Valeur moyenne et valeur efficace d'un signal à la sortie d'un redresseur

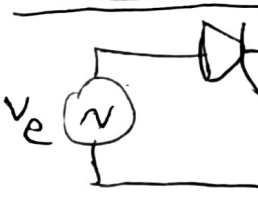
القيمة المتوسطة والقيمة الفعالة عند مخرج مقوّم

رياضيا تعرف هذه المقادير كما يلي :

$$V_{moy} = \frac{1}{T}\int_0^T V(t)\,dt \qquad \text{القيمة المتوسطة}$$

$$V_{eff} = \sqrt{\frac{1}{T}\int_0^T V^2(t)\,dt} \qquad \text{القيمة الفعالة}$$

1) Redresseur simple alternance :



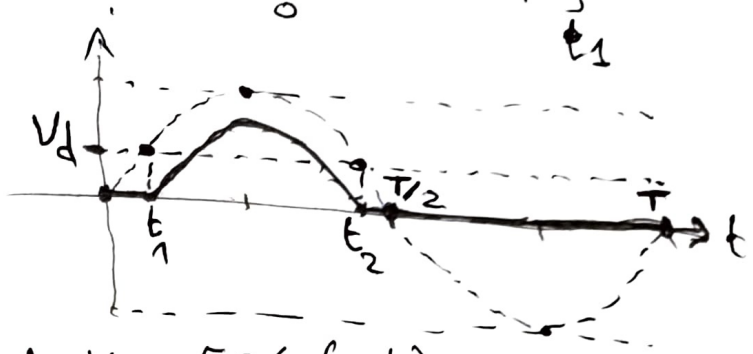
$$V_s = \begin{cases} 0 & \text{si } V_e \le V_d \\ \frac{R_L}{R_L + r_d}(V_e - V_d) & \text{si } V_e > V_d \end{cases}$$

* Pour une diode idéale : $V_d = 0$ et $r_d = 0$

$$\Rightarrow V_s = \begin{cases} 0 & \text{si } V_e \le 0 \\ V_e & \text{si } V_e > 0 \end{cases}$$

a) Valeur moyenne :

$$V_{s(moy)} = \frac{1}{T}\int_0^T V_s(t)\,dt = \frac{1}{T}\int_{t_1}^{t_2} V_s(t)\,dt$$



$V_d = E\sin(\omega t)$

$$\Rightarrow \begin{cases} t_1 = \frac{1}{\omega}\arcsin\left(\frac{V_d}{E}\right) \\ t_2 = \frac{T}{2} - t_1 \end{cases}$$

$$V_s = \begin{cases} 0 & \text{si } 0 < t < t_1 \text{ and } t_2 \le t \le T \\ aV_e + b & \text{si } t_1 \le t \le t_2 \end{cases}$$

$$a = \frac{R_L}{R_L + r_d}\ ;\ b = -\frac{R_L}{R_L + r_d}\cdot V_d$$

$$\Rightarrow V_{s(moy)} = \frac{1}{T}\int_{t_1}^{t_2}\left(a \cdot E\sin(\omega t) + b\right)dt$$

$$= \frac{aE}{T\omega}\left[-\cos(\omega t)\Big|_{t_1}^{t_2}\right] + \frac{b}{T}(t_2 - t_1)$$

$$V_{s(moy)} = \frac{aE}{T.\frac{2\pi}{T}}\left[-\cos(wt_2)+\cos(wt_1)\right] + \frac{b}{T}(t_2-t_1)$$

$$\Rightarrow \boxed{V_{s(moy)} = \frac{aE}{2\pi}\left[-\cos(wt_2)+\cos(wt_1)\right]+\frac{b}{T}(t_2-t_1)}$$

avec: $t_1 = \frac{1}{w}\arcsin\left(\frac{V_d}{E}\right)$

$t_2 = \frac{T}{2} - t_1$

في حالة ديود مثالية: $r_d = 0$ & $V_d = 0$

$t_1 = 0$ et $t_2 = T/2$

$a = 1$ et $b = 0$

$$V_{s(moy)} = \frac{E}{2\pi}\left[-\cos\left(\frac{2\pi}{T}.\frac{T}{2}\right)+\cos(0)\right] + 0$$

$\boxed{V_{s(moy)} = \frac{E}{\pi}}$ → Diode idéale

b) Valeur efficace القيمة الفعالة

$$V_{s(eff)}^2 = \frac{1}{T}\int_{t_1}^{t_2} V_s^2(t)\,dt$$

$V_s(t) = aV_e + b \Rightarrow V_s^2(t) = a^2V_e^2 + b^2 + 2abV_e$

$$V_{s(eff)}^2 = \frac{1}{T}\int_{t_1}^{t_2} a^2V_e^2\,dt + \frac{1}{T}\int_{t_1}^{t_2} b^2\,dt + \frac{1}{T}\int_{t_1}^{t_2} 2abV_e\,dt$$

A_1 A_2 A_3

$$A_1 = \frac{a^2E^2}{T}\int_{t_1}^{t_2}\sin^2(wt)\,dt$$

$$= \frac{a^2E^2}{2T}\int_{t_1}^{t_2}\left(1-\cos(2wt)\right)dt$$

$$A_1 = \frac{a^2E^2}{2T}\left[(t_2-t_1)-\frac{1}{2w}\left(\sin(2wt_2)-\sin(2wt_1)\right)\right]$$

$$A_2 = \frac{b^2}{T}(t_2-t_1)$$

$$A_3 = 2ab\cdot V_{e(moy)}$$

$$A_3 = 2ab\cdot\left\{\frac{aE}{2\pi}\left[-\cos(wt_2)+\cos(wt_1)\right]+\frac{b}{T}(t_2-t_1)\right\}$$

في حالة ديود مثالية: $r_d = 0$ et $V_d = 0$

$a = 1,\ b = 0$

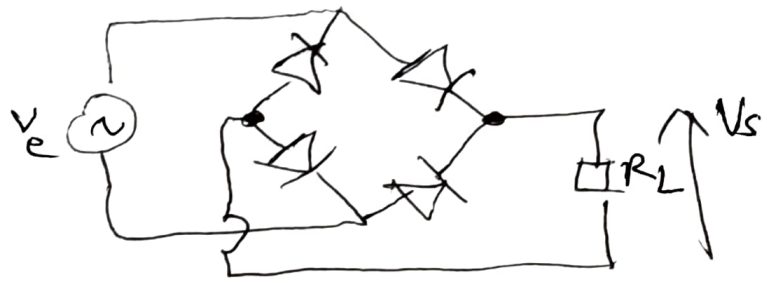
$t_1 = 0,\ t_2 = T/2$

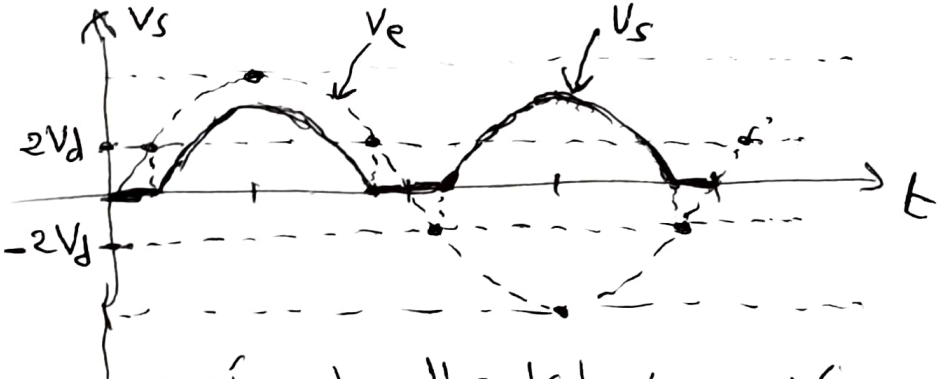
$A_2 = 0,\ A_3 = 0$

$$V_{s(eff)}^2 = \frac{E^2}{2T}\left(\frac{T}{2}\right) = \frac{E^2}{4}$$

$\Rightarrow \boxed{V_{s(eff)} = \frac{E}{2}}$ → Diode idéale

2) Redressement double alternance :





يمكن بدون اعادة الحساب أن نحسب القيمة المتوسطة والفعالة كما يلي :

$$V_{s(moy)}\left(\text{Double alternance}\right) = 2\, V_{s(moy)}\left(\text{simple alternance}\right)$$

$$V_{s(eff)}^2\left(\text{Double alternance}\right) = 2\, V_{s(eff)}^2\left(\text{simple alternance}\right)$$

إذن من حالة ديود مثالية :

$$V_{s(moy)} = 2\frac{E}{\pi}$$

$$V_{s(eff)}^2 = 2 \cdot \frac{E^2}{4} = \frac{E}{2}$$

$$\Rightarrow V_{s(eff)} = \frac{E}{\sqrt{2}}$$