\frac{1}{2}} = 0{,}0269\,A$

4.2 Modélisation de Norton

a)



$\Longleftrightarrow$



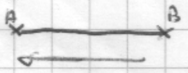
$Z_{N_0} = jL\omega$

$$e = +L\frac{di}{dt}$$

$$= L\frac{d}{dt}(e^{j\omega t}) = j\omega L\, i$$

$$\tilde{e}(t) = e\, e^{j\omega t}$$

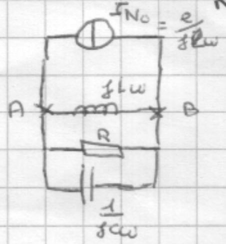
I_{N_0} ?



$$u_{AB} = 0 = e(t) - jL\omega \tilde{I}_{N_0} \Rightarrow \tilde{I}_{N_0} = I_{N_0} e^{j\omega t} = \frac{\tilde{e}(t)}{jL\omega}$$

$$\Rightarrow I_{N_0} = \frac{e}{jL\omega}$$

$\Rightarrow$



Calcul de Z_{AB}

$$\frac{1}{\tilde{Z}_{AB}} = Y = \frac{1}{R} + jC\omega + \frac{1}{jL\omega} = \left(\frac{1}{R} + j\left(C\omega - \frac{1}{L\omega}\right)\right)$$

$$\tilde{Z}_{AB} = \frac{1}{\left(\frac{1}{R} + j\left(C\omega - \frac{1}{L\omega}\right)\right)} \Rightarrow U_{AB} = \tilde{Z}_{AB} I_{N_0} = \frac{I_{N_0}}{Y}$$

$$\bar{U}_{AB} = RI_R \Rightarrow I_R = \frac{I_{N_0}}{RY} = \frac{e}{jL\omega} \times \left(\frac{1}{R\left(\frac{1}{R} + j\left(C\omega - \frac{1}{L\omega}\right)\right)}\right) = \frac{e}{jL\omega + R(1 - LC\omega^2)}$$

b $\bar{I}_R = \dfrac{e}{jL\omega + R(1 - LC\omega^2)}$

valeur eff de $e(t)$

$$e(t) = E\sqrt{2}\cos(\omega t) \rightarrow e(t) = E\sqrt{2}\, e^{j\omega t}$$

$$\left|\begin{array}{l} e_{eff} = E\sqrt{2} \\ \mathrm{Arg}(e(t)) = \omega t \end{array}\right.$$

$$\bar{I}_R = I e^{j(\omega t + \varphi)}$$

$$= I_{Reff}\sqrt{2}\, e^{j(\omega t + \varphi)} \qquad \text{avec} \begin{cases} I = I_{Reff}\sqrt{2} \\ \mathrm{Arg}\, I = \omega t + \varphi \end{cases}$$

$$|\bar{I}_R| = \frac{E\sqrt{2}}{\underset{\substack{\uparrow \\ \text{module}}}{|jL\omega + R(1 - LC\omega^2)|}}$$

$$\left.\begin{array}{l} X = |jL\omega + R(1 - C\omega^2 L)| \\ = |a + bj| = \sqrt{a^2 + b^2} \quad j^2 = -1 \\ = \left(L^2\omega^2 + R^2(1 - CL\omega^2)^2\right)^{\frac{1}{2}} \end{array}\right\} \quad I_{Reff} = \frac{E}{\sqrt{(L\omega)^2 + R^2(1 - CL\omega^2)^2}}$$

$$\mathrm{Arg}\, I = \mathrm{Arg}\, e - \mathrm{Arg}(X)$$

$$\omega t + \varphi = \omega t - \mathrm{Arg}\, X \Rightarrow \varphi = -\mathrm{Arg}\, X$$

Calcul de $-\mathrm{Arg}\, X$

$$-\mathrm{Arg}\, X = -\mathrm{Arg}\left(R(1 - CL\omega^2) + jL\omega\right) = -\mathrm{Arctan}\left(\frac{L\omega}{R(1 - LC\omega^2)}\right)$$

$$\Rightarrow \varphi = \mathrm{Arctan}\left(\frac{L\omega}{R(LC\omega^2 - 1)}\right)$$

$$\bar{I}_R = \frac{E\sqrt{2}}{R(1-LC\omega^2)+(L\omega)^2} e^{j(\omega t+\varphi)}$$

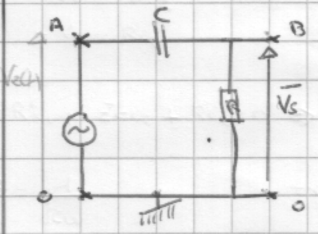
I_R independant quand $(1-LC\omega^2)=0$

$$\omega_0 = \frac{1}{\sqrt{LC}} \quad \text{quand} \quad \omega_0 = \frac{1}{(LC)^{\frac{1}{2}}}$$

$$\varphi = \text{Arctan}\left(\frac{L\omega}{0}\right) \Rightarrow \varphi = \frac{\pi}{2}$$

V Fonction de transfert et filtres

5.1 Filtre RC passe-haut



$$\tilde{V_s}(t) = V_s e^{j(\omega t+\varphi)}$$

$$\tilde{V_e}(t) = V_e e^{j\omega t}$$

$$H(j\omega) = \frac{\tilde{V_s}}{\tilde{V_e}} = \frac{\bar{U}_{OB}}{\bar{U}_{OA}}$$

Fonction de transfert.

$V_e(t) = V_e e^{j\omega t}$

① $v_e = Z_C i(t) + R i(t) = i(t)\left[R + \frac{1}{jC\omega}\right] = \bar{Z}_e i(t)$ avec $\bar{Z}_e = \left(R + \frac{1}{jC\omega}\right)$

$Z_C = \frac{1}{jC\omega}$

② $v_S = R i(t)$

avec ① et ② $\quad \bar{H}(j\omega) = \frac{v_s}{v_e} = \left(\frac{(R+\frac{1}{jC\omega})i}{R\,i}\right)^{-1}$

$$= \frac{1}{\left(1+\frac{1}{jRC\omega}\right)}$$

$\omega_0 = \frac{1}{RC}$

$\rightarrow \quad H(j\omega) = \frac{1}{1-j\left(\frac{\omega_0}{\omega}\right)}$

Representation graphique de la fonction de transfert.

1) ~~Representation~~ Representation graphique de $|H(j\omega)|$

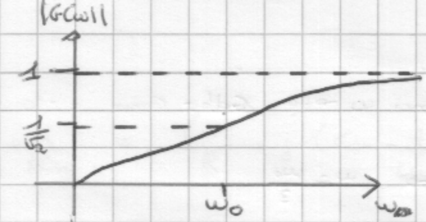
Filtre passe haut car $\lim\limits_{\omega \to \infty} H(j\omega) = 1$

$H(j\omega) = |H(j\omega)| e^{j\varphi}$

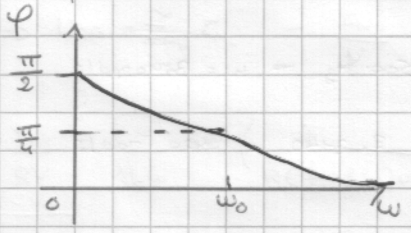
$$G(j\omega) = |H| = \frac{1}{\left|1-j\frac{\omega_0}{\omega}\right|} = \frac{1}{\sqrt{1+\frac{\omega_0^2}{\omega^2}}}$$

$\varphi(\omega) = \text{Arg}\,H = \text{Arg}\,1 - \text{Arg}\left(1-\frac{j\omega_0}{\omega}\right) = 0 - \text{Arctan}\left(\frac{-\frac{\omega_0}{\omega}}{1}\right) = \text{Arctan}\left(\frac{\omega_0}{\omega}\right)$

$$G(\omega) = \frac{1}{\left(1+\left(\frac{\omega_0}{\omega}\right)^2\right)^{\frac{1}{2}}}$$



$$\varphi = \text{Arctan}\ \frac{\omega_0}{\omega}$$



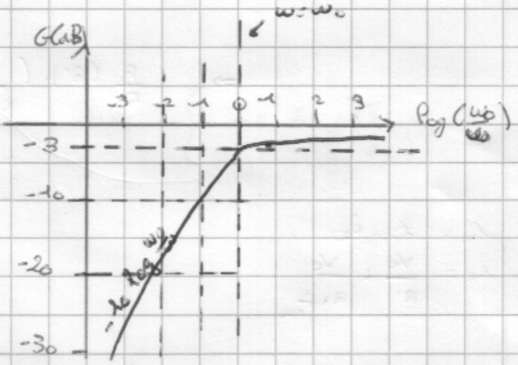
ω	$\lvert G(\omega)\rvert$	φ
0	0	$\frac{\pi}{2}$
∞	1	0
ω_0	$1/\sqrt{2}$	$\frac{\pi}{4}$

2) $G_{db} = 20 \log G = 20 \log \left(1+\left(\frac{\omega_0}{\omega}\right)^2\right)^{-\frac{1}{2}}$

$= -10 \log \left(1+\left(\frac{\omega_0}{\omega}\right)^2\right)$

db = decibel

ω	Gdb	
0	$-10 \log\left(\frac{\omega_0}{\omega}\right)$	
ω_0	$-10 \log(2)$	$= -3$db
∞	0	



Pour chaque passage de ω à $10\,\omega$ on a 1 décroissance de 10 dB la pente de courbe est $\alpha = -1$ on parle d'1 filtre de 1^er ordre.

Frequence de coupure

1) Par def la frequence de coupure opère à ω_0

$$\rightarrow G(\omega_0) = \frac{G_{max}}{\sqrt{2}}$$

AN: $\frac{1}{\left(1+\left(\frac{\omega_0}{\omega}\right)^2\right)^{\frac{1}{2}}} = \frac{1}{\sqrt{2}} \Rightarrow \omega_0 = \omega_c = \frac{1}{RC}$

A.N $f_c = \frac{1}{2\pi}\omega_c = 795\,Hz$ $\qquad R = 5\,\Omega$ et $C = 40\,\mu F$

$^{*} \Rightarrow \left(\frac{\omega_0}{\omega}\right)^2 = 9$

$\frac{\omega_0}{\omega} = 3 \Rightarrow \omega = \frac{\omega_0}{3}$

2) On cherche R/ω affaiblie de 10 dB $\quad G_{dB} = 20 \log G = -10 \log \left(1+\left(\frac{\omega_0}{\omega}\right)^2\right)$

affaiblissement de 10 dB

$G_{dB} = G_{max} - 10 = \log 1 - 10 = -10 = -10 \log \left(1+\left(\frac{\omega_0}{\omega}\right)^2\right)$

$\Rightarrow \log \left(1+\left(\frac{\omega_0}{\omega}\right)^2\right) = 1 \Rightarrow 1 + \left(\frac{\omega_0}{\omega}\right)^2 = 10^1 \Rightarrow ^{*}$

(Suite) Quand $\omega \to +\infty$ $G_{db} = G_{max} = -10 \log\left(1+\left(\frac{\omega_0}{\omega}\right)^2\right) = 0$

$$\frac{\omega_0}{\omega} = 3 \to \omega = \frac{\omega_0}{3}$$

A.N : $f = 500$ Hz $\to \omega = 3140$ rad/s

$\omega_0 = \frac{1}{RC} = 3 \cdot 3140 = 9420$ rad/s $R = 2620\ \Omega$

Utilisation d'une résistance pour R'

1) $-V_e = R' i_2$ $\frac{V_s}{V_e}$?

$-V_s = R i_2$

$\frac{1}{CR} = \omega_0$

$-R' i_1 + Z_c i_2 + R i_2 = 0 \Rightarrow \left(\frac{1}{jC\omega} + R\right) i_2 = R' i_1$

$Z_c = \frac{1}{jC\omega}$ $\Rightarrow \frac{i_1}{i_2} = \frac{1}{R'}\left(\frac{1}{jC\omega} + R\right)$ $\frac{V_s}{V_e} = \frac{R}{R'} \frac{i_2}{i_1}$

$$\Rightarrow \frac{R}{R'} (R') \left(\frac{1}{R + \frac{1}{jC\omega}}\right) = \frac{jRC\omega}{jC\omega R + 1} = \frac{1}{1 + \frac{1}{jCR\omega}} = \frac{1}{1 - j\frac{\omega_0}{\omega}}$$

inchangé (voir fonction de transfert)

2) $i_e = i_1 + i_2$ $V_e = Z_e i_e$

$i_e = \frac{V_e}{R'} + \frac{V_e}{R + \frac{1}{jC\omega}}$

$$i_e = v_e \left(\frac{1}{R'} + \frac{1}{R + \frac{1}{jC\omega}}\right) \Rightarrow Z_e = \frac{1}{\frac{1}{R'} + \frac{1}{R + 1/jC\omega}} = \frac{R'(1 + jC\omega R)}{1 + (R + R') jC\omega}$$

$$|Z_e| = \frac{R'\left(1 + \left(\frac{\omega}{\omega_0}\right)^2\right)^{\frac{1}{2}}}{\left(1 + \frac{(R+R')^2}{R^2}\left(\frac{\omega}{\omega_0}\right)^2\right)^{\frac{1}{2}}}$$

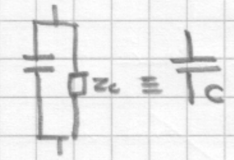
$\omega \to 0$ $|Z_e| = R'$

$\omega \to +\infty$ $|Z_e| \to \frac{RR'}{R+R'}$

5.2 Filtre du 2^{nd} ordre chargé.

Calcul de la fréquence de coupure à -3 dB.

1) $Z_c = \infty$



$u_1 = u_2 + R i_2$ avec $u_2 = \frac{1}{jC\omega} i_2$

$u_1 = u_2 + RC\omega j\, u_2$
$= u_2 (1 + Rj C\omega)$

$H(j\omega) = \frac{u_2}{u_1} = \frac{1}{1 + Rj C\omega} \Rightarrow G = |H| = \frac{1}{[1 + (RC\omega)^2]^{\frac{1}{2}}}$

$$G = \frac{1}{\sqrt{1 + (RC\omega)^2}}$$

$\begin{cases} G(0) = 1 \\ G(\omega \to +\infty) = 0 \end{cases}$ filtre passe-bas

à -3 dB on a $G = \frac{G_{max}}{\sqrt{2}} \Rightarrow \frac{1}{\sqrt{2}} = \frac{1}{\sqrt{1 + (RC\omega)^2}}$

$\Rightarrow (RC\omega)^2 + 1 = 2 \Rightarrow (RC\omega)^2 = 1 \Rightarrow \omega_c = \frac{1}{RC}$

$f_c = \frac{\omega_c}{2\pi} = \frac{1}{2\pi RC} = 530\ Hz$.

2) $Z_c = R$

$\equiv Z_{eq} = \left(\frac{1}{R} + jC\omega\right)^{-1} = \frac{R}{1 + RC\omega j}$

$\begin{cases} u_1 = u_2 + R i_2 \\ u_2 = Z_{eq}\, i_2 \end{cases}$ $\quad u_1 = u_2 \left(1 + \frac{R}{Z_{eq}}\right)$
$\quad u_1 = u_2 (2 + RC\omega j)$

$$H(j\omega) = \frac{1}{2 + (RC\omega) j}$$

$G = \frac{1}{\sqrt{4 + (RC\omega)^2}}$ $\quad G_{max} = G(0) = \frac{1}{2}$

à -3 dB $\quad G(\omega_c) = \frac{G_{max}}{\sqrt{2}} = \frac{1}{2\sqrt{2}} = \frac{1}{(4 + (RC\omega)^2)^{\frac{1}{2}}} \rightarrow (RC\omega)^2 + 4 = 8 \Rightarrow \omega_0 = \frac{2}{RC}$

$f_c = 1060\ Hz$.

Impédance de charge arrangée sur la valeur $Z_c = R$

1) $u_1 = Z_{eq}\, i$
$i = i_1 + i_2$
$i_1 = jC\omega u_1 \qquad i_2 = \frac{u_2}{Z_{eq}} = u_2 \left(\frac{1 + RC\omega j}{R}\right)$

$u_2 = \frac{u_1}{(2 + Rj C\omega)}$

on a $i = jC\omega u_1 + \frac{u_1}{2 + RC\omega j}\left(\frac{1 + RC\omega j}{R}\right)$

$= u_1 \left(jC\omega + \frac{1 + RC\omega j}{R(2 + RC\omega j)}\right)$

$= u_1 \left(\frac{1 + 3RC\omega j - R^2C^2\omega^2}{R(2 + RC\omega j)}\right)$

à $\omega_0 = \frac{2}{RC}$

$\Downarrow$

$Z_c = \frac{R(2 + 2j)}{1 + 6j - 4} = \frac{2R}{3}\left(\frac{1 + j}{2j - 1}\right) \qquad Z_e = \frac{2R}{15}(1 + 3j)$

$R_1 = \frac{2R}{15} \qquad \frac{j}{C_1\omega_0} = -\frac{6R}{15} j \Rightarrow C_1 = \frac{5}{4} C \qquad R_1 = 4\ k\Omega \quad C_1 = 12,5\ nF$.

6) DIODES

si $U_{AB} < V$ $i_{AB} = 0$

$i_{AB} \neq 0$ passant.

$\forall$ U_{AB} $i_{AB} = 0$

Loi des mailles.

$V = R_1 I + R_2 (I - i)$

$U_{BM} = R_2 (I - i)$

$U_{BC} = -R_3 i + R_2 (I - i)$

$U_{CM} = R_3 i$

Si D est passante $U_{BC} = 0{,}7 = V_S$

$$\begin{cases} V = R_1 I + R_2 (I - i) & (1) \\ V_{BC} = V_S = -R_3 i + R_2 (I - i) & (2) \end{cases}$$

$V_S = -i (R_3 + R_2) + R_2 I$

$i (R_3 + R_2) = R_2 I - V_S$

$$i = \frac{(R_2 I - V_S)}{R_2 + R_3} \quad (3)$$

(1) $V = (R_1 + R_2) I - R_2 i$ $\Rightarrow I = \dfrac{V + R_2 i}{R_1 + R_2}$ $\Rightarrow$ (3') $i = \dfrac{R}{(R_2 + R_3)} \dfrac{(V + R_2 i)}{(R_1 + R_2)} - \dfrac{V_S}{R_2 + R_3}$

$\Rightarrow \dfrac{V_S}{\cancel{(R_2 + R_3)}} = \dfrac{R_2 (V + R_2 i)}{(R_2 + R_3)(R_1 + R_2)} - \dfrac{i (R_2 + R_3)}{\cancel{R_2 + R_3}}$

$\Rightarrow \dfrac{V_S}{} =$

$$\Rightarrow \frac{V_S \left(\frac{R_2}{R_1 + R_2} \right) V}{\frac{R_2^2}{R_1 + R_2} - (R_2 + R_3)} = i \quad \Rightarrow \quad I = \frac{V}{R_1 + R_2} + \frac{R_2}{R_1 + R_2} \left(\frac{V_S - \frac{R_2}{R_1 + R_2} V}{\frac{R_2^2}{R_1 + R_2} - (R_2 + R_3)} \right)$$

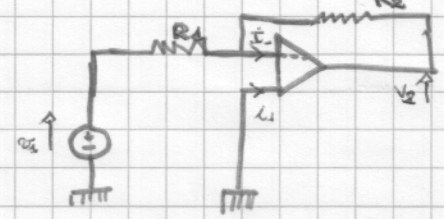
$$U_{BM} = R_2 (I - i) = V - R_1 I = \left(1 - \frac{R_1}{R_1 + R_2}\right) V - \frac{R_1 R_2}{R_1 + R_2} \left(\frac{V_S - \frac{R_2 V}{R_1 + R_2}}{\frac{R_2^2}{R_1 + R_2} - (R_2 + R_3)} \right)$$

$$U_{CM} = R_3 \left(\frac{V_S - \frac{R_2 V}{R_1 + R_2}}{\frac{R_2^2}{R_1 + R_2} - (R_2 + R_3)} \right)$$

$U_{BM} = 7{,}03\ V$

$U_{CM} = 6{,}16\ V$.

7) Amplificateur opérationnel en regime continue.



$i_+ = i_- = 0$

alors $t=0 \rightarrow v_1 = R_1 i$

$v_2 = -R_2 i$

$$\frac{V_2}{V_1} = \frac{V_s}{V_e} = \frac{-R_2 \cancel{i}}{R_1 \cancel{i}}$$

$$\Rightarrow \frac{V_s}{V_e} = -\frac{R_2}{R_1}$$

$$T = \frac{-R_2}{R_1}$$

$$G = 20 \log \left(\frac{R_2}{R_1}\right)^{\frac{1}{2}} = 10 \log \frac{R_2}{R_1}$$