Cours du 21 octobre 2022

Electrotechnique : alimentation et machines

Partie 2. Convertisseurs

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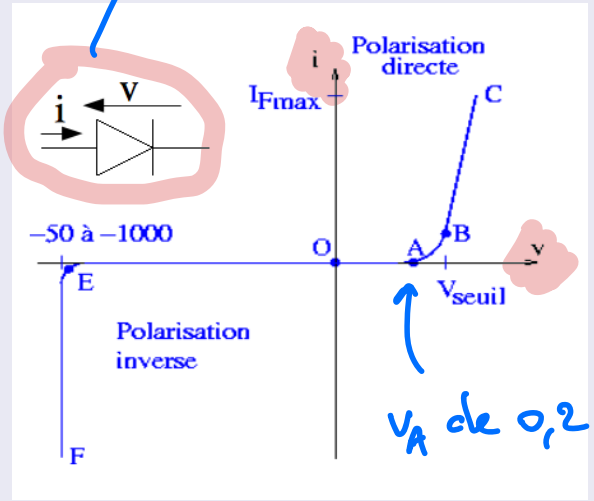
CPGE PSI / L3 GECCLEERE

On va utiliser beaucoup de circuits comportant des diodes — convention "récepteur" (v et i opposés).

Caractéristique

↳ Tracé de $i = f(v)$

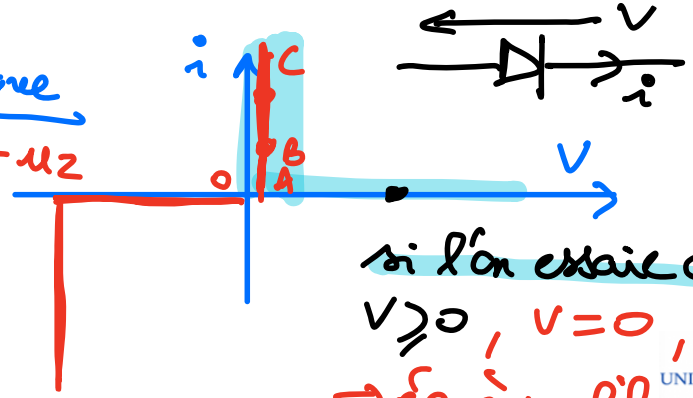


V_A de 0,2 à 0,8 V

d'où schématisation de la caractéristique

u_z : tension ZENER

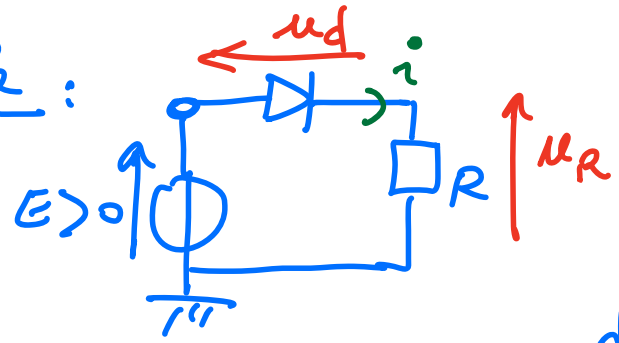
↳ diode Zener



si l'on essaie d'imposer $V \geq 0$, $v = 0$, $i \neq 0$ (en fait $i > 0$)

⇒ éq. à un fil ($R = 0$).

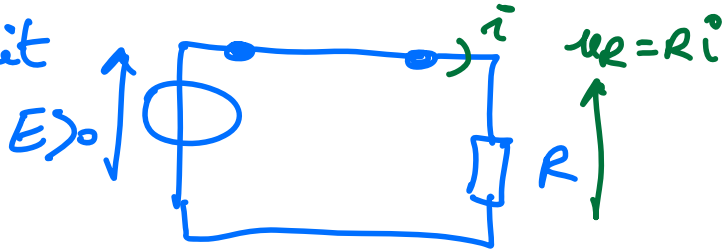
exemple :

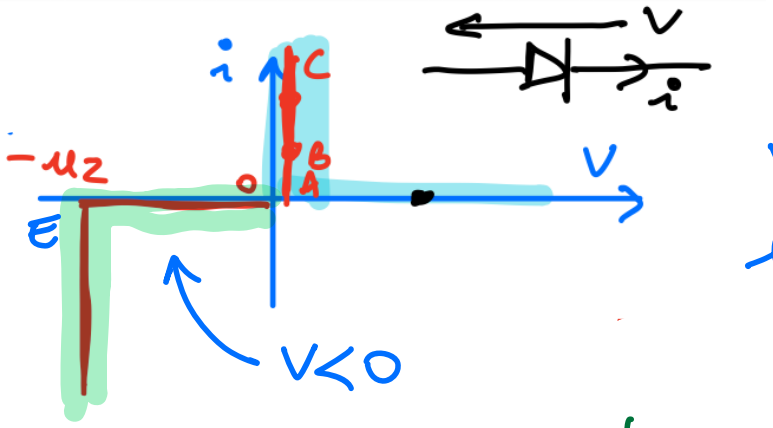


si $u_d > 0$ (faible) $\Rightarrow$ diode est "passante" $\boxed{(i \neq 0)}$

et on dit $u_d \simeq 0 \Rightarrow$ fil

donc le circuit

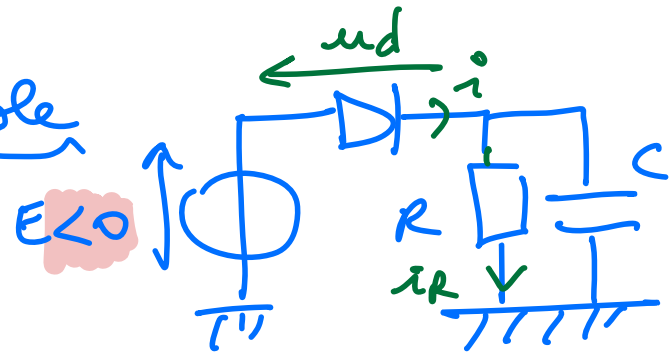




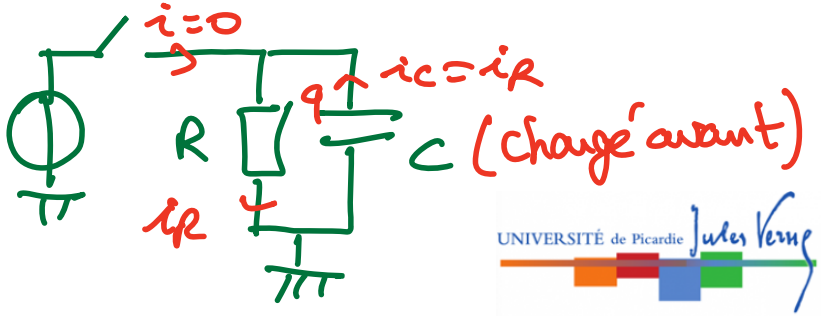
$V_E < V < 0 \Rightarrow \boxed{i = 0}$

la diode s'oppose au passage du courant $\Rightarrow$  interrupteur ouvert.

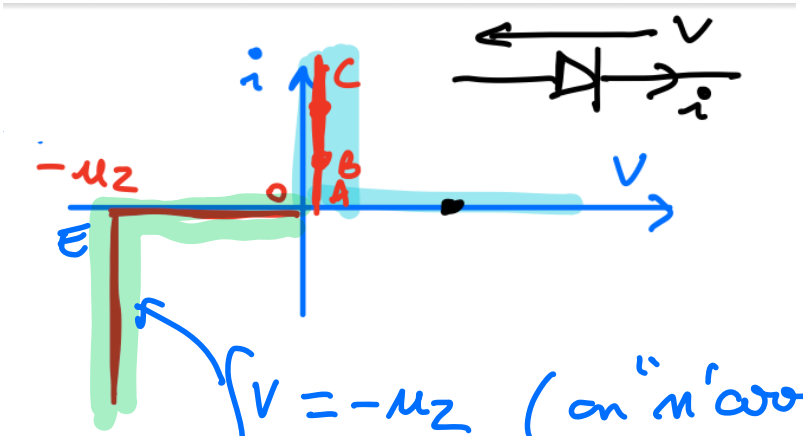
exemple



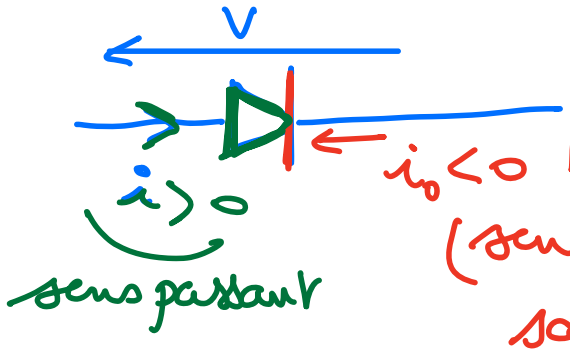
Dans le cas $V_E < u_d < 0$



Rem

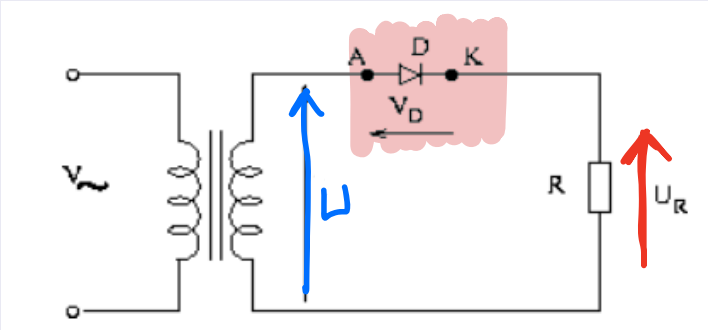


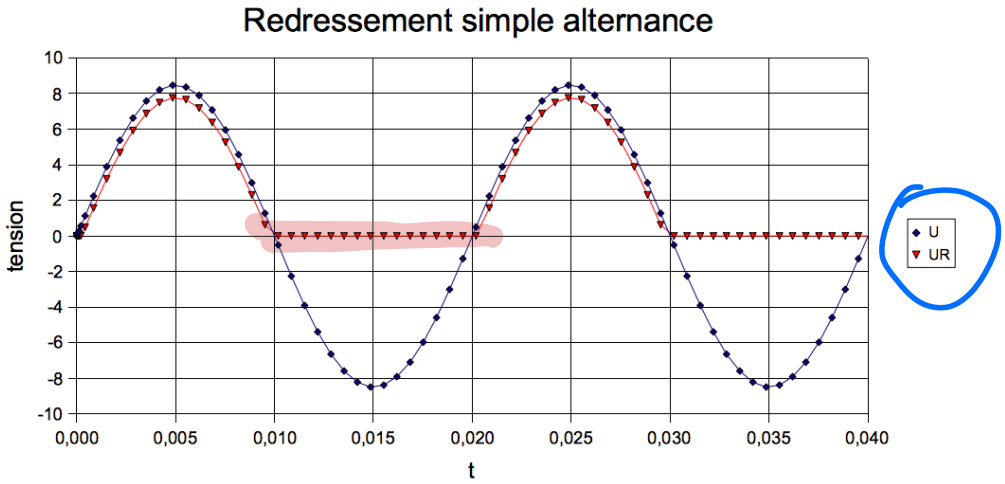
$\begin{cases} V = -u_z \\ i \neq 0 \\ i < 0 \end{cases}$ (on "n'arrive pas" à avoir V plus basse que $-u_z$).

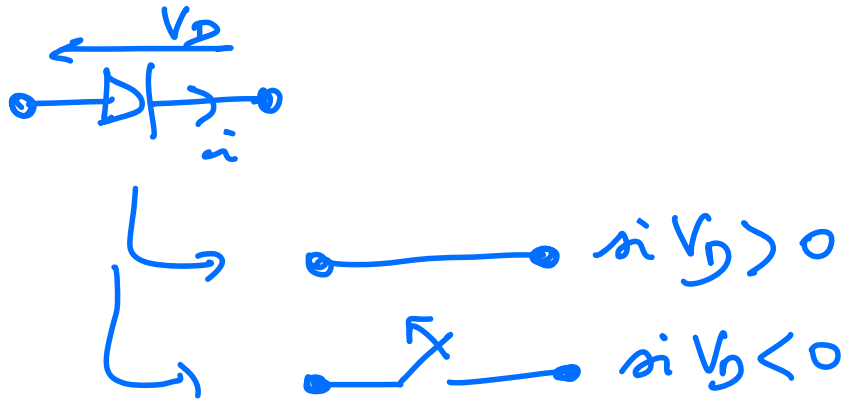


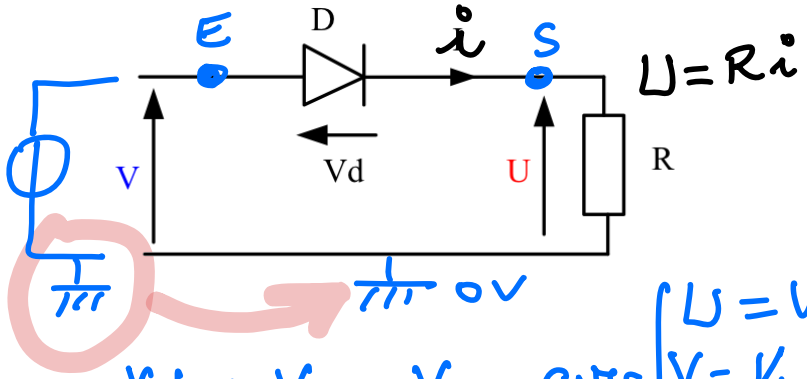
sauf "avalanche" du sens bloqué (Equ. à un éclair dans l'air).

Montage


A
D
K
V_D
$V_\sim$
U
R
U_R

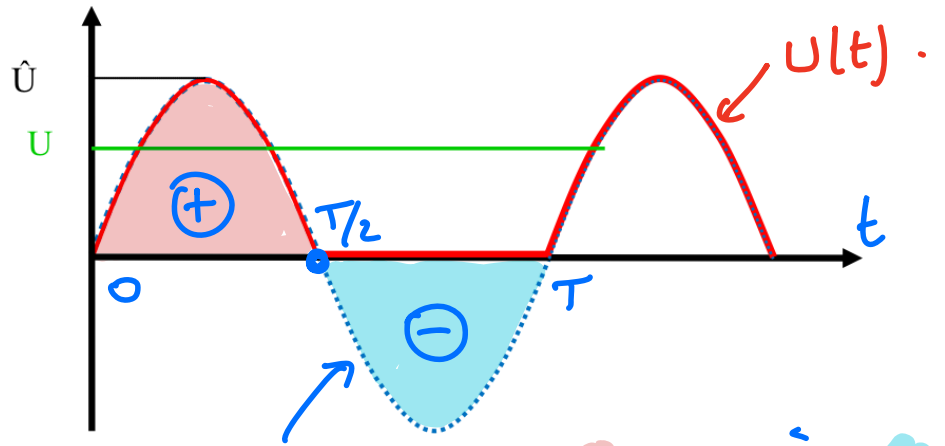

Redressement simple alternance
tension
t
U
UR


V_D
si $V_D > 0$
si $V_D < 0$



$V_d = V_E - V_S$ avec $\begin{cases} U = V_S - 0 \\ V = V_E - 0 \end{cases}$

$= V - U$



$V(t)$: aire = - aire

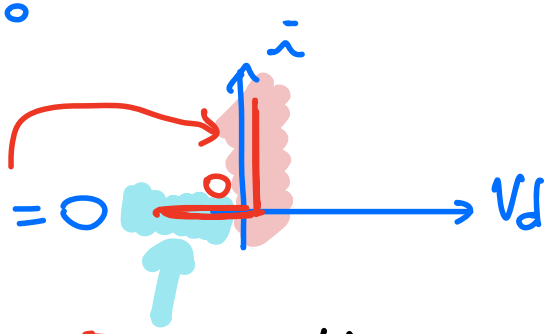
↳ somme nulle

$\Rightarrow \overline{V} = 0$ (moyenne)

(car $\overline{V} = \frac{1}{T}\int_0^T V(t)\,dt$)

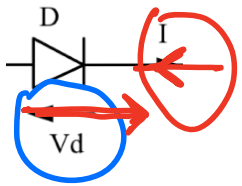
$t = \frac{T}{2} \Rightarrow V = 0$

de 0 à $\frac{T}{2} \Rightarrow U = V$ (diode passante) $V_d = V - U = 0$



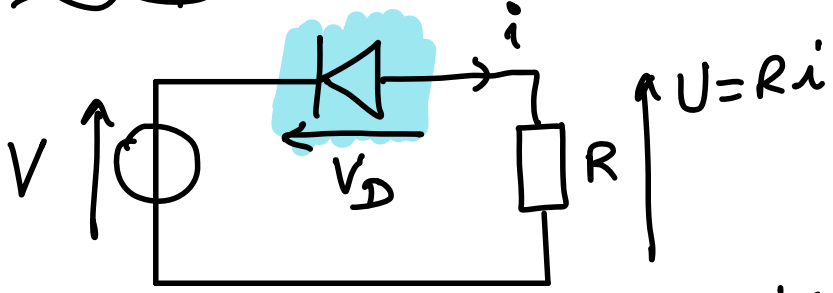
à partir de $\frac{T}{2}$, $V(t) < 0$

↳ $V_d = \underbrace{+V}_{<0} - 0 < 0$

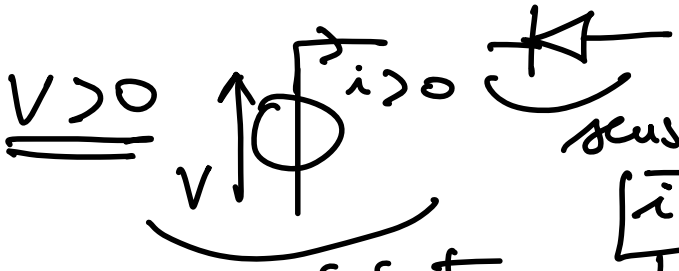


sens bloqué $\Rightarrow i = 0$ $\Rightarrow U = 0$

Exemple

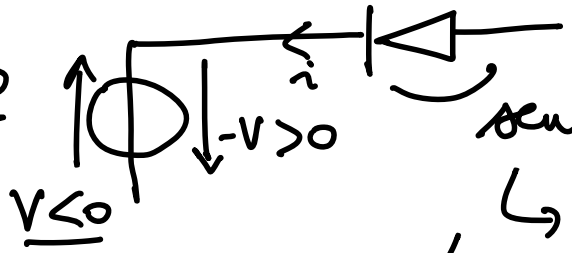


$V>0$



générateur

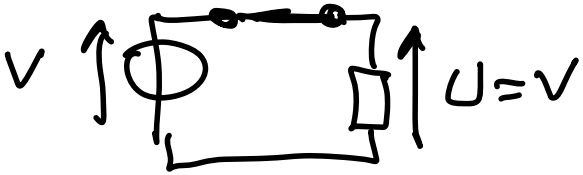
$V<0$

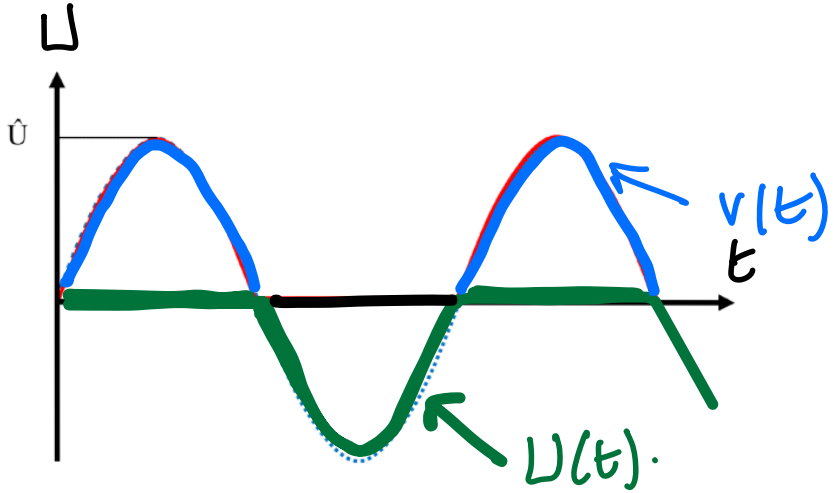


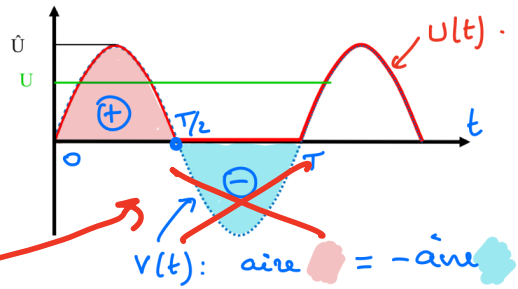
sens passant

↳ $V_d = 0$ (fil)

↳ $U = -Ri$

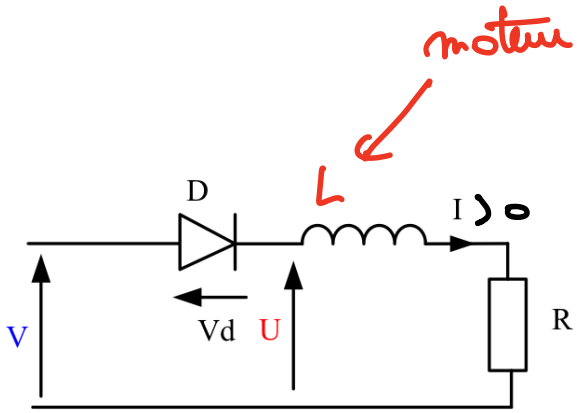


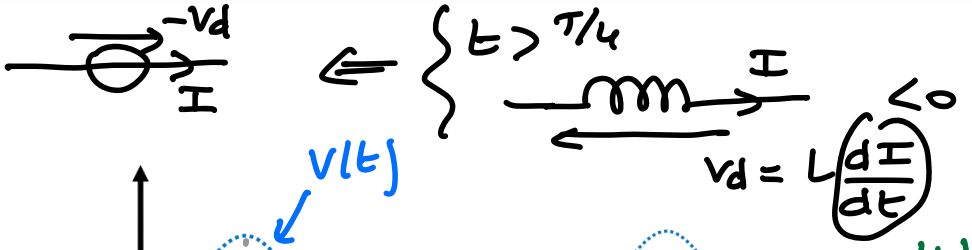


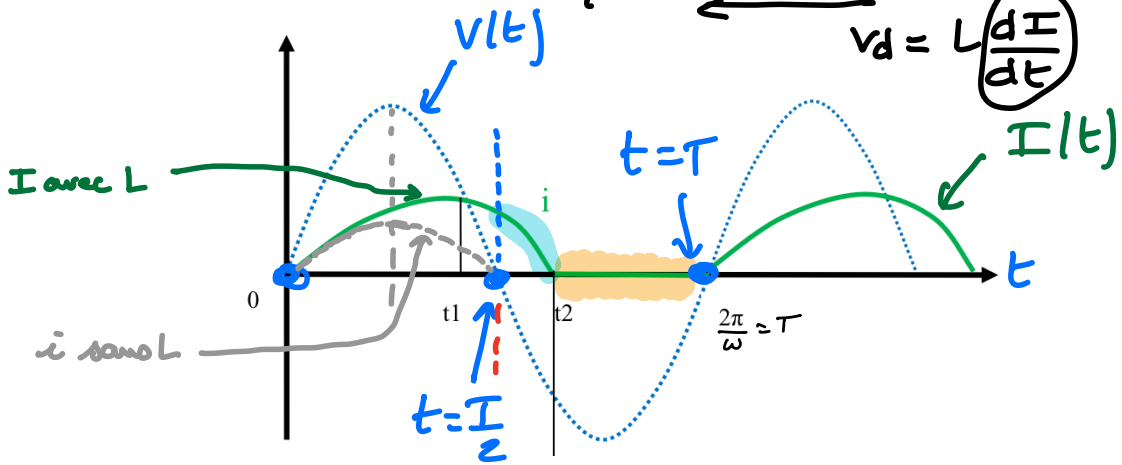


⚠ "redresseur" monoalternance.

on perd une alternance

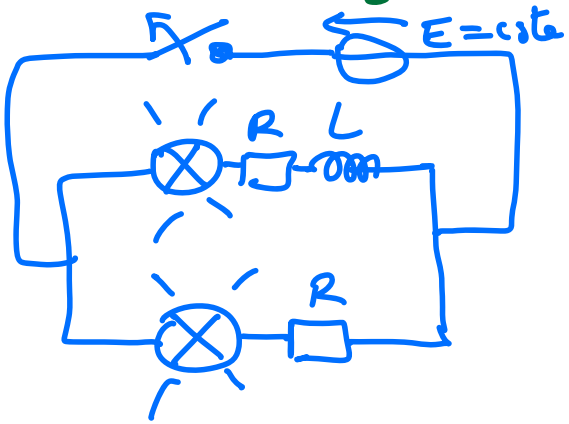


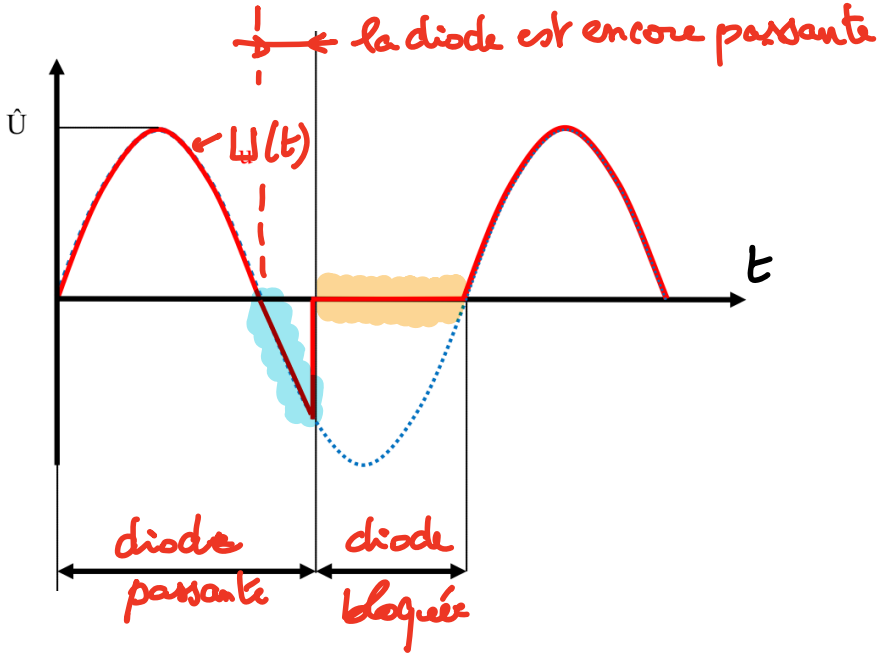


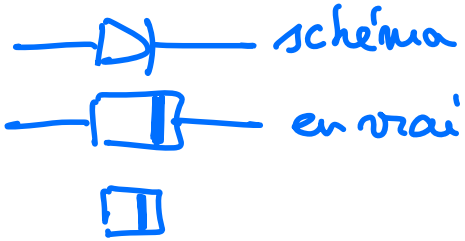


Énergie stockée $\mathcal{E} = \frac{1}{2} L I^2$

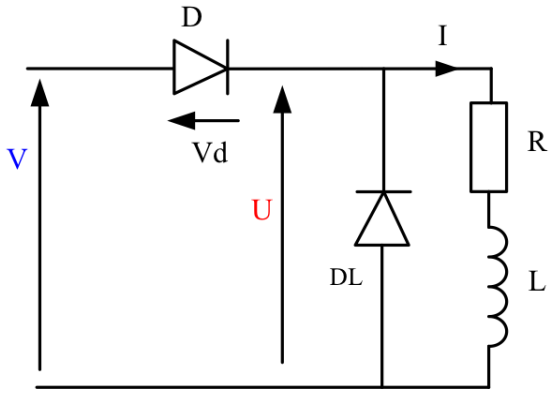
donc $0 < t < \frac{I}{2}$, $I \uparrow \Rightarrow \mathcal{E} \uparrow$

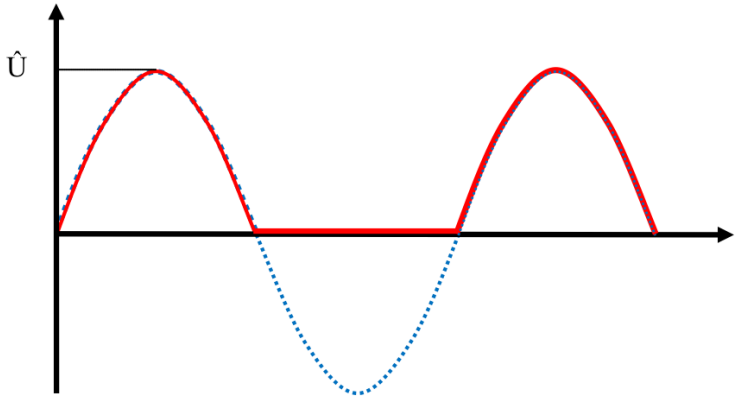


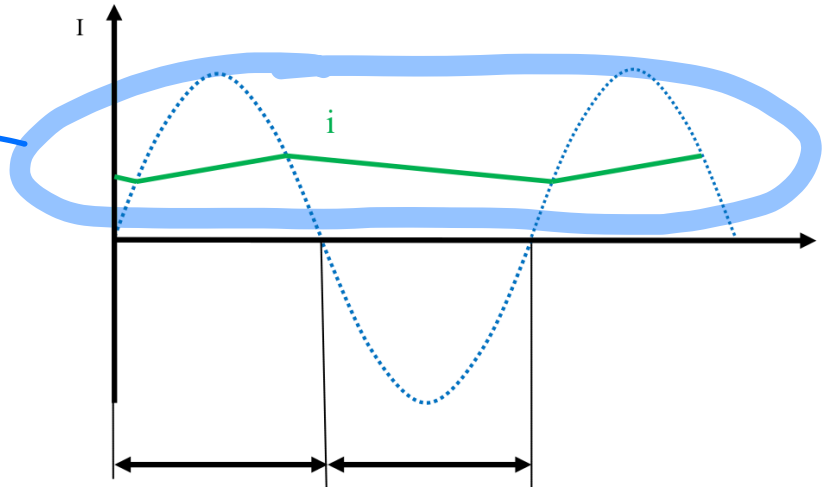




HACHEURS



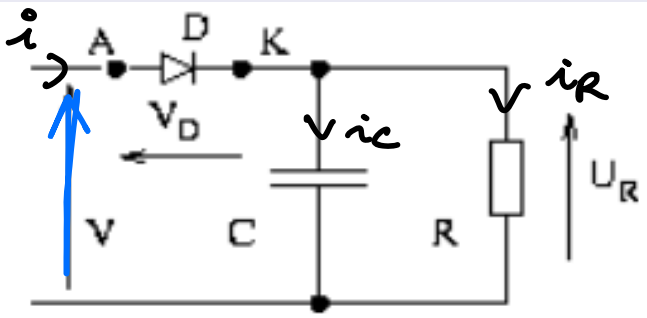




I ≃ cste pour alimenter un rotor (L)

Montage

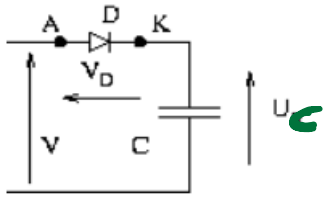
$\begin{cases} \omega = 2\pi/T \\ v(t) = V_M \sin(\omega t) \end{cases}$

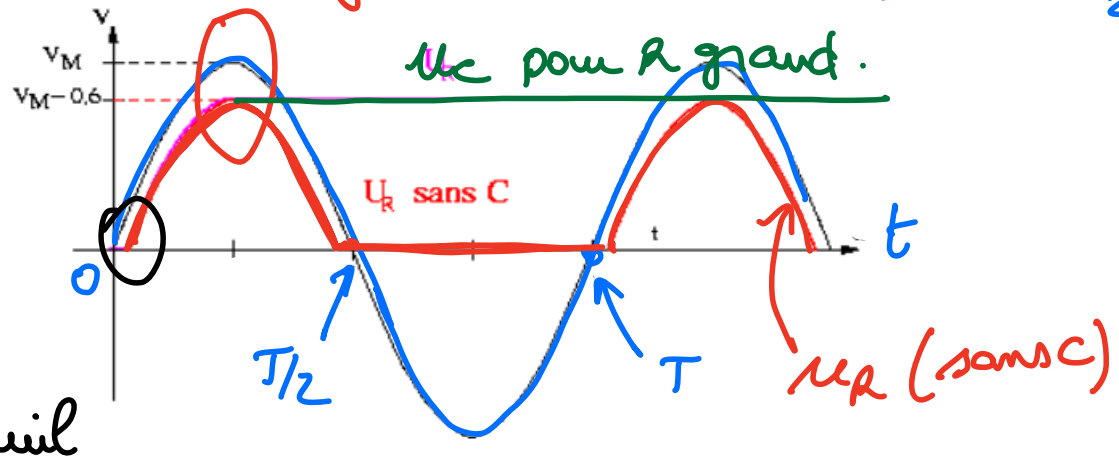


Deux cas à analyser : 1) diode passante 2) diode bloquée $v(t=\frac{T}{2}) = 0$?

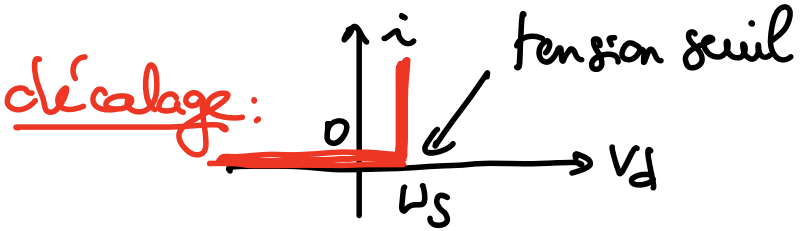
Cas idéal : $R \to \infty$ décalage ? $V_M \sin(\omega \frac{T}{2}) = V_M \sin(\frac{2\pi}{2}) = 0$

Si R est grand



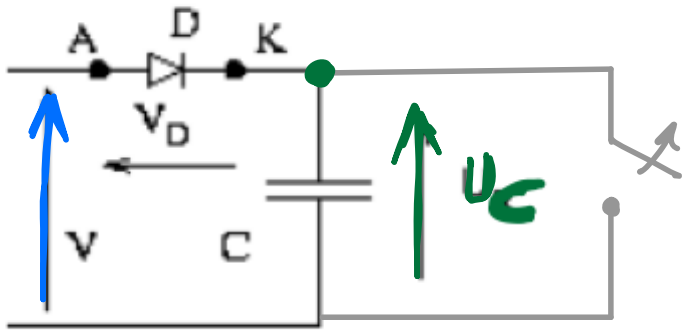


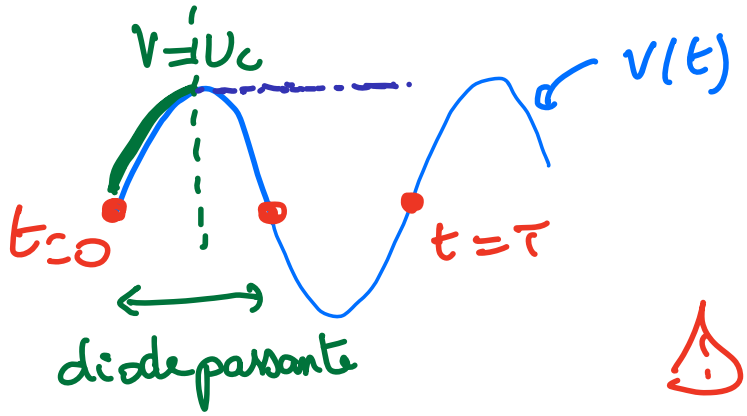
décalage :

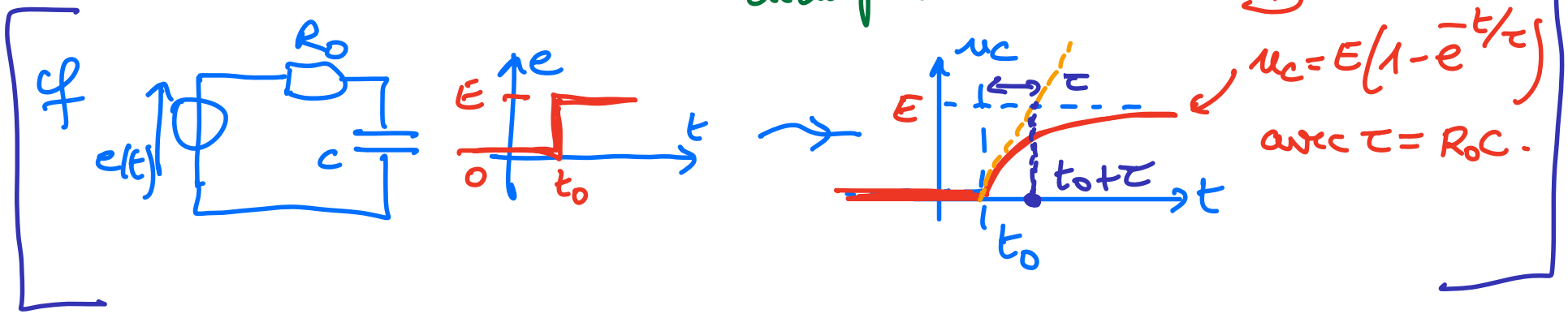


Si R est grand $u_R = R i_R \Rightarrow i_R = \frac{u_R}{R} \xrightarrow[R \to \infty]{} 0$ donc

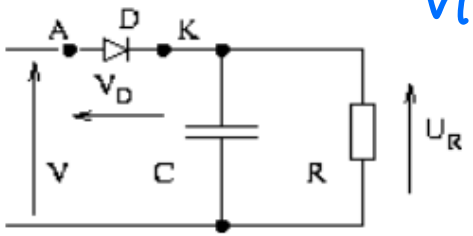
interrupteur ouvert





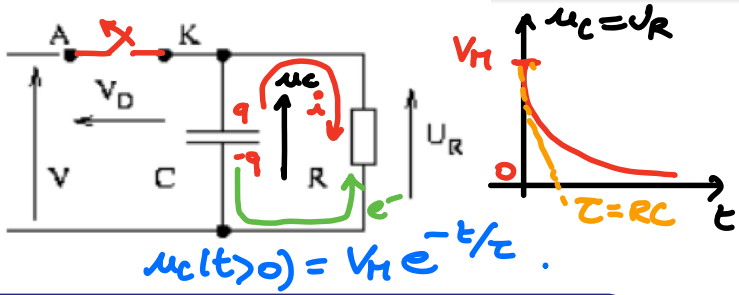


donc ici $R_0 = 0$ donc $\tau = 0$ donc la "charge" de C est instantanée.



$v(t) = V_M \sin(\omega t)$

$\begin{cases} R \neq 0 \\ R \neq \infty \end{cases}$



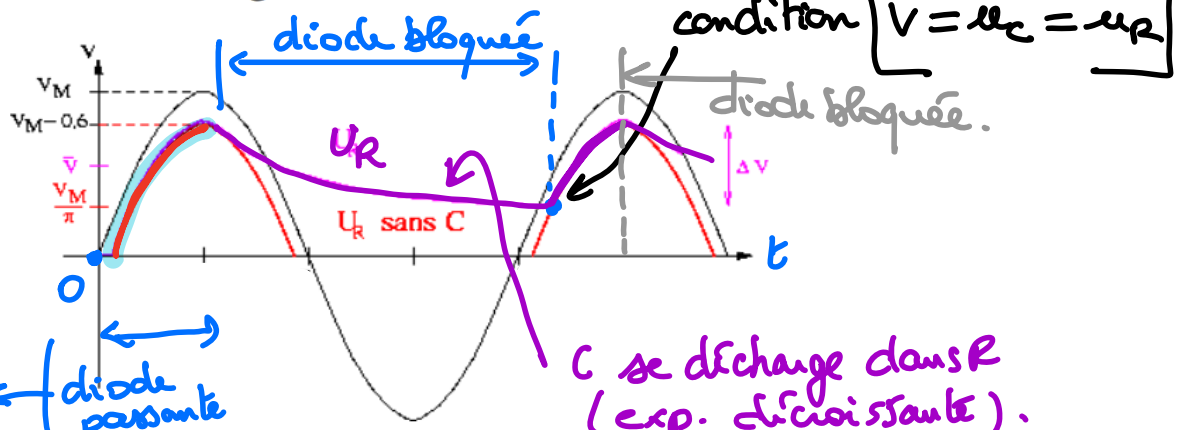
$u_c(t>0) = V_M e^{-t/\tau}$.

Cas d'une résistance non nulle

Quand la diode est bloquée, le condensateur se décharge dans la résistance

Dès que la diode se bloque, le condensateur se décharge dans la résistance.

$$\Delta V < V_M,\ \overline{V} > 2\frac{V_M}{\pi}$$



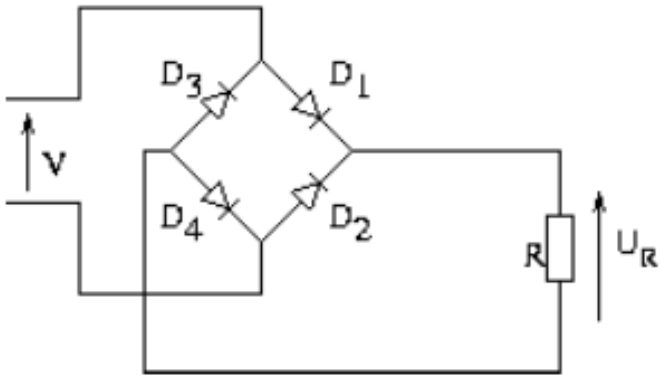
$V = u_c = u_R$ ← $V_d = 0$ ← diode passante

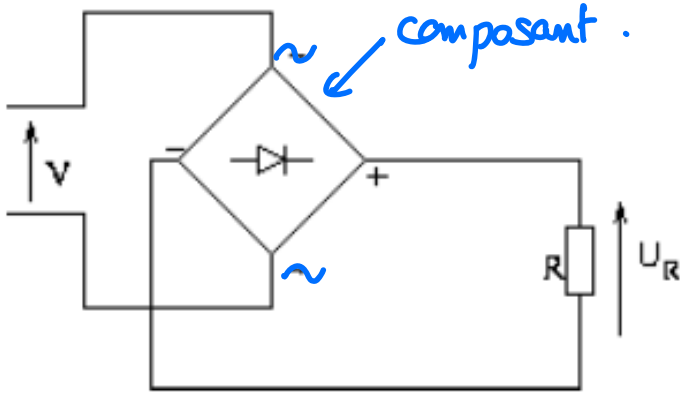
$i \neq 0$

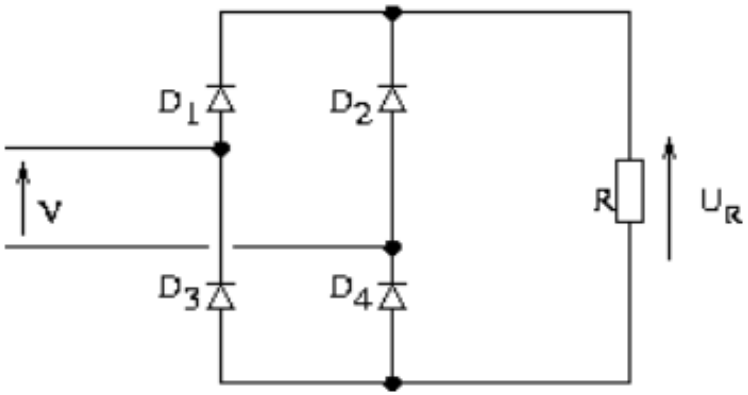
Montage : utilisation de l'inversion du courant

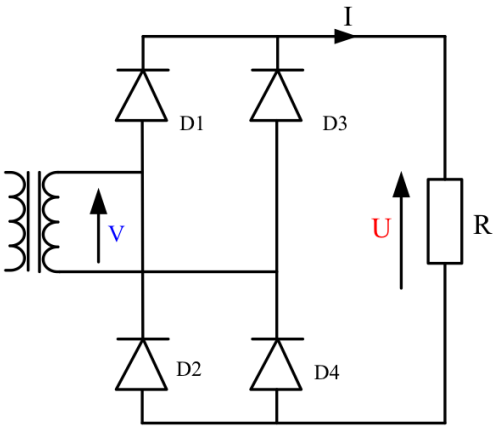
On maintient un courant de même signe dans la résistance.

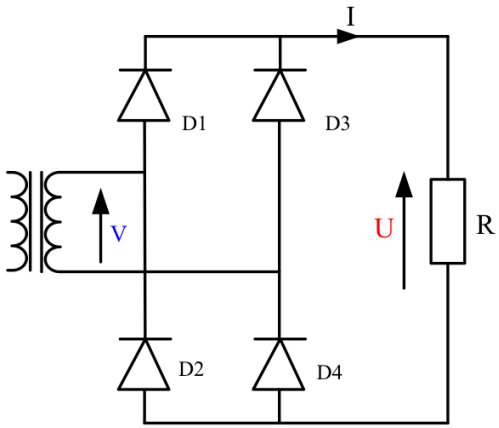
Pont de GRAETZ







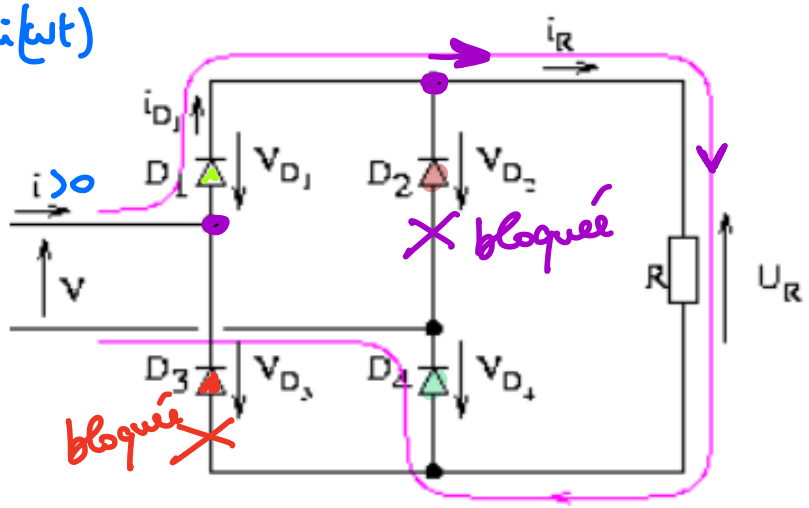

I
D1
D3
V
U
R
D2
D4

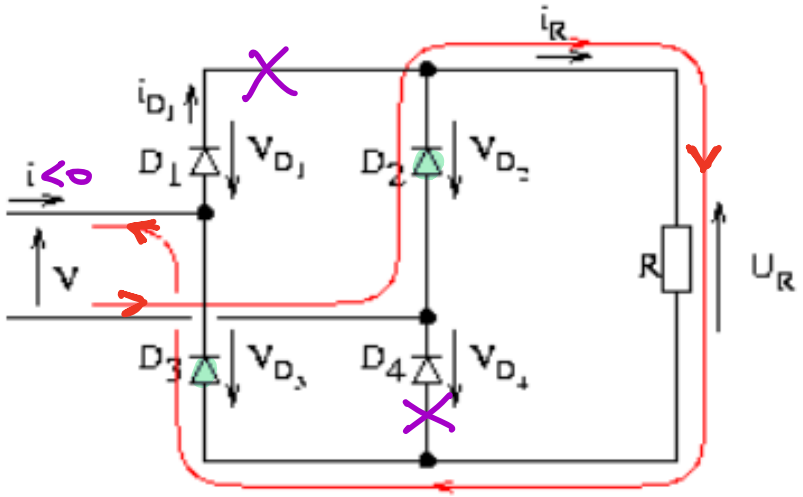

I
D1
D3
V
U
R
D2
D4

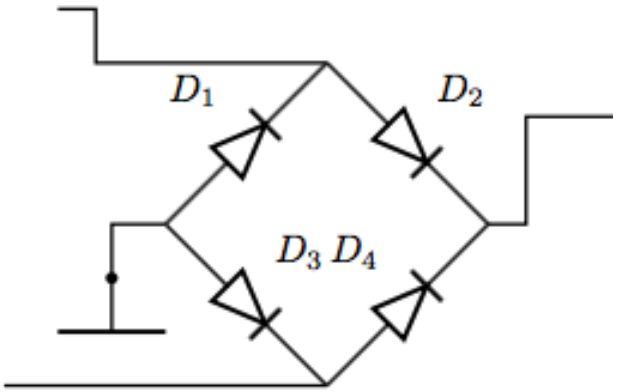
Parcours du courant

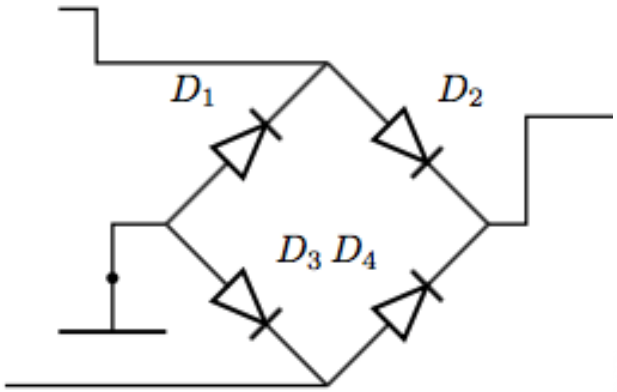
On maintient un courant de même signe dans la résistance.

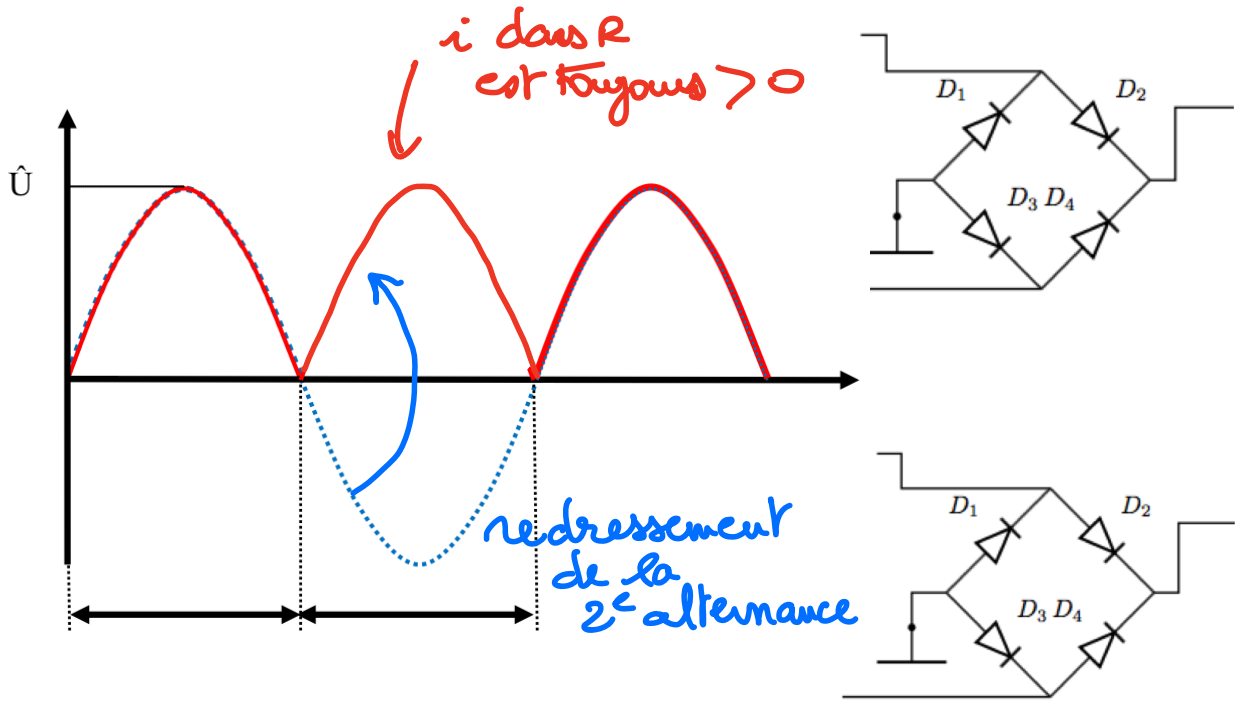
$v(t) = V_m \sin(\omega t)$





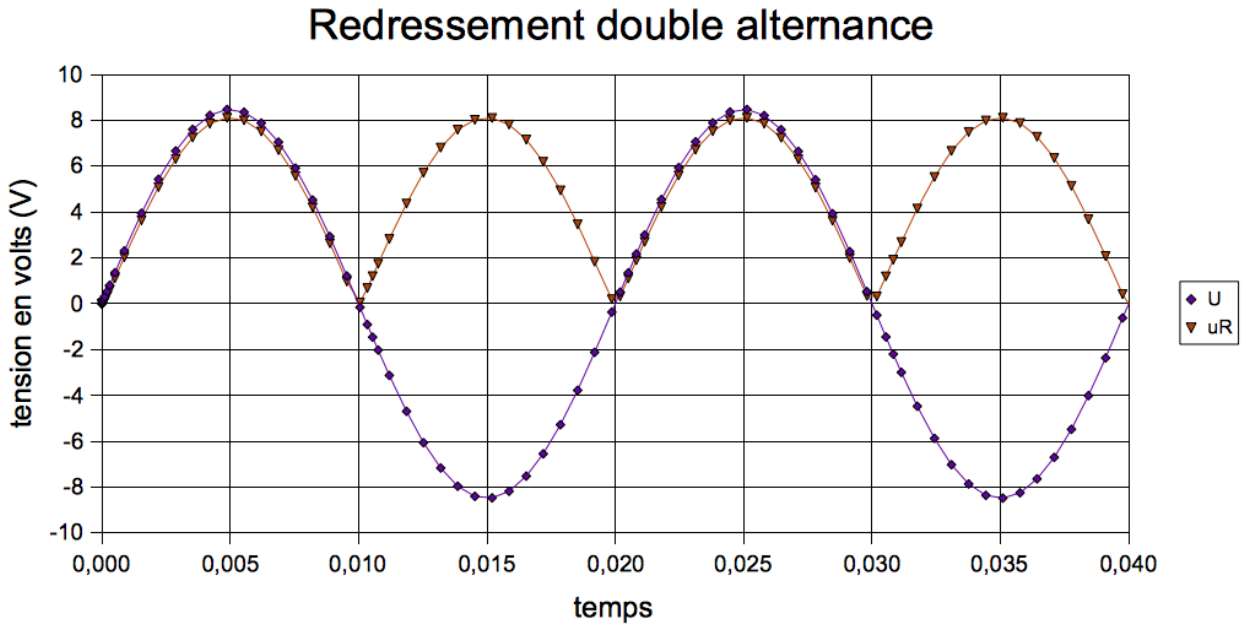




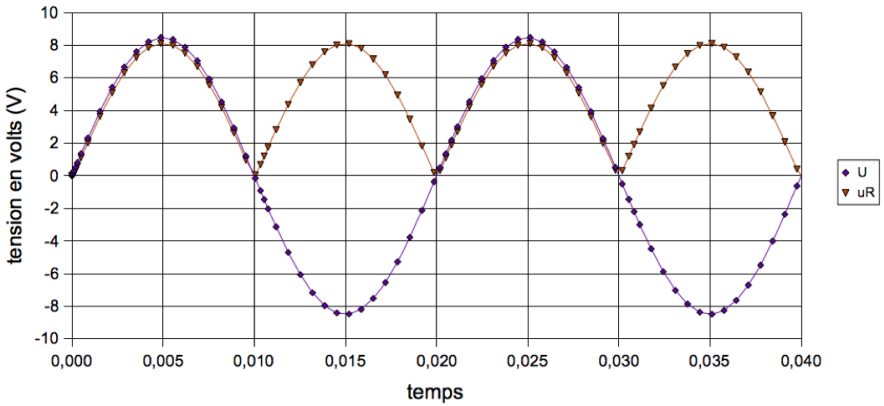

i dans R
est toujours > 0
Û
redressement
de la
2e alternance
D1
D2
D3 D4
D1
D2
D3 D4

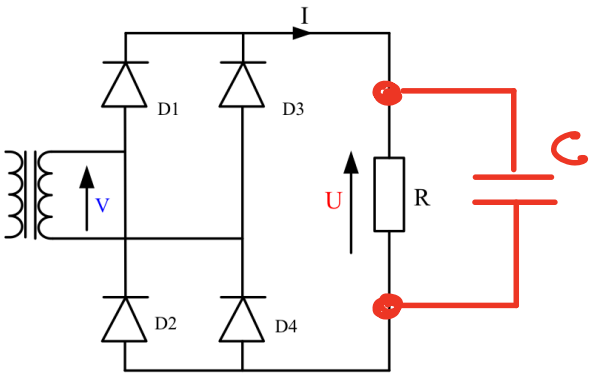
forme du signal bialternance

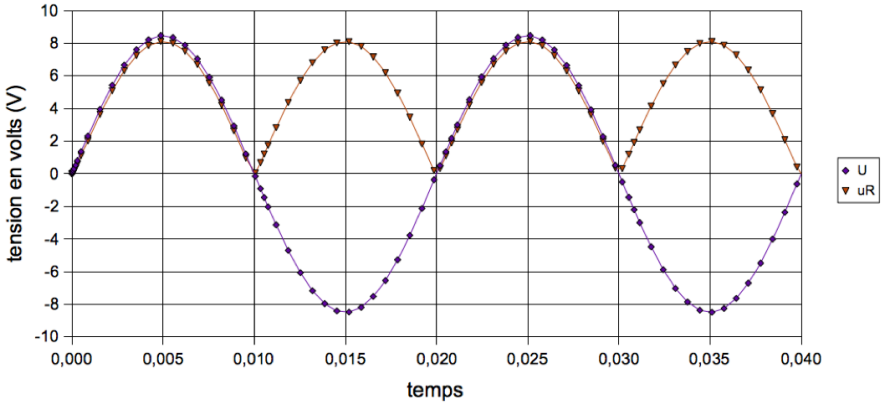
Pour un signal d'entrée $v_e(t) = V_m \sin(\omega t)$, on obtient la valeur absolue si les tensions seuils des diodes sont négligeables



Intérêt : la valeur moyenne est non nulle.
But ultérieur : lissage de cette tension.

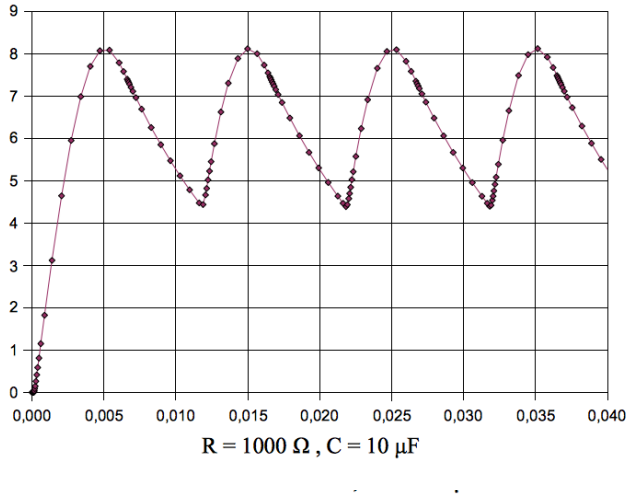

tension en volts (V)
temps
U
uR

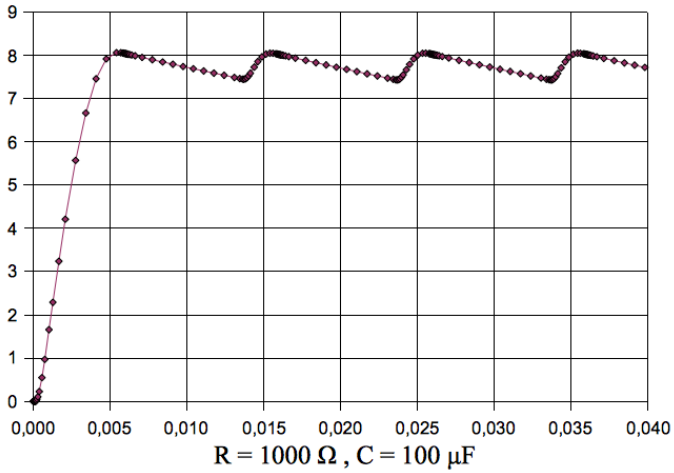

I
D1
D3
D2
D4
V
U
R
C

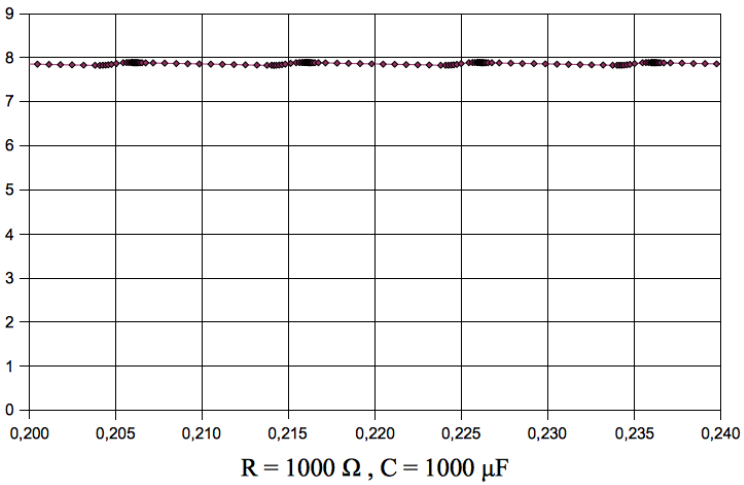

tension en volts (V)
temps
U
uR

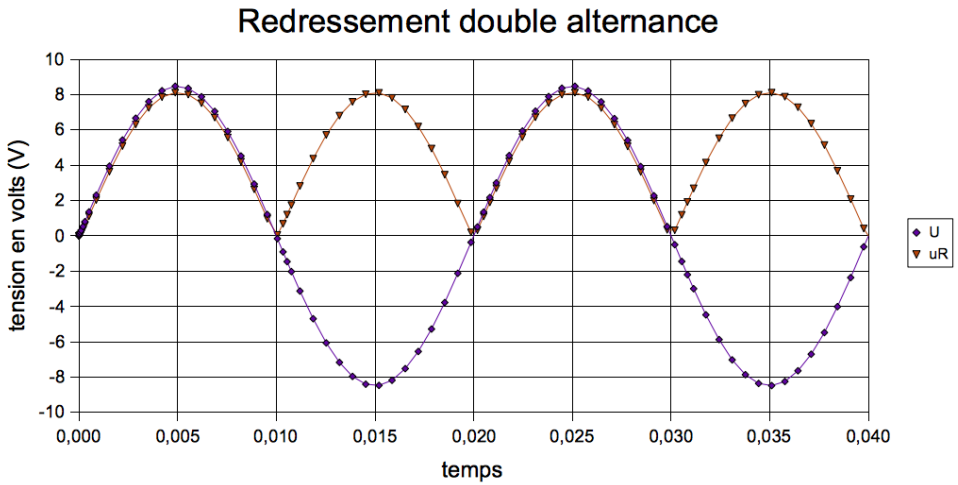
forme du signal bialternance

On utilise un condensateur en parallèle avec la charge R

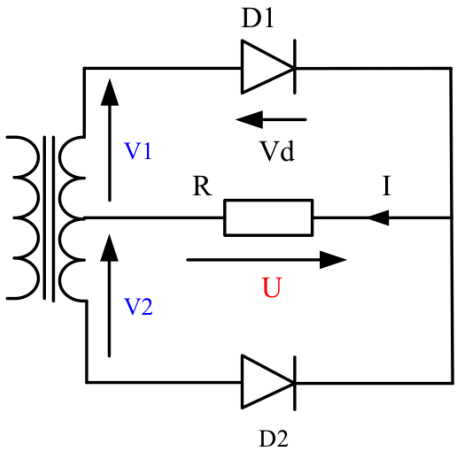








Autre redressement :



redressement triphasé simple alternance (P3)