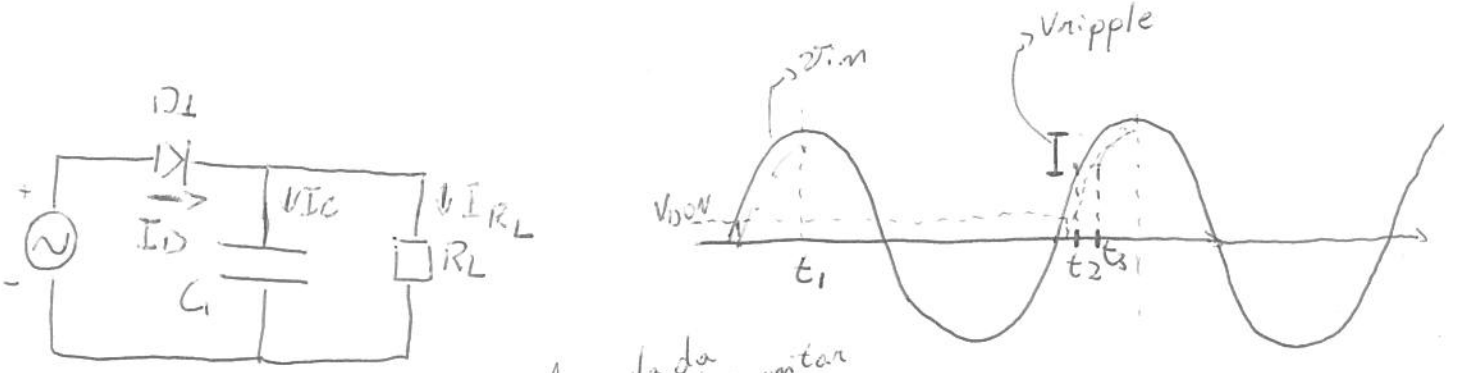
* Retificador 1/2 onda



fórmula da descarga do capacitor

tempo de descarga

- $V_{out}(t) = (V_p - V_{DON}) \exp \frac{-\Delta t}{R_L C_1}$; $\Delta t = t_3 - t_1$

- $\exp -\frac{\Delta t}{R_L C_1} \underset{\text{Taylor } (\Delta t = 0)}{\cong} \exp\left(\frac{-0}{R_L C_1}\right) \cdot (\Delta t - 0)^0 + \frac{1}{R_L C_1} \cdot \exp\left(\frac{-0}{R_L C_1}\right) \cdot (\Delta t - 0)^1 \Rightarrow \boxed{\exp\left(-\frac{\Delta t}{R_L C_1}\right) = 1 - \frac{\Delta t}{R_L C_1}}$

- $V_{out}(t) \cong (V_p - V_{DON})\left(1 - \frac{\Delta t}{R_L C_1}\right) = (V_p - V_{DON}) - (V_p - V_{DON}) \cdot \frac{\Delta t}{R_L C_1}$

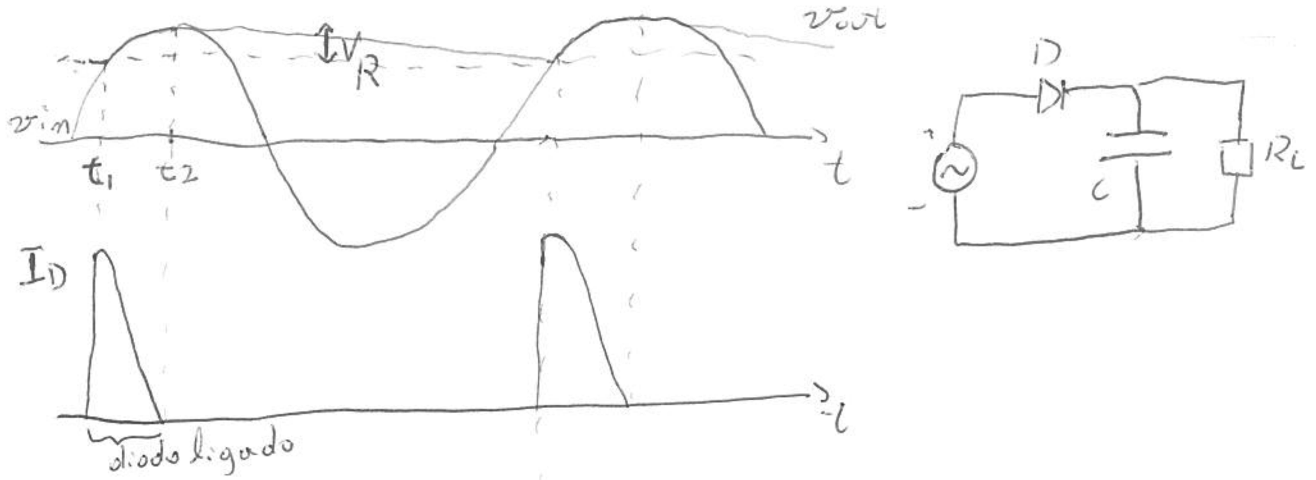
- $\begin{cases} V_{out} \cong V_p - V_{DON} - V_{ripple} \\ V_{ripple} = (V_p - V_{DON}) \frac{\Delta t}{R_L C_1} \end{cases} \overset{\Delta t \sim T}{\Rightarrow} V_{ripple} \cong (V_p - V_{DON}) \cdot \frac{T}{R_L C_1}$

$$\boxed{V_{ripple} \cong \frac{V_p - V_{DON}}{R_L C_1 f}}$$

- $\frac{V_p - V_{DON}}{R_L} \cong I_L \Rightarrow \boxed{V_{ripple} \cong \frac{I_L}{C_1 F}}$

* Corrente do diodo

- Assumindo que $V_p >> V_{D\,ON}$ =



- $i_L = \frac{v_{out}}{R}$; $i_C = C\frac{dv_o}{dt}$
- $i_D = i_C + i_L$
- $i_D = C\frac{dv_{out}}{dt} + \frac{v_{out}}{R}$ ① $\Rightarrow$ como $V_R << V_p \Rightarrow \frac{v_{out}}{R} \cong \frac{V_p}{R} \Rightarrow i_D \cong C\frac{dv_{out}}{dt} + \frac{V_p}{R}$
- $v_{out} = V_p\,\mathrm{sen}\,\omega t$, $t_1 \leq t \leq t_2$ ②

- em t_1
  - $v_{out} = V_p - V_R$
  - $v_{out} = V_p\,\mathrm{sen}\,\omega t_1$

$$\Rightarrow \begin{cases} \mathrm{sen}\,\omega t_1 = 1 - \frac{V_R}{V_p} & ③ \\ \cos\omega t_1 = \sqrt{1-\left(1-\frac{V_R}{V_p}\right)^2} & ④ \end{cases}$$

$\Rightarrow \mathrm{sen}^2\theta + \cos^2\theta = 1$

- De ① e ②

$$I_D \cong \underbrace{C\,V_p\,\omega\cos\omega t}_{C\frac{dv_{out}}{dt}} + \frac{V_p}{R}$$

- I_D pico $\Rightarrow t = t_1$

$$I_{Dp} \cong V_p\,\omega C\cos\omega t_1 + \frac{V_p}{R} \overset{④}{\Rightarrow} I_p \cong V_p\,\omega C\sqrt{1-\underbrace{\left(1-\frac{V_R}{V_p}\right)^2}_{1-\frac{2V_R}{V_p}+\left(\frac{V_R}{V_p}\right)^2}} + \frac{V_p}{R}$$

$$I_{Dp} \cong C\,\omega\,V_p\sqrt{\frac{2V_R}{V_p} - \frac{V_R^2}{V_p^2}} + \frac{V_p}{R_L}$$

- Como $V_R << V_p \Rightarrow \frac{2V_R}{V_p} >> \frac{V_R^2}{V_p^2} \Rightarrow$ $\boxed{I_{Dp} \cong \frac{V_p}{R_L}\cdot\left(R_L C\omega\sqrt{\frac{2V_R}{V_p}} + 1\right)}$ ripple

* Corrente no diodo → outra forma de resolver

$$I_D = I_{R_L} + I_C \Rightarrow \boxed{I_{Dp} \cong \frac{V_p}{R_L} + C\frac{dV_{out}}{dt}} \quad (1)$$

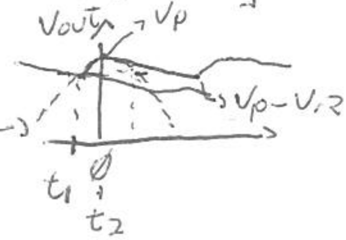
• Para $t_1 < t \le t_2$

$\Rightarrow V_{out} = V_p \cos \omega t$

Taylor ($t_2 = 0$)

$$V_{out} = V_p \cdot \left[\cos 0\,(\omega t - 0)^0 - \cancel{\text{sen}\,0\,(\omega t - 0)^1} - \frac{\cos 0 \cdot (\omega t - 0)^2}{2!}\right]$$

$$\boxed{V_{out} \cong V_p\left[1 - \frac{\omega^2 t^2}{2}\right]} \quad (2) \Rightarrow$$



parábola

$t = t_2 = 0 \Rightarrow V_{out} = V_p$

(2) • $$\frac{dV_{out}}{dt} \cong -V_p \cdot \cancel{2}\,\frac{\omega^2 t^{1}}{\cancel{2}} \Rightarrow \boxed{\frac{dV_{out}}{dt} = -V_p \omega^2 t} \quad (3)$$

(2) • $$t = t_1 \Rightarrow V_{out} = V_p\left[1 - \frac{\omega^2 t_1^2}{2}\right] = V_p - V_R \Rightarrow \cancel{V_p} - \frac{V_p\,\omega^2 t_1^2}{2} = \cancel{V_p} - V_R$$

$$\boxed{t_1 = \pm\sqrt{\frac{2V_R}{V_p}} \cdot \frac{1}{\omega}} \Rightarrow \boxed{t_1 = -\sqrt{\frac{2V_R}{V_p}} \cdot \frac{1}{\omega}} \quad (4)$$

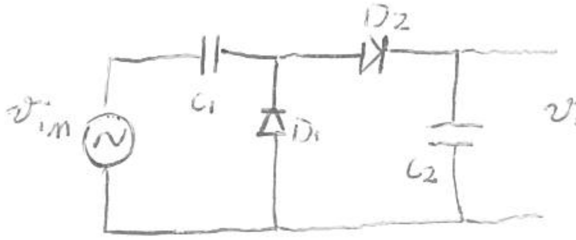
$t_1 < t_2 = 0$

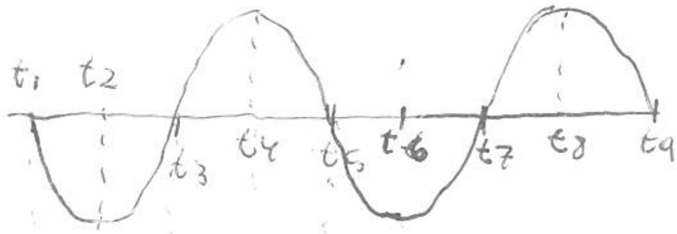
(4)→(3) • $$\frac{dV_{out}}{dt} = -V_p\,\omega^{\cancel{2}}\,\cancel{t} \cdot \left(-\sqrt{\frac{2V_R}{V_p}} \cdot \frac{1}{\cancel{\omega}}\right) \Rightarrow \boxed{\frac{dV_{out}}{dt} = V_p \cdot \omega\sqrt{\frac{2V_R}{V_p}}} \quad (5)$$

↳ em $t = t_1$ (pico máx)

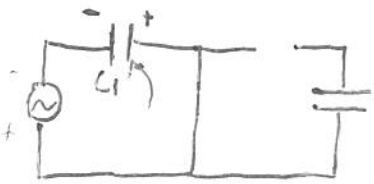
(5)→(1) • $$I_{Dp} \cong \frac{V_p}{R_L} + C V_p \omega \sqrt{\frac{2V_R}{V_p}} \Rightarrow \boxed{I_{Dp} \cong \frac{V_p}{R_L}\left(1 + R_L C \omega \sqrt{\frac{2V_R}{V_p}}\right)}$$

※ Duplicador de tensão





$t_1 < t \le t_2 \Rightarrow D_1$ fechado; D_2 aberto



$v_{out} = 0$

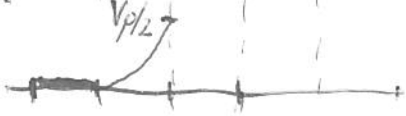
$v_{C_1}(t_2) = v_p$

$v_{D_1}(t_2) = 0 \; (-v_p + v_p)$

$t_2 < t \le t_3 \Rightarrow D_1$ aberto; D_2 fechado

↳ $V_{D_1} < 0$

⇒ Divisor capacitivo

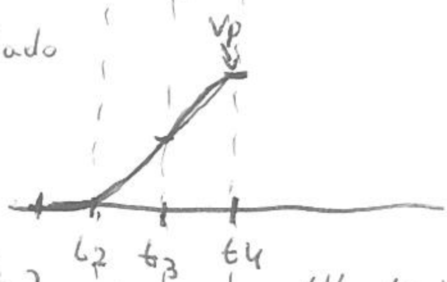


$\Delta V_C = \frac{V_p}{2} \Rightarrow V_{C2} = V_p/2$

$V_{C1} = V_p - V_p/2 = V_p/2$ } em t_3

$t_3 < t \le t_4 \Rightarrow D_1$ aberto; D_2 fechado

$\Delta V_C = V_p/2$

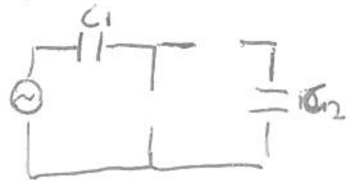


$V_{C2} = V_{C2}(t_3) + \Delta V_C$

$V_{C1} = V_{C1}(t_3) - \Delta V_C$ } em t_4 $\Rightarrow$ $\Delta V_{C2}(t_4) = V_p$

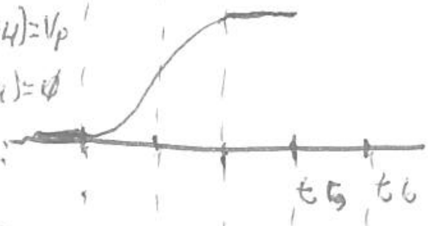
$V_{C1}(t_4) = 0$

$t_4 < t \le t_5 \Rightarrow D_1$ aberto; D_2 aberto

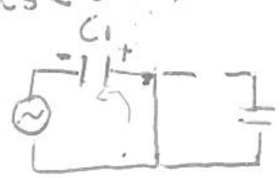


• $V_{C2}(t_5) = V_{C2}(t_4) = V_p$

• $V_{C1}(t_5) = V_{C1}(t_4) = 0$



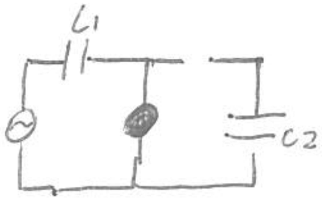
$t_5 < t \le t_6 \Rightarrow D_1$ fechado; D_2 aberto



• $V_{C2}(t_6) = V_{C2}(t_5) = V_p$

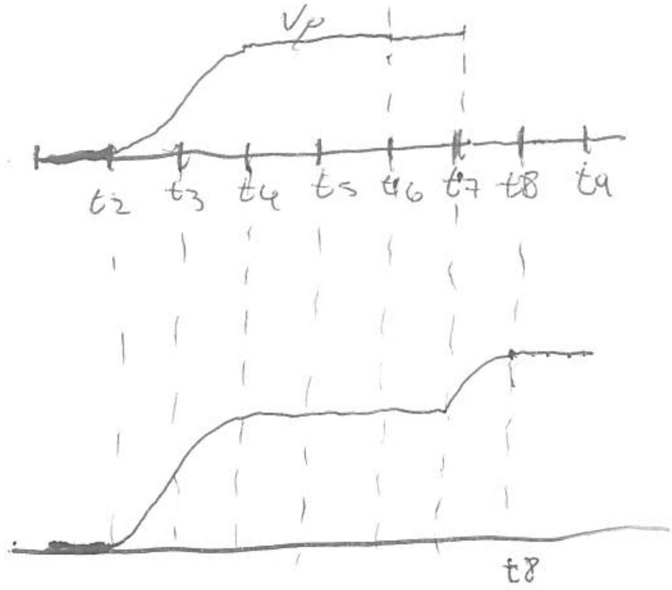
• $V_{C1}(t_6) = V_p$

$t_6 < t < t_7 \to D_1$ Aberto ; D_2: aberto



$V_{C2}(t_7) = V_{C2}(t_6) = V_p$

$V_{C1}(t_7) = V_{C2}(t_6) = V_p$

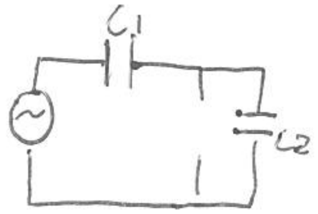


$t_7 < t \le t_8 \to D_1$ aberto; D_2 fechado

$\Delta V_C = V_p/2$

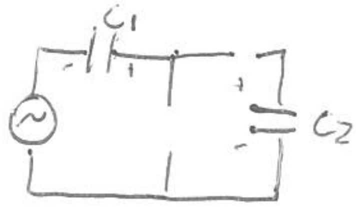
$V_{C2}(t_8) = V_{C2}(t_7) + V_p/2$

$V_{C1}(t_8) = V_{C1}(t_7) - V_p/2$



$$\Rightarrow \begin{cases} V_{C2}(t_8) = V_p + V_p/2 \\ V_{C1}(t_8) = V_p - \dfrac{V_p}{2} \end{cases}$$

$t_8 < t \le t_9 \to D_1$ aberto e D_2 Aberto



$V_{C2}(t_9) = V_{C2}(t_8) = V_p + V_p/2$

$V_{C1}(t_9) = V_{C1}(t_8) = V_p/2$