TABLE DES MATIERES

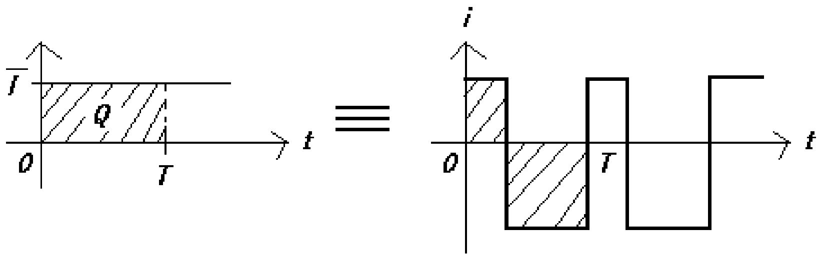
1) DEFINITIONS

1.1) LE REDRESSEMENT

Le redressement consiste à rendre monodirectionnel un signal bidirectionnel

1.2)VALEUR MOYENNE

On peut comparer un signal périodique à un signal continu :
Si les deux signaux transportent la même quantité d'électricité pendant le même temps (une période), on parle alors de valeur moyenne.

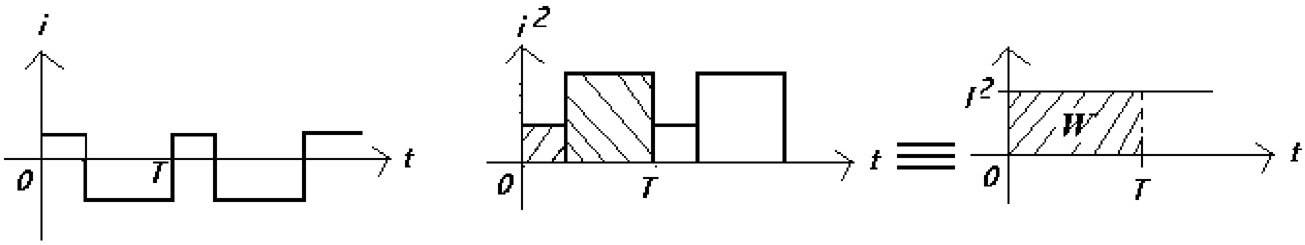


$$Q = \bar{I} \times T = \int_0^T i(t) \times dt$$

$$\Rightarrow \bar{I} = \frac{1}{T}\int_0^T i(t) \times dt \text{ = valeur moyenne}$$

1.3)VALEUR EFFICACE

Si les deux signaux dissipent la même puissance dans la même charge pendant le même temps (une période), on parle alors de valeur efficace.(même énergie fournie)

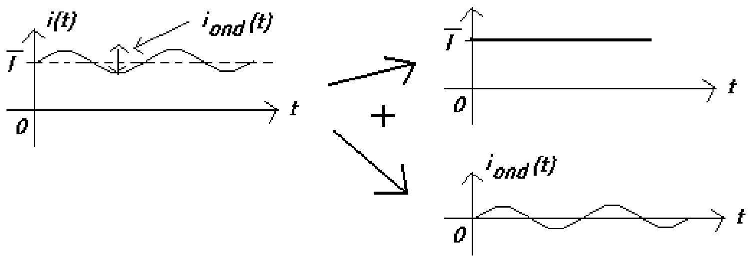


$$W = P \times T = R \times I^2 \times T = R \times \int_0^T i^2(t) \times dt$$

$$\Rightarrow I^2 = \frac{1}{T} \times \int_0^T i^2(t) \times dt$$

$$\Rightarrow I = \sqrt{\frac{1}{T} \times \int_0^T i^2(t) \times dt} \text{ = valeur efficace}$$

1.4) ONDULATION



$$\boxed{i(t) = \bar{I} + i_{ond}(t)}$$

$$\boxed{\overline{I_{ond}} = 0}$$

1.5) TAUX D'ONDULATION

$$\boxed{\tau = \frac{I_{ond}}{\bar{I}}}$$ sans unité

1.6) FACTEUR DE FORME

$$\boxed{F = \frac{I}{\bar{I}}}$$ sans unité

1.7) RELATION ENTRE TAUX D'ONDULATION ET FACTEUR DE FORME

$$\boxed{F^2 = 1 + \tau^2}$$

Démonstration :

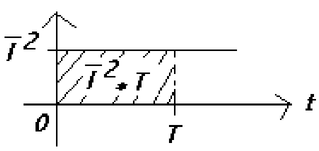
$$I^2 = \frac{1}{T}\times\int_0^T i^2(t)\times dt = \frac{1}{T}\times\int_0^T [\bar{I} + iond(t)]^2(t)\times dt = \frac{1}{T}\times\int_0^T [\,\bar{I}^2 + i_{ond}(t)^2 + 2\times\bar{I}\times i_{ond}(t)\,]dt$$

$$\Rightarrow I^2 = \underbrace{\frac{1}{T}\times\int_0^T \bar{I}^2 dt}_{\bar{I}^2\times T} + \underbrace{\frac{1}{T}\times\int_0^T i_{ond}(t)^2 dt}_{I_{ond}{}^2} + 2\times\bar{I}\times\frac{1}{T}\times\underbrace{\int_0^T i_{ond}(t)dt}_{0}$$

$$\Rightarrow I^2 = \bar{I}^2 + I_{ond}{}^2$$

$$\frac{I^2}{\bar{I}^2} = \frac{\bar{I}^2}{\bar{I}^2} + \frac{I_{ond}{}^2}{\bar{I}^2}$$

$$F^2 = 1 + \tau^2$$

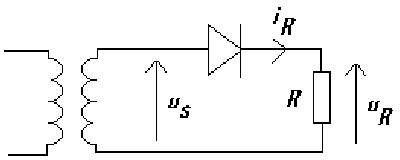


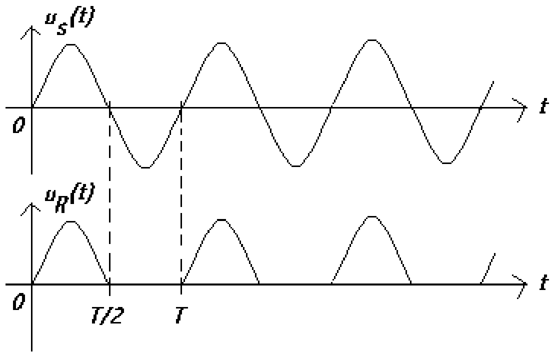
2) REDRESSEMENT MONOALTERNANCE (TYPE P1)

Rappel :

$$\sin^2(\theta)=\frac{1-\cos(2\times\theta)}{2} \qquad \cos(\theta)=\frac{e^{j\times\theta}+e^{-j\times\theta}}{2}$$

$$\cos^2(\theta)=\frac{1+\cos(2\times\theta)}{2} \qquad \sin(\theta)=\frac{e^{j\times\theta}-e^{-j\times\theta}}{2\times j}$$





$$u_s(t)=U_{\max}\times\sin(\omega\times t)$$
$$u_s(t)=u_D(t)+u_R(t)$$

$$\overline{U_R}=\frac{1}{T}\times\int_0^{T/2}u_s(t)dt=\frac{1}{T}\times\int_0^{T/2}U_{\max}\times\sin(\omega\times t)dt \quad \text{or } \theta=\omega\times t\Rightarrow d\theta=\omega\times dt\Rightarrow dt=\frac{d\theta}{\omega}$$

donc $\overline{U_R}=\frac{1}{\omega\times T}\times\int_0^{\pi}U_{\max}\times\sin(\theta)d\theta=\frac{U_{\max}}{2\times\pi}\times\int_0^{\pi}\sin(\theta)d\theta=\frac{U_{\max}}{2\times\pi}\times\left[-\cos(\theta)\right]_0^{\pi}$

donc $\boxed{\overline{U_R}=\frac{U_{\max}}{\pi} \quad et \quad \overline{I_R}=\frac{\overline{U_R}}{R}=\frac{I_{\max}}{\pi}}$

$$U_R^{\ 2}=\frac{1}{T}\times\int_0^{T/2}u_s^{\ 2}(t)dt=\frac{1}{T}\times\int_0^{T/2}U_{\max}^{\ 2}\times\sin^2(\omega\times t)dt=\frac{U^2_{\max}}{\omega\times T}\times\int_0^{\pi}\sin^2(\theta)d\theta$$

$$U_R^{\ 2}=\frac{U_{\max}^{\ 2}}{2\times\pi}\times\int_0^{\pi}\frac{1-\cos(2\times\theta)}{2}d\theta=\frac{U_{\max}^{\ 2}}{4\times\pi}\times\left[\theta-\frac{\sin(2\times\theta)}{2}\right]_{00}^{\pi}=\frac{U_{\max}^{\ 2}}{4}$$

donc $\boxed{U_R=\frac{U_{\max}}{2} \quad et \quad I_R=\frac{U_R}{R}=\frac{I_{\max}}{2}}$

Pour la diode :

$$\overline{I_D}=\overline{I_R}=\frac{I_{\max}}{\pi}$$

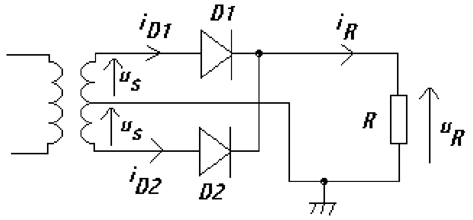
$$I_{FRM}=I_{\max}$$

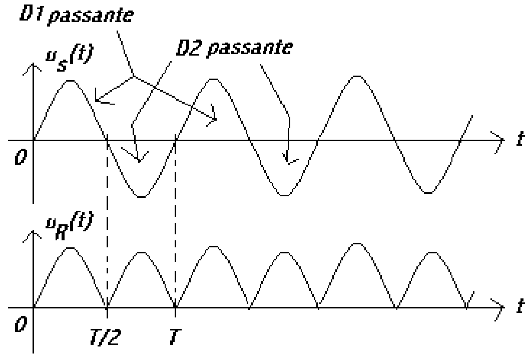
$$V_{RRM}=V_{\max}$$

$$F=\frac{U_R}{\overline{U_R}}=\frac{\frac{U_{\max}}{2}}{\frac{U_{\max}}{\pi}} \quad \Rightarrow \boxed{F=\frac{\pi}{2}=1{,}57}$$

$$\tau=\sqrt{F^2-1} \quad \Rightarrow \boxed{\tau=1{,}21}$$

3) REDRESSEMENT DOUBLE ALTERNANCE A POINT MILIEU (TYPE P2)





$$u_s(t) = U_{max} \times \sin(\omega \times t)$$
$$u_s(t) = u_D(t) + u_R(t)$$

$$\overline{U_R} = \frac{2}{T} \times \int_0^{T/2} u_s(t)dt = \frac{2}{T} \times \int_0^{T/2} U_{max} \times \sin(\omega \times t)dt \quad \text{or } \theta = \omega \times t \Rightarrow d\theta = \omega \times dt \Rightarrow dt = \frac{d\theta}{\omega}$$

donc $\overline{U_R} = \frac{2}{\omega \times T} \times \int_0^{\pi} U_{max} \times \sin(\theta)d\theta = \frac{2 \times U_{max}}{2 \times \pi} \times \int_0^{\pi} \sin(\theta)d\theta = \frac{U_{max}}{\pi} \times \left[-\cos(\theta)\right]_0^{\pi}$

donc $\boxed{\overline{U_R} = \frac{2 \times U_{max}}{\pi} \quad et \quad \overline{I_R} = \frac{\overline{U_R}}{R} = \frac{2 \times I_{max}}{\pi}}$

$$U_R^{\,2} = \frac{2}{T} \times \int_0^{T/2} u_s^{\,2}(t)dt = \frac{2}{T} \times \int_0^{T/2} U_{max}^{\,2} \times \sin^2(\omega \times t)dt = \frac{2 \times U^2_{max}}{\omega \times T} \times \int_0^{\pi} \sin^2(\theta)d\theta$$

$$U_R^{\,2} = \frac{2 \times U_{max}^{\,2}}{2 \times \pi} \times \int_0^{\pi} \frac{1 - \cos(2 \times \theta)}{2} d\theta = \frac{U_{max}^{\,2}}{2 \times \pi} \times \left[\theta - \frac{\sin(2 \times \theta)}{2}\right]_0^{\pi} = \frac{U_{max}^{\,2}}{2}$$

donc $\boxed{U_R = \frac{U_{max}}{\sqrt{2}} \quad et \quad I_R = \frac{U_R}{R} = \frac{I_{max}}{\sqrt{2}}}$

Pour la diode :

$\overline{I_D} = \frac{\overline{I_R}}{2} = \frac{I_{max}}{\pi}$

$I_{FRM} = I_{max}$

$V_{RRM} = 2 \times V_{max}$

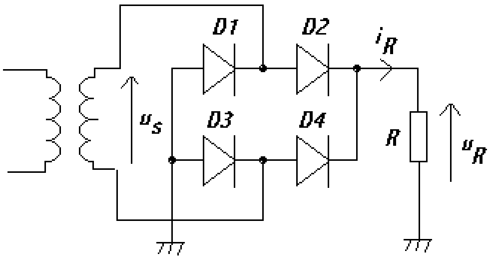
$$F = \frac{U_R}{\overline{U_R}} = \frac{\frac{U_{max}}{\sqrt{2}}}{\frac{2 \times U_{max}}{\pi}} \Rightarrow \boxed{F = \frac{\pi}{2 \times \sqrt{2}} = 1{,}11}$$

$$\tau = \sqrt{F^2 - 1} \Rightarrow \boxed{\tau = 0{,}48}$$

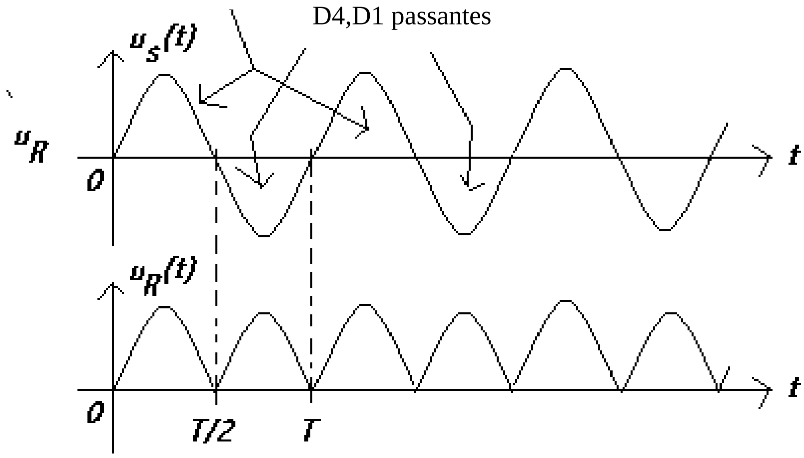
<u>Remarque</u> : <u>inconvénients</u> :
* transformateur à point milieu
* la tension inverse des diodes est doublée par
* au montage P1

<u>Avantages</u> :
* 2 diodes seulement
* A charge égale, les diodes supportent la moitié du courant du montage P1

4 **) REDRESSEMENT DOUBLE ALTERNANCE A PONT DE GRAETZ (TYPE PD2)**



$$u_s(t) = U_{\max} \times \sin(\omega \times t)$$
$$u_s(t) < 0 \Rightarrow = u_{D1}(t) + u_{D4}(t) + u_R(t)$$
$$u_s(t) > 0 \Rightarrow = u_{D2}(t) + u_{D\ 3}(t) + u_R(t)$$
$$u_s(t) = 2 \times u_D(t) + u_R(t)$$



Le signal $u_R(t)$ est identique au montage P2 donc les résultas sont les mêmes.

$$\overline{U_R} = \frac{2 \times U_{\max}}{\pi} \quad et \quad \overline{I_R} = \frac{\overline{U_R}}{R} = \frac{2 \times I_{\max}}{\pi}$$

$$U_R = \frac{U_{\max}}{\sqrt{2}} \quad et \quad I_R = \frac{U_R}{R} = \frac{I_{\max}}{\sqrt{2}}$$

$$F = \frac{\pi}{2 \times \sqrt{2}} = 1{,}11$$

$$\tau = 0{,}48$$

Pour les diodes, les résultats diffèrent un peu : $\overline{I_D} = \frac{\overline{I_R}}{2} = \frac{I_{\max}}{\pi}$ (Idem)

$I_{FRM} = I_{\max}$ (Idem)

mais $V_{RRM} = V_{\max}$

Remarque : inconvénients : * 4 diodes

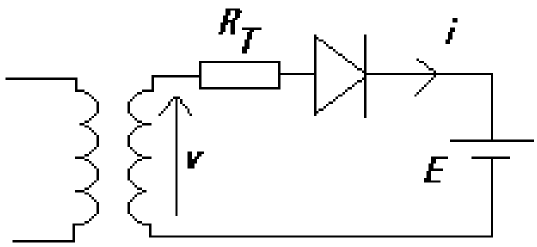
Avantages : * Transfo simple

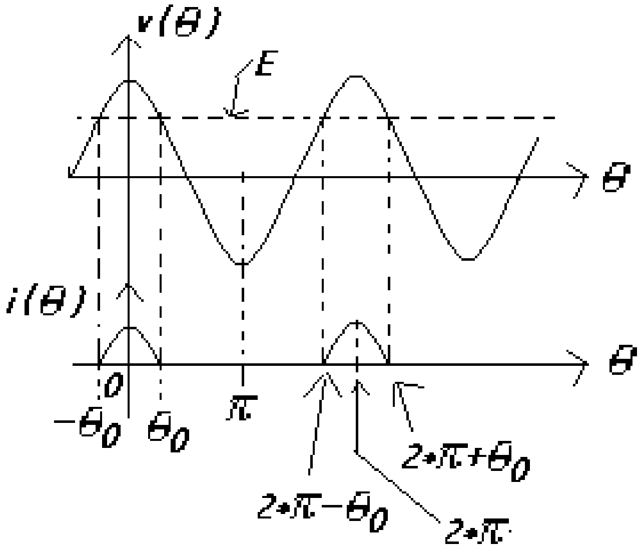
* A charge égale, les diodes supportent la moitié du courant du montage P1.

* La tension inverse des diodes est moitié de celle du montage P2

2

5) REDRESSEMENT SUR FCEM





Angle de conduction = $2\times\theta_0$

$v(t)=V_{\max}\times\cos(\omega\times t)=V_{\max}\times\cos(\theta)$

$v(t)=R_T\times i(t)+v_D(t)+E$

$R_T=r\ \ transfo+r\ \ diode+r\ \ fcem$

Si $v_D=0$, $v(t)=R_T\times i(t)+E$

La diode conduit si $v(t)\geq E$

$v(t)=E\Rightarrow v(\theta)=E\Rightarrow V_{\max}\times\cos(\theta)=E$

$$i(t)=\frac{v(t)-E}{R_T}=\frac{v(\theta)-E}{R_T}=\frac{V_{\max}\times\cos(\theta)-E}{R_T}=\frac{V_{\max}\times\cos(\theta)-V_{\max}\times\cos(\theta_0)}{R_T}$$

$$\boxed{\Rightarrow i_D(\theta)=\frac{V_{\max}\times(\cos(\theta)-\cos(\theta_0))}{R_T}}$$

$v(\theta)=V_{\max}$ quand $\theta=0$ donc $\boxed{i_{FRM}=\frac{V_{\max}}{R_T}\times(1-\cos(\theta_0))}$

$$\bar{I}=\frac{1}{T}\times\int_0^T i(t)dt=\frac{1}{\omega\times T}\times\int_0^{2\times\pi}i(\theta)d\theta=\frac{2}{2\times\pi}\times\int_0^{\theta_0}i(\theta)d\theta=\frac{1}{\pi}\times\int_0^{\theta_0}\frac{V_{\max}\times\cos(\theta)-E}{R_T}d\theta$$

$$\Rightarrow\bar{I}=\frac{1}{\pi\times R_T}\times\left[V_{\max}\times\sin(\theta)-E\times\theta\right]_0^{\theta_0}$$

$$\Rightarrow\bar{I}=\frac{V_{\max}}{\pi\times R_T}\times\left[\sin(\theta_0)-\frac{E}{V_{\max}}\times\theta_0\right]_0^{\theta_0}$$

or $\boxed{\frac{E}{V_{\max}}=\cos(\theta_0)}$

donc $\boxed{\Rightarrow\bar{I}=\frac{V_{\max}}{\pi\times R_T}\times(\sin(\theta_0)-\theta_0\times\cos(\theta_0))}$

$\boxed{V_{RRM}=V_{MAX}+E}$

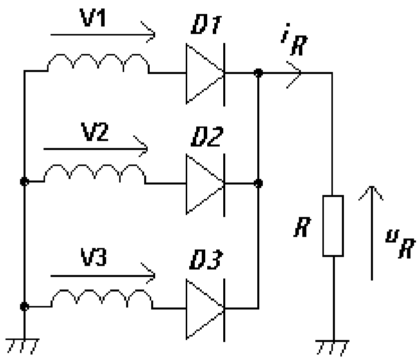
<u>AN</u> : E=6V, Rtransfo=0,8Ω, Rd=0,4Ω, Rfcem=0,1Ω, U=6V

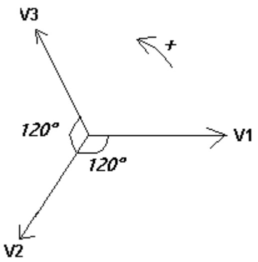
Imax= ? $\bar{I}=$? V_{RRM} = ?

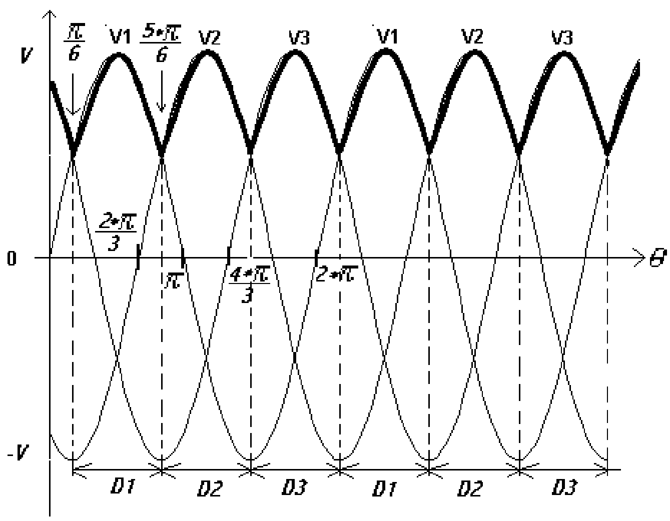
6) REDRESSEMENT TRIPHASE

6.1) REDRESSEMENT TYPE P3

$$v_1 = V \times \sin(\omega \times t) = V \times \sin(\vartheta)$$
$$v_2 = V \times \sin(\omega \times t - \frac{2\times\pi}{3}) = V \times \sin(\vartheta - \frac{2\times\pi}{3})$$
$$v_3 = V \times \sin(\omega \times t - \frac{4\times\pi}{3}) = V \times \sin(\vartheta - \frac{4\times\pi}{3})$$
$$f = 50 \quad Hz$$







Le courant i_R est fourni par la tension v la plus positive

$$\overline{U_R} = \frac{1}{T} \times \int_0^T u_R(t)dt = \frac{1}{\omega \times T} \times \int_0^{2\times\pi} u_R(\theta)d\theta = 3 \times \frac{1}{2\times\pi} \times \int_{\frac{\pi}{6}}^{\frac{5\times\pi}{6}} v_1(\theta)d\theta = \frac{3}{2\times\pi} \times \int_{\frac{\pi}{6}}^{\frac{5\times\pi}{6}} V \times \sin(\theta)d\theta$$

$$\overline{U_R} = \frac{3\times V}{2\times\pi} \times \left[-\cos(\theta)\right]_{\frac{\pi}{6}}^{\frac{5\times\pi}{6}}$$

$$\boxed{\overline{U_R} = \frac{3\times\sqrt{3}}{2\times\pi} \times V = 0{,}826 \times V}$$ or $\overline{I_R} = \frac{\overline{V_R}}{R}$ donc $\boxed{\overline{I_R} = 0{,}826 \times I_{\max}}$ avec $I_{\max} = \frac{V}{R}$

$$U_R{}^2 = \frac{1}{T} \times \int_0^T u_R{}^2(t)dt = \frac{1}{\omega \times T} \times \int_0^{2\div\pi} u_R{}^2(\theta)d\theta = 3 \times \frac{1}{2\times\pi} \times \int_{\frac{\pi}{6}}^{\frac{5\times\pi}{6}} v_1{}^2(\theta)d\theta = \frac{3}{2\times\pi} \times \int_{\frac{\pi}{6}}^{\frac{5\times\pi}{6}} V^2 \times \sin^2(\theta)d\theta$$

or $\sin^2(a) = \frac{1-\cos(2\times a)}{2}$ donc

$$U_R{}^2 = \frac{3}{2\times\pi} \times \int_{\frac{\pi}{6}}^{\frac{5\times\pi}{6}} V^2 \times \frac{1-\cos(2\times\theta)}{2} d\theta = \frac{3\times V^2}{4\times\pi} \times \int_{\frac{\pi}{6}}^{\frac{5\times\pi}{6}} 1-\cos(2\times\theta)d\theta = \frac{3\times V^2}{4\times\pi} \times \left[\theta - \frac{\sin(2\times\theta)}{2}\right]_{\frac{\pi}{6}}^{\frac{5\times\pi}{6}}$$

$$\boxed{U_R = \sqrt{\frac{1}{2} + \frac{3\times\sqrt{3}}{8\times\pi}} \times V = 0{,}84 \times V}$$ or $I_R = \frac{V_R}{R}$ donc $\boxed{I_R = 0{,}84 \times I_{\max}}$ avec $I_{\max} = \frac{V}{R}$

$$F = \frac{I_R}{\overline{\overline{I_R}}} = 1{,}016$$

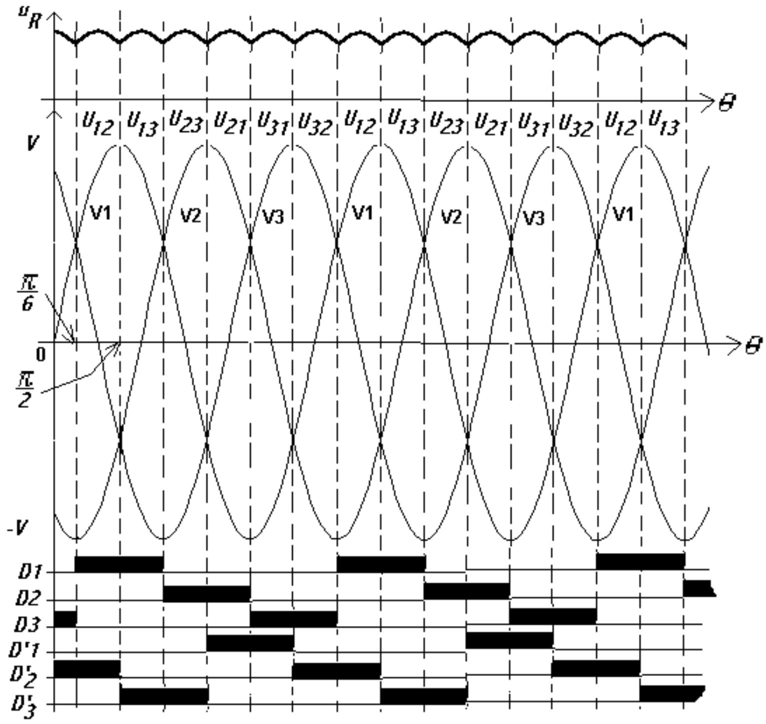
$$\tau = \sqrt{F^2 - 1} = 0{,}18$$

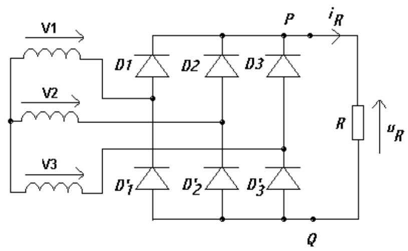
Pour la diode :

$$\overline{I_D} = \frac{\overline{I_R}}{3} = \frac{\sqrt{3}}{2\pi} \times I_{max} \qquad I_{FRM} = I_{max}$$

$$V_{RRM} = \sqrt{3} \times V$$

6.2) REDRESSEMENT TYPE PD3





Des 3 tensions simples $v(t)$, la plus positive rend passante la diode correspondante du haut.
Des 3 tensions simples $v(t)$, la plus négative rend passante la diode correspondante du bas.
La tension au point P est toujours >0. La tension au point Q est toujours <0.
La tension $u_R(t)$ est donc toujours positive.
La charge est alimentée par des calottes de tension composée $u(t)$.

Exemple : Entre $\frac{\pi}{6}$ et $\frac{\pi}{2}$,

$$u_{12}(t) = v_1(t) - v_2(t)) \Rightarrow u_{12}(\theta) = V \times \sin(\vartheta) - V \times \sin(\vartheta - \frac{2\times\pi}{3}) = V \times [\sin(\vartheta) - \sin(\vartheta - \frac{2\times\pi}{3})]$$

or $\sin(p) - \sin(q) = 2 \times \sin(\frac{p-q}{2}) \times \cos(\frac{p+q}{2})$

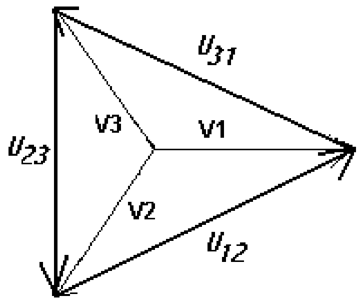
donc $u_{12}(t) = V \times 2 \times \sin(\frac{\pi}{3}) \times \cos(\vartheta - \frac{\pi}{3}) = V \times 2 \times \frac{\sqrt{3}}{2} \times \cos(\vartheta - \frac{\pi}{3})$

or $\cos(\theta) = \sin(\theta + \frac{\pi}{2})$ donc

$$u_{12}(\theta) = V \times \sqrt{3} \times \sin(\vartheta + \frac{\pi}{6}) = U \times \sin(\vartheta + \frac{\pi}{6})$$ avec $U = V \times \sqrt{3}$

De même, on montre que $u_{23}(\theta) = u_{12}(\theta - \frac{2\times\pi}{3})$

et que $u_{31}(\theta) = u_{23}(\theta - \frac{2\times\pi}{3})$



$$\overline{U_R} = \frac{1}{T}\times\int_0^T u_{12}(t)dt = \frac{1}{\omega\times T}\times\int_0^{2\times\pi} u_{12}(\theta)d\theta = 6\times\frac{1}{2\times\pi}\times\int_{\frac{\pi}{6}}^{\pi/2} u_{12}(\theta)d\theta = \frac{3}{\pi}\times\int_{\frac{\pi}{6}}^{\pi/2} U\times\sin(\theta+\frac{\pi}{6})d\theta$$

$$\overline{U_R} = \frac{3\times U}{\pi}\times\int_{\frac{\pi}{6}}^{\frac{\pi}{2}}\sin(\theta+\frac{\pi}{6})d\theta = -\frac{3\times\sqrt{3}\times V}{\pi}\times\left[\cos(\theta+\frac{\pi}{6})\right]_{\frac{\pi}{6}}^{\frac{\pi}{2}} = -\frac{3\times\sqrt{3}\times V}{\pi}\times\left(-\frac{1}{2}-\frac{1}{2}\right)$$

$\overline{U_R} = \frac{3\times\sqrt{3}}{\pi}\times V = 1{,}653\times V$ or $\overline{I_R} = \frac{\overline{U_R}}{R}$ donc $\overline{I_R} = 1{,}653\times I_{max}$ avec $I_{max} = \frac{V}{R}$

$$U_R^2 = \frac{1}{T}\times\int_0^T u_R^2(t)dt = \frac{1}{\omega\times T}\times\int_0^{2\div\pi} u_{12}^2(\theta)d\theta = 6\times\frac{1}{2\times\pi}\times\int_{\frac{\pi}{6}}^{\frac{\pi}{2}} u_{12}^2(\theta)d\theta = \frac{3}{\pi}\times\int_{\frac{\pi}{6}}^{\frac{\pi}{2}} U^2\times\sin^2(\theta+\frac{\pi}{6})d\theta$$

or $\sin^2(a) = \frac{1-\cos(2\times a)}{2}$ donc

$$U_R^2 = \frac{3\times U^2}{\pi}\times\int_{\frac{\pi}{6}}^{\frac{\pi}{2}}\frac{1-\cos(2\times\theta+\frac{\pi}{3})}{2}d\theta = \frac{3\times(\sqrt{3}\times V)^2}{2\times\pi}\times\left[\theta-\frac{1}{2}\times\sin(2\times\theta+\frac{\pi}{3})\right]_{\frac{\pi}{6}}^{\frac{\pi}{2}}$$

$$U_R^2 = \frac{9\times V^2}{2\times\pi}\times\left(\frac{\pi}{2}-\frac{\pi}{6}-\frac{1}{2}\times(-\frac{\sqrt{3}}{2}-\frac{\sqrt{3}}{2})\right) = \frac{9\times V^2}{2\times\pi}\times\left(\frac{\pi}{3}+\frac{\sqrt{3}}{2}\right) = V^2\times\left(\frac{3}{2}+\frac{9\times\sqrt{3}}{4\times\pi}\right)$$

$U_R = V\times\sqrt{\frac{3}{2}+\frac{9\times\sqrt{3}}{4\times\pi}} = 1{,}655\times V$ or $I_R = \frac{U_R}{R}$ donc $I_R = 1{,}655\times I_{max}$ avec $I_{max} = \frac{V}{R}$

$F = \frac{I_R}{\overline{I_R}} = 1{,}0009$

$\tau = \sqrt{F^2 - 1} = 0{,}042$

Pour la diode :

$\overline{I_D} = \frac{\overline{I_R}}{3} = \frac{3}{\pi}\times I_{max}$

$I_{FRM} = \sqrt{3}\times I_{max}$

$V_{RRM} = \sqrt{3}\times V$