Exercice 1:/ (Multivibrateur)

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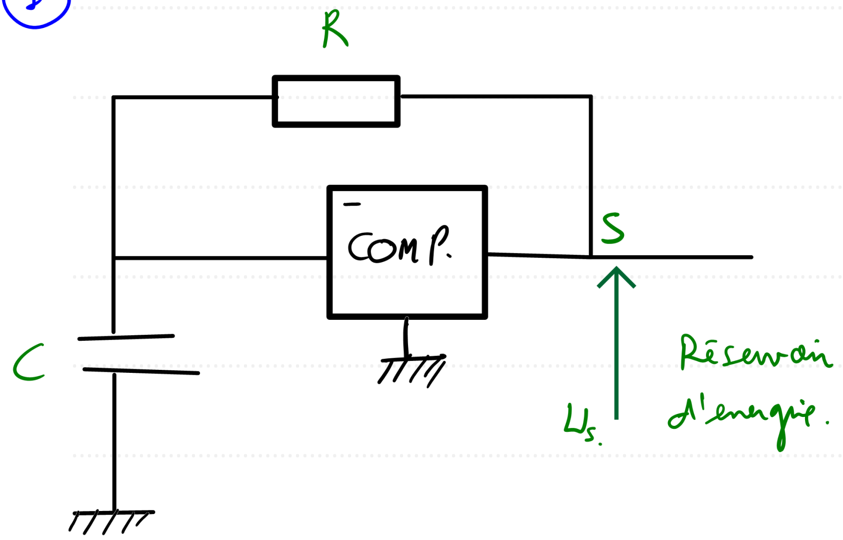
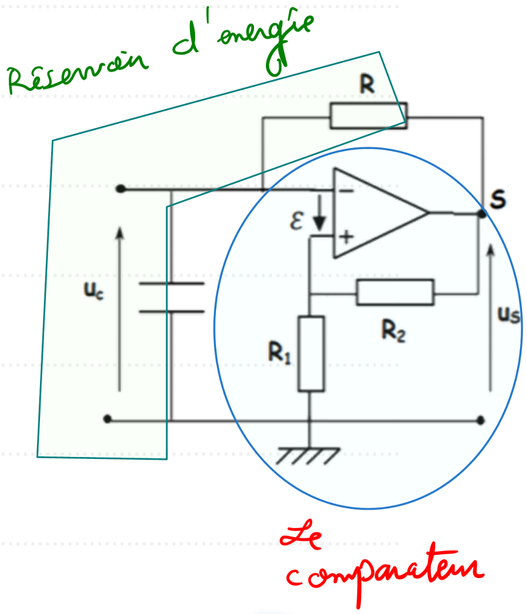




A.O.P : $i^- = i^+ = 0$.

$(\varepsilon \neq 0)$

linéaire

$\varepsilon = 0$.

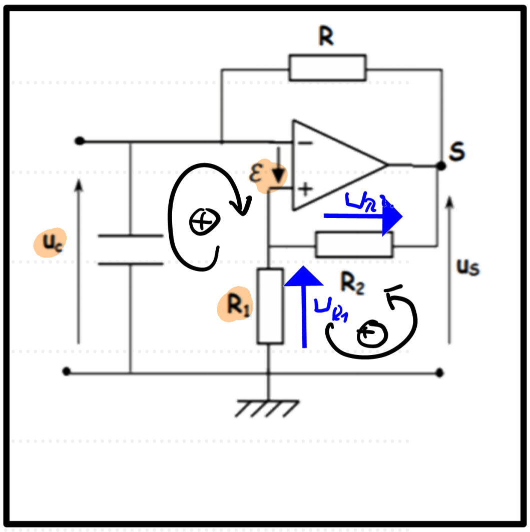
(Filtres).

non linéaire.

$\varepsilon \neq 0$. (multivibrateur).

1 * Réservoir d'énergie (circuit RC).

* Le comparateur inverseur à 2 seuils de basculement constitué d'un A.O.P et de 2 résistors R_1 et R_2.



② Loi des mailles :

(+) $U_e + \varepsilon - U_{R_1} = 0.$

$$\boxed{U_e + \varepsilon - R_1 . i = 0.}$$

(**) $U_s - U_{R_2} - U_{R_1} = 0.$

$U_s - i\left(R_2 + R_1\right) = 0.$

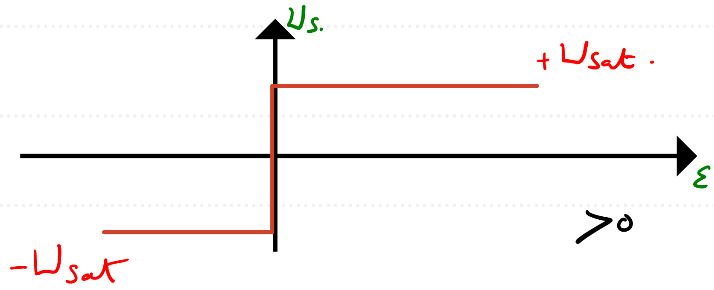
$$\boxed{i = \frac{U_s}{R_1 + R_2}}$$

(**) dans (+) $\Rightarrow$ $U_e + \varepsilon - R_1 \dfrac{U_s}{R_1 + R_2} = 0$

$$\boxed{\varepsilon = \frac{R_1 . U_s}{R_1 + R_2} - U_e}$$

b/ On pose $\beta = \dfrac{R_1}{R_1 + R_2}$ $\varepsilon = \beta . U_s - U_e.$

Allure de $U_s = f(\varepsilon)$.



* Si $\varepsilon > 0 \Rightarrow U_s = + U_{sat}$

$\varepsilon = \beta U_s - U_e > 0$

$\beta U_s > U_e$

$$\boxed{U_e < \beta U_s)_{sat} = U_{HB}.}$$

* Si $\varepsilon < 0 \Rightarrow U_s = - U_{sat}.$

$\varepsilon = \beta U_s - U_e < 0$

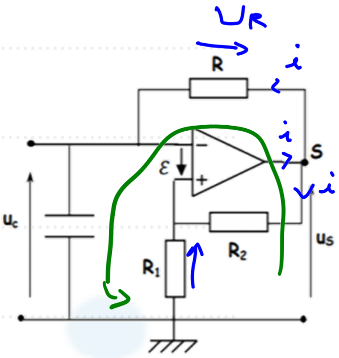
$\beta U_s < U_e.$

$$\boxed{U_e > \beta U_s)_{sat} = U_{BH}}$$

$$\Rightarrow \begin{cases} \text{si } U_e < \beta U_{sat} \Rightarrow U_s = +U_{sat}. \\ \text{si } U_e > \beta U_{sat} \Rightarrow U_s = -U_{sat}. \end{cases}$$

⇒ Ce montage est un comparateur à 2 seuils de basculement.

2). Loi des mailles :



(x -1) $U_s - U_R - U_c = 0$.

$U_R + U_c = U_s$.

$R.i + U_c = U_s$.

$$\boxed{R.C \frac{dU_c}{dt} + U_c = U_s.}$$

b) $U_c(t) = A e^{-t/\tau} + B.$

• à $t = 0$ s. $U_c(0) = A e^0 + B = A + B$. (1).

• à $t \to \infty$. $\lim\limits_{t \to \infty} U_c(t) = B$. (2)

(1) − (2) $U_c(0) - U_c(\infty) = A + B - B$

$$\boxed{U_c(0) - U_c(\infty) = A.}$$

avec $\begin{cases} U_c(0) = U_{ci} \\ U_c(\infty) = U_{cf}. \end{cases}$

$$\boxed{U_c(t) = (U_{ci} - U_{cf})\, e^{-t/\tau} + U_{cf}.}$$

c). $U_c(t) - U_{cf} = (U_{ci} - U_{cf})\, e^{-t/\tau}$

$$\ln\left[e^{-t/\tau}\right] = \ln\left[\frac{U_c(t) - U_{cf}}{(U_{ci} - U_{cf})}\right]$$

$\ln(e^{a}) = a$

$$t/\tau = -\ln\left[\frac{U_c - U_{cf}}{U_{ci} - U_{cf}}\right]$$

$$t = -\tau \ln\left[\frac{U_c(t) - U_{cf}}{U_{ci} - U_{cf}}\right]$$

d'où :

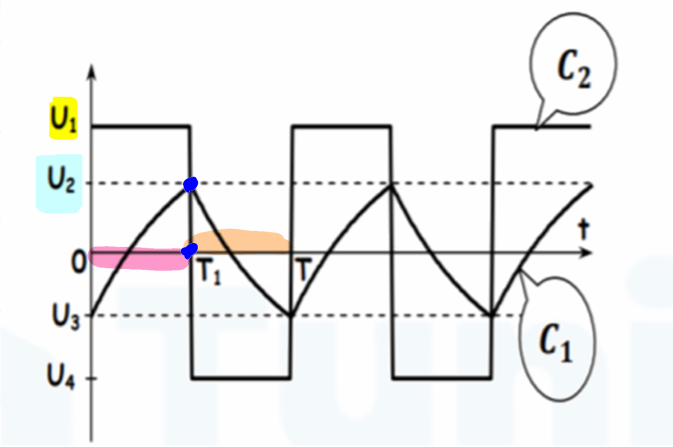
$$\boxed{T_i = \tau \ln\left(\frac{U_{ci} - U_{cf}}{U_c(T_i) - U_{cf}}\right)}$$

$\ln\left(\frac{a}{b}\right) = -\ln\left(\frac{b}{a}\right)$

$\ln a - \ln b = -(\ln b - \ln a)$

4) a/. C_2 est caractérisée par 2 états $(+U_{sat} ; -U_{sat})$

$$\begin{cases} C_2 \longrightarrow U_S. \\ C_1 \longrightarrow U_C \end{cases}$$



b) $\begin{cases} E_H = +U_{sat} = U_1 = 15V. \\ E_B = -U_{sat} = U_4 = -15V. \end{cases}$

$$\begin{cases} E_{HB} = U_2 = \beta\, U_{sat} = \dfrac{R_1}{R_1 + R_2} U_{sat} = \dfrac{1}{2} \times 15 = 7,5V. \\ E_{BH} = U_3 = -7,5V. \end{cases}$$

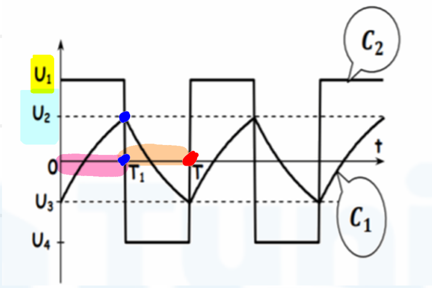
c)

* $[0, T_1]$: charge du condensateur ; $U_s = U_{sat}$.
* $[T_1, T]$: décharge du condensateur ; $U_s = -U_{sat}$.

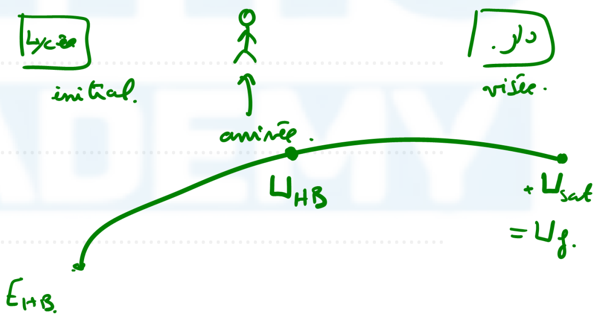
d) c'est un circuit qui génère un signale périodique qui oscille entre 2 états instables.

$\Rightarrow$ Le multivibrateur est dit astable.

e) $t = RC \ln\left(\dfrac{U_{ci} - U_{cf}}{U_c(t) - U_{cf}}\right) \rightarrow$ U_{ci} : départ. $U_c(t)$: arrivée. U_{cf} : Tension visée.



$$T_1 = RC \ln\left(\frac{U_{BH} - U_{sat}}{U_{HB} - U_{sat}}\right)$$



$$T_1 = RC \ln\left(\frac{-\beta \cancel{U_{sat}} - \cancel{U_{sat}}}{\beta \cancel{U_{sat}} - \cancel{U_{sat}}}\right).$$

$$= RC \ln\left(\frac{-\beta - 1}{\beta - 1}\right).$$

$$= RC \ln\left(\frac{-(\beta + 1)}{-(1 - \beta)}\right)$$

$$= RC \ln\left(\frac{\frac{R_1}{R_1+R_2} + 1}{1 - \frac{R_1}{R_1+R_2}}\right).$$

$$= RC \ln\left(\frac{\frac{R_1 + R_1 + R_2}{\cancel{R_1+R_2}}}{\frac{R_2 + \cancel{R_1} - \cancel{R_1}}{\cancel{R_1+R_2}}}\right)$$

$$T_1 = RC \ln\left(\frac{2R_1 + R_2}{R_2}\right)$$

$1\,K\Omega \xrightarrow{\times 10^{3}} 1\Omega.$

$$\boxed{T_1 = RC \ln\left(\frac{2R_1}{R_2} + 1\right).}$$

$$T_1 = 10.10^{3}.10^{-7} \ln(3)$$

$$\boxed{T_1 = \ldots\ldots \ S.}$$

$$T_2 = RC \ln\left(\frac{U_{HB} + U_{sat}}{U_{BH} + U_{sat}}\right).$$

$$= RC \ln\left(\frac{\beta \cancel{U_{sat}} + \cancel{U_{sat}}}{-\beta \cancel{U_{sat}} + \cancel{U_{sat}}}\right)$$

$$= RC \ln\left(\frac{\beta + 1}{-\beta + 1}\right) = RC \ln\left(\frac{\frac{R_1 + R_2 + R_1}{\cancel{R_1 + R_2}}}{\frac{-\cancel{R_1} + R_2 + \cancel{R_1}}{\cancel{R_1 + R_2}}}\right)$$

$$= RC \ln\left(\frac{2R_1 + R_2}{R_2}\right).$$

$$T_2 = RC \ln\left(\frac{2R_1}{R_2} + 1\right).$$

$\underline{or}$: $R_1 = R_2 = R = 10\,K\Omega \Rightarrow T_2 = RC \ln(3) = T_1.$

$T = T_1 + T_2 = 2T_1 = \qquad S.$

f).
$$\delta = \frac{T_1}{T} = \frac{\cancel{RC\ln(3)}}{2\cancel{RC\ln(3)}} = \frac{1}{2} = 0,5.$$

g). si $R_1 = 3R_2$.

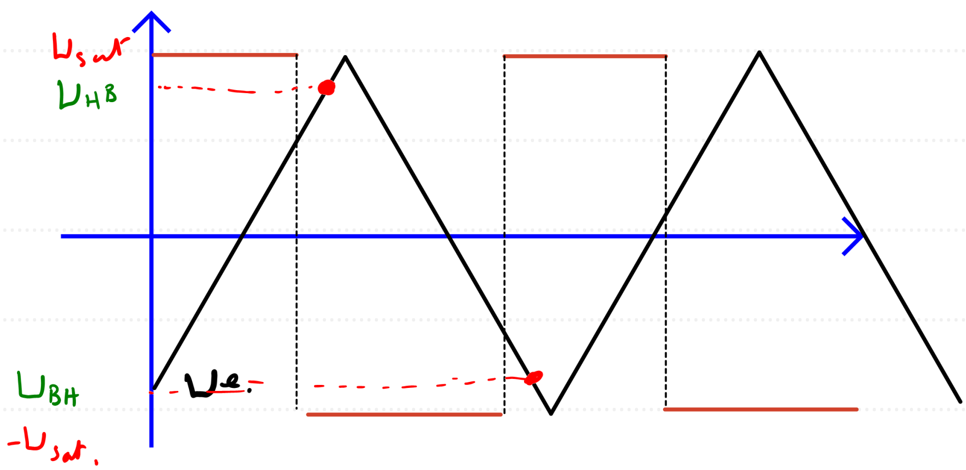
$$\beta = \frac{R_1}{R_1+R_2} = \frac{3R_2}{3R_2+R_2} \; ; \; \beta = \frac{3}{4} = 0,75.$$

$$\begin{cases} U_{HB} = \beta U_{sat} = 0,75 \times 15 = 11,25V. \\ U_{BH} = -\beta U_{sat} = -0,75 \times 15 = -11,25V. \end{cases}$$

$$T_1 = RC \ln\left(2\frac{R_1}{R_2}+1\right).$$
$$= RC \ln\left(2\frac{3\cancel{R_2}}{\cancel{R_2}}+1\right) = RC\ln(7)$$

$$T_2 = RC\ln(7).$$

$$T = T_1 + T_2 = 2RC\ln(7).$$



$U_e < U_{HB} \Rightarrow U_s = U_{sat}$.

$U_e > U_{HB} \Rightarrow U_s = -U_{sat}$.