Électronique de puissance

$\cos(a \pm b) = \cos a \cos b \mp \sin(a) \sin(b)$

$\sin(a \pm b) = \cos a . \sin b \pm \cos b \sin a$

$\cos(2a) = \cos^2 a - \sin^2 a$

$\cos^2(a) = \dfrac{1 + \cos 2a}{2}$; $\sin^2(a) = \dfrac{1 - \cos 2a}{2}$

$\cos a . \cos b = \dfrac{\cos(a+b) + \cos(a-b)}{2}$ $\qquad \sin(2\pi - \theta) = -\sin\theta$

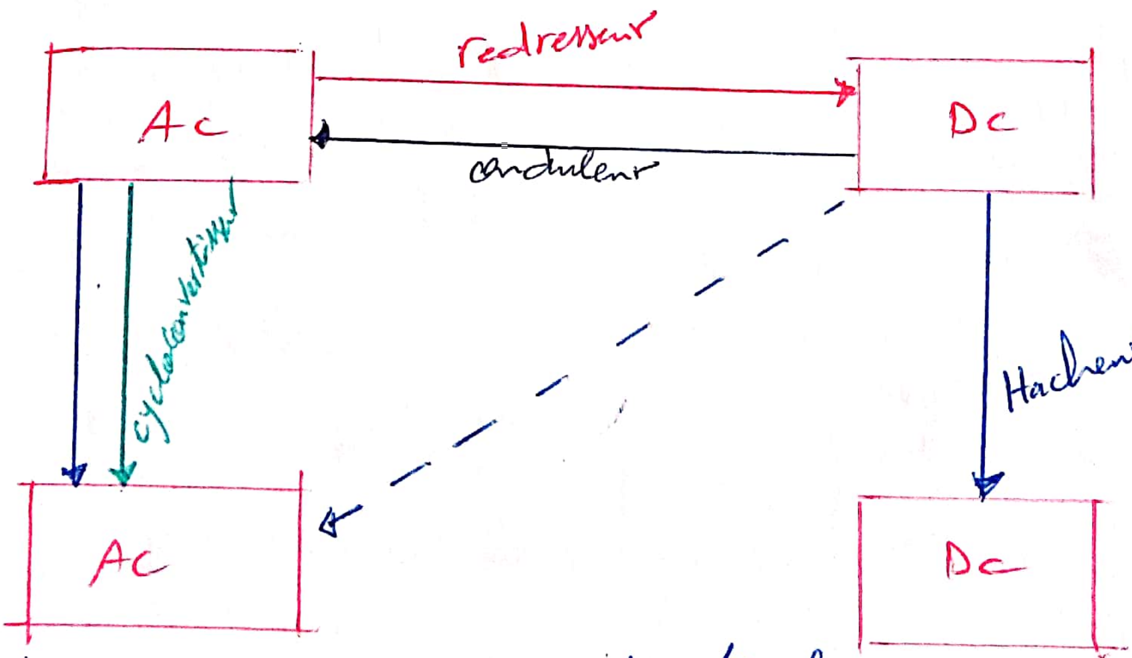
$\sin(\pi - \theta) = \sin\theta$, $\cos(\pi - \theta) = -\cos\theta$

$P_R = R I_{eff}^2$ [W] , $P = V_{eff} I_{eff} \cos\varphi$

$FF = \dfrac{V_{eff}}{\bar{V}}$, $\tau = \sqrt{(FF)^2 - 1}$ taux d'ondulation

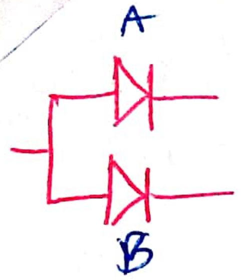
facteur de forme

facteur de qualité $\boxed{\dfrac{L\omega}{R} = Q}$



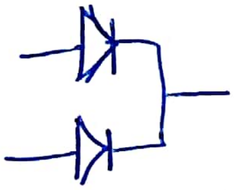
AC → DC → AC : Convertisseur indirect de fréquence

DC → AC → DC : " " " tension



Anode Commun $V_A < V_B$ A passante

الأكثر سلبية تجتاز.



Cathode Commun $V_A > V_B$ A passante

الأكثر إيجابية تجتاز

Homogéne	≠	particulier
libre	≠	forcé
transitoire	≠	permanante

même sens

{ transistor et thyristor commandé par I
{ " Mos " " U

Rcc : Régime de Conduction Continu $L \to \infty$ — $\boxed{i_c(t) = cte}$ → lissage parfait

RCD : " " Déscontinu $L \to 0$

* **l'importance Diode de roue libre**

- évaquation de la courant magasiné dans la bobine
- Augmenter la valeur moyenne de Tension :

$\boxed{\omega t = \theta}$

* **les étapes à suivre pour Analyser le schéma**

1. les équations et les conditions d'amortissement et Blocage.
2. répartition les intervalles

$\boxed{\text{Double } (R) \quad \bar{V}_c = \frac{2V_m}{\pi}, \; V_{eff} = \frac{V_m}{\sqrt{2}}}$

Diode (RL) simple

$$V_c = Ri_c + L\frac{di_c}{dt} \Rightarrow V_m \sin\theta = Ri_c + L\frac{di_c}{dt}$$

$$i\left(\frac{\theta}{\omega}\right) = \frac{\sqrt{2}V}{|Z|}\left[\sin(\theta - \varphi) + \sin\varphi \, e^{-\frac{\theta}{\tan(\varphi)}}\right]$$

$i(\beta) = 0$
$\theta = \beta$

$$\bar{V}_c = \frac{V_m}{2\pi}\, 1 - \cos(\beta) \qquad V_{eff}^2 = \frac{1}{2\pi}\left(\beta - \frac{1}{2}\, 2\beta\right)$$

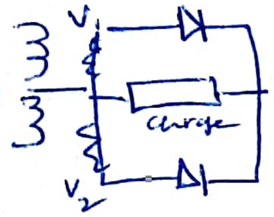
$$\bar{I}_c = \frac{\bar{V}_c}{R}$$

$\boxed{\bar{V}_{L\frac{di}{dt}} = 0}$

$\varphi = \tan^{-1}\left(\frac{L\omega}{R}\right)$

$\boxed{\beta = \pi + \varphi}$

2

② 

$V_1(\theta) = V_m \sin(\theta)$

$V_2(\theta) = -V_m \sin\theta = V_m \sin(\theta - \pi)$

$\overline{V_c} = \frac{2V_m}{\pi}$

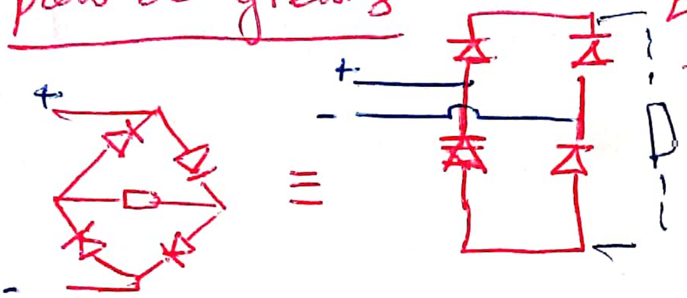
$i = \frac{V}{R}$

l'inconvénient de montage transformateur point de milieu

Dans le séquence négatif $\boxed{V_{d_1} \text{ et } V_{d_2} = -2V_m}$

$V_{eff} = \frac{V_m}{\sqrt{2}}$

pont de greatz

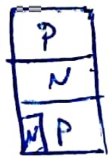


Lumateur de semi conducteur et Unidirectionnel

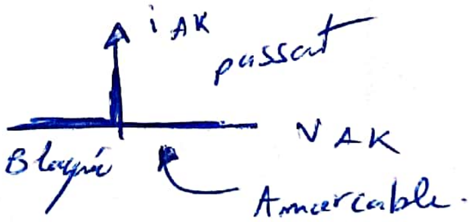
redressement commandée

tête bêche

Thyristor classique, Triac (bidirectionnel),
photo thyristor, GTO (amorcable, blocage) commandé



4 couche
3 jonction



Cond Amorçage

$$\begin{cases} V_A > V_K \\ i_G > 0 \end{cases}$$

Blocage

$$\begin{cases} i_{AK} = 0 \\ \text{ou} \\ V_K > V_A \end{cases}$$

$\boxed{\text{SEA : Accéable à être Amorcé}}$

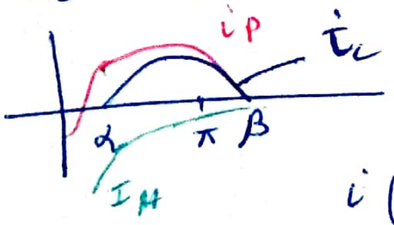
charge R

$\overline{V_c} = \frac{V_m}{2\pi}(1 + \cos\alpha)$ (α) gachette $[0, \pi]$

β : l'angle d'extinction θ_{ex}

$0 \; \alpha \; \pi \; \pi+\alpha \; 2\pi$

$i_c = i_p + i_H$



$i_H = K e^{-\frac{\theta}{\frac{L\omega}{R}}}$, $I_p = \frac{V_m e^{j\theta}}{|Z| e^{j\varphi}} = \frac{V_m}{|Z|}\sin(\theta - \varphi)$

$i\left(\frac{\theta}{\omega}\right) = K e^{-\frac{\theta}{Q}} + \frac{V_m}{|Z|}\sin(\theta - \varphi)$

$i_c\left(\frac{\theta}{\omega}\right) = \frac{V_m}{|Z|}\left[\sin(\theta - \varphi) - \sin(\beta - \varphi) e^{-\frac{\theta}{Q}}\right]$

condition initiale $i_c(\alpha) = 0$

$\overline{U} = \frac{V_m}{2\pi}(\cos\alpha - \cos\beta)$

RA

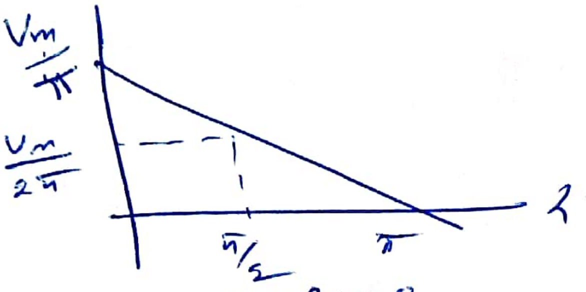
Red Non Comm

$\overline{U_c} = \frac{V_m}{\pi} = cte$

Red Comm

$\overline{U_c} = f(\alpha) = \frac{V_m}{2\pi}(1+\cos\alpha)$

Si $\alpha = 0$ $\overline{U_c} = \frac{V_m}{\pi}$



$\cos 90 = 0$

$\sum V_i = 0$

thyristor transfo point Milieu

$\overline{V_c} = \frac{V_m}{\pi}(1+\cos\alpha)$; $V_{eff} = \frac{V_m}{2\pi}\left(\pi - \alpha + \frac{\sin 2\alpha}{\pi}\right)$

Simple Redressement 3ϕ $\boxed{V_m = \sqrt{2}\, V_{eff}}$

$V_1 = V_m \sin\theta$; $V_2 = V_m \sin\left(\theta - \frac{2\pi}{3}\right)$; $V_3 = V_m \sin\left(\theta - \frac{4\pi}{3}\right)$

$T = \boxed{\frac{5\pi}{6} - \frac{\pi}{6} = \frac{2\pi}{3}}$ $\int_{-\pi/3}^{\pi/3}$

$\overline{U_c} = \frac{1}{\frac{2\pi}{3}} \int_{\pi/6}^{5\pi/6} V_m \sin\theta \, d\theta$

$T = \frac{2\pi}{3}$

$U_c = \frac{3\sqrt{3}}{2\pi} V_m$ $V_{eff} = V_m \sqrt{1 + \frac{3\sqrt{3}}{4\pi}}$

double

$V_c \int_{-\pi/6}^{\pi/3} \ldots = \frac{3\sqrt{6}}{\pi} V$ $V_m = \sqrt{2} V$

$V_{eff} = V\sqrt{3 + \frac{9\sqrt{3}}{2\pi}}$

3ϕ Commandé

$T = 2\pi/3$ $\overline{U_c} = \int_{\pi/6+\alpha}^{5\pi/6+\alpha} \ldots = \frac{3\sqrt{6}}{2\pi} V \cos\alpha$

$V_{eff} = \sqrt{6}\, V \sqrt{\frac{1}{6} + \frac{\sqrt{3}}{2\pi} \cdot \sin(2\alpha)}$

* pour $0 < \alpha < \pi/2$ $\overline{P_c} > 0$ la charge reçoit l'énergie

* " $\alpha = \pi/2$ $\overline{P_c} = 0$ signale Alternatif

* pour $\pi/2 < \alpha < \pi$ $\overline{P_c} < 0$ recepteur Actif sera source génératrice cc

V_1 D_1
V_2 D_2
V_3 D_3

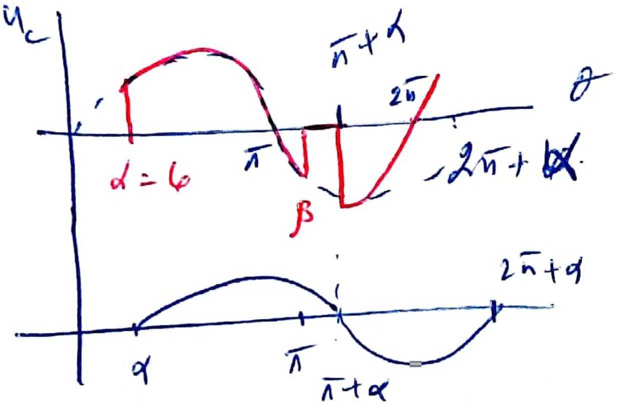
$V_{D_1} = V_1 - V_c$
$V_{D_2} = V_2 - V_c$

gradateur charge RL

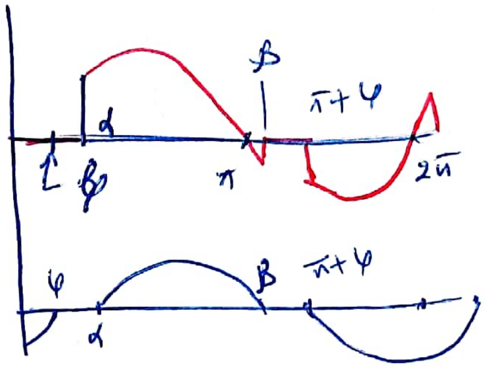
$$i_c\left(\frac{\theta}{\omega}\right) = \frac{V_m}{|Z|}\left[\sin(\theta-\varphi) - \sin(\alpha-\varphi)\, e^{-\left(\frac{\alpha-\theta}{Q}\right)}\right]$$

1) $\alpha = \cancel{\beta}\varphi$ pas de regime transitoire

$$i(\varphi) = \frac{V_m}{|Z|}\sin(\theta-\varphi)$$



2) $\varphi < \alpha < \pi$ $\quad \pi < \beta < \pi+\varphi$



3) $\varphi > \alpha$ $\quad \pi+\alpha < \cancel{\beta} \; \pi+\varphi < \pi+\beta$

- impulsion court durée : Thy le montage fonctionne comme un redresseur simple Alternance.
- Train d'impulsion : fonctionne comme interrupteur permanente.

* **Onduleur Autonome**

c'est une fonctionnement spéciale avec l'angle de commande α supérieur à $\frac{\pi}{2}$

$$\theta_{ex} = \pi + \varphi - \tan^{-1}\left(\frac{img}{reel}\right)$$

$P = E\,\overline{i_{ch}}$

puissance fourni par la charge.

Scanned with CamScanner

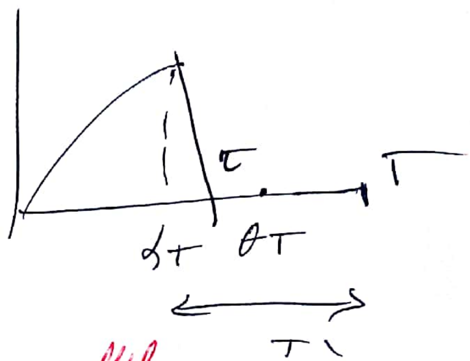
$\bar{U} = \alpha E \quad 0 \leq \alpha \leq 1$

Abaisseur

$\bar{u} = Ri + E'$ $\quad \bar{u} \leq E$ $\quad \alpha E = Ri + E'$

choix de fréquence pour marche à RCC $\quad T \ll \tau$

$$\bar{u} = \frac{1}{T}\left[\int_0^{\alpha T} E\,dt + \int_{\alpha T}^{\theta T} 0\,dt + \int_{\theta T}^{T} E'\,dt\right]$$

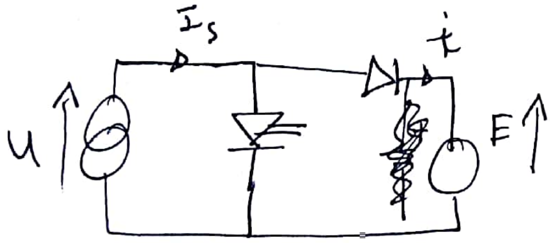


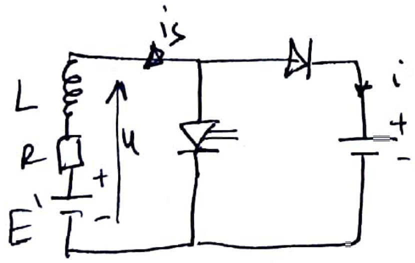
$$\boxed{\bar{u} = \alpha E + (1-\theta)E'}$$

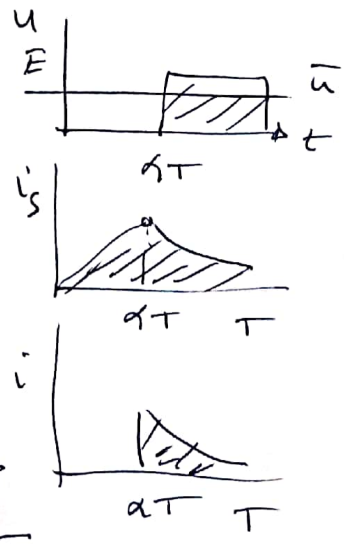
Hacher parallèle

élévateur, survolteur

SI → SV







$$\bar{u} = \frac{1}{T}\int_{\alpha T}^{T} E\,dt = (1-\alpha)E$$

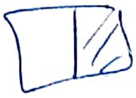
$E \geq \bar{u}$

$$\bar{u} = E' - R\bar{I}_s = (1-\alpha)E \qquad E = \frac{E' - RI_s}{1-\alpha}$$

$$E' \geq (1-\alpha)E$$

6

Hacheur non réversible



liaison direct

indirect

- liaison direct
  - Série Abaisseur
  - parallèle (élévateur)

SI → SV

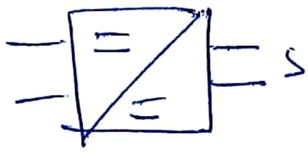
SV → SI

- indirect
  - accumulation selfique
  - Accumulation capacitive

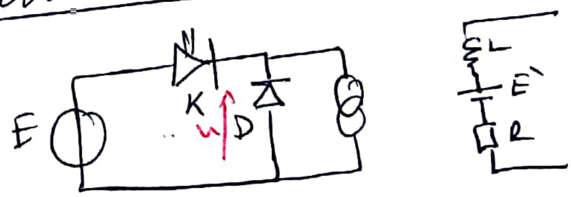
H réversible

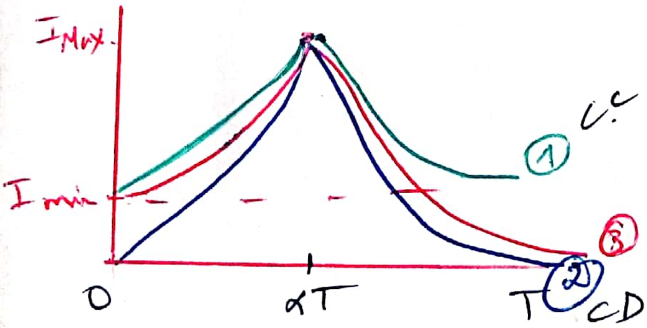
- 2 quadrant
  - Courant
  - Tension
- 4 quadrant
  - partiel
  - Total

V, I → 4Q



Hacheur série





[0, αT] K fermé forcé D bloquée

* $u = E = Ri + L\frac{di}{dt} + E'$

$$i(t) = A e^{-t/\tau} + \frac{E-E'}{R}$$

CI : $i(0) = I_{min}$ $\Rightarrow$ $i(t) = \left[I_{min} - \left(\frac{E-E'}{R}\right)\right] e^{-t/\tau} + \frac{E-E'}{R}$

$t \to \infty$ $\quad i(\infty) = \frac{E-E'}{R}$

[αT, T] $t = \alpha T$ K bloquée D passant.

* $0 = Ri + L\frac{di}{dt} + E'$

$$i(t) = \beta e^{-t/\tau} - \frac{E'}{R}$$

CI $i(\alpha T) = I_{Max}$

$$i(t) = \left(I_{Max} + \frac{E'}{R}\right) e^{-\left(\frac{t-\alpha T}{\tau}\right)} - \frac{E'}{R}$$