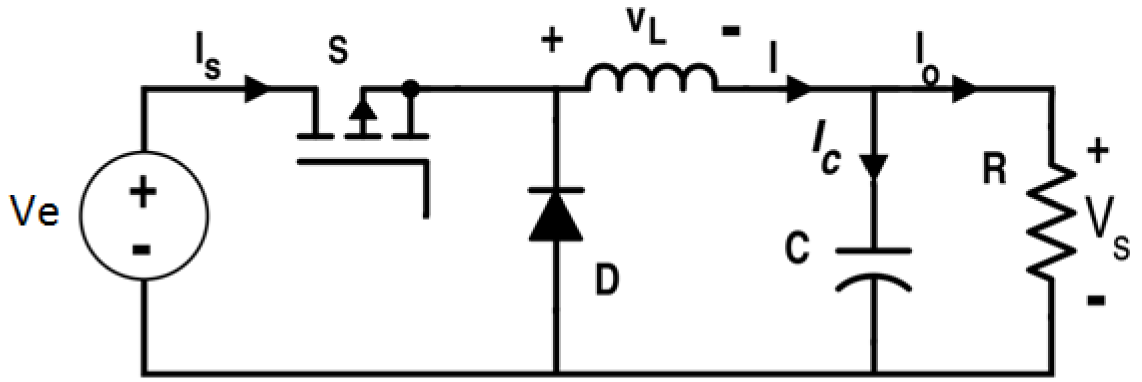
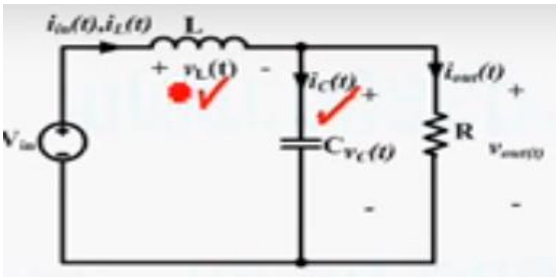
Corrigé TD4

Exercice 1

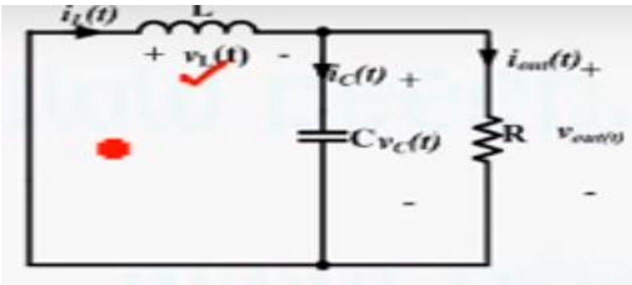


1. Relation entre entrée et sortie

$0 < t < \alpha T$



$\alpha T < t < T$



$[0, \alpha T] : H : \textit{fermé}; D : \textit{bloquée}$

$$\begin{cases} v_H = 0 \\ v_d = -E \end{cases} \Rightarrow \begin{cases} i_H = i_L \\ i_d = 0 \end{cases} \Rightarrow v_L = E - v_s$$

$[\alpha T, T] : H : \textit{ouvert}; D : \textit{passante}$

$$\begin{cases} v_H = E \\ v_d = 0 \end{cases} \Rightarrow \begin{cases} i_H = 0 \\ i_d = i_L \end{cases} \Rightarrow v_L = -v_s$$

$$U_{Lmoy} = \frac{1}{T}\left(\int_0^{\alpha T} (E - v_s)\,dt + \int_{\alpha T}^{T} -v_s dt\right) = \alpha (E - v_s) - v_s (1-\alpha) = 0$$

$$\Rightarrow v_s = \alpha E$$

Donc/ c'est un hacheur série.

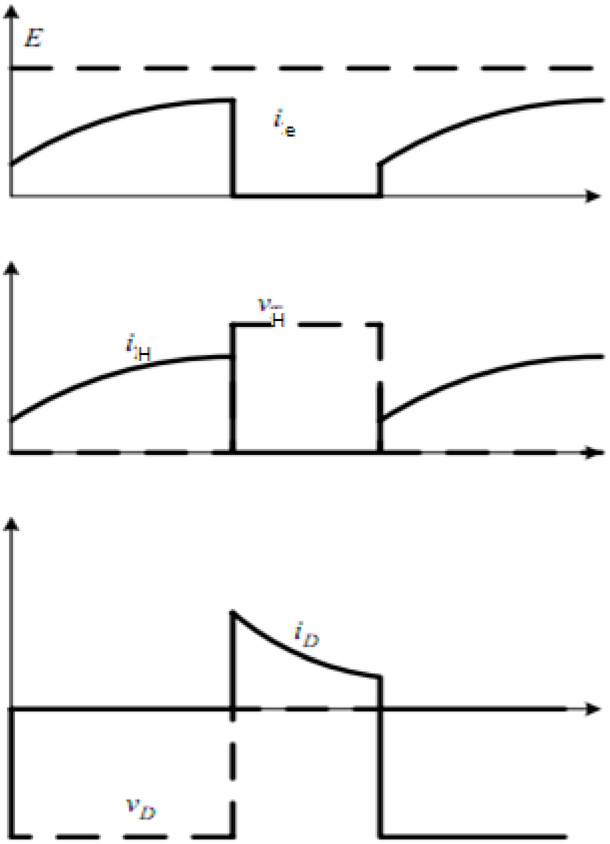
2. Forme d'ondes

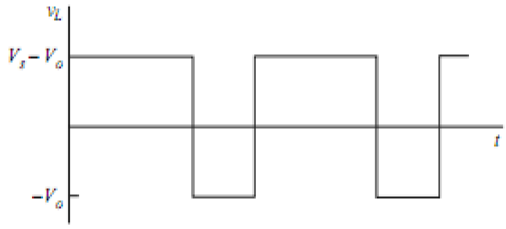
$0 < t < \alpha T$

$$\begin{cases} V_L = V_e - V_s \\ L\dfrac{di_L}{dt} = V_e - V_s \Rightarrow i_L(t) = \dfrac{V_e - V_s}{L} t + I_{L\min} \end{cases}$$

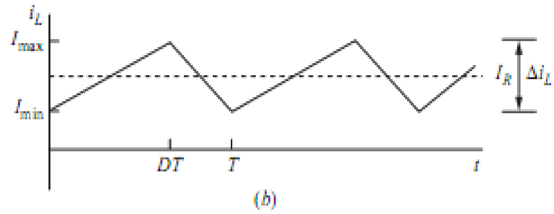
$\alpha T < t < T$

$$\begin{cases} V_L = -V_s \\ L\dfrac{di_L}{dt} = -V_s \Rightarrow i_L(t) = \dfrac{-V_s}{L} t + I_{L\max} \end{cases}$$





(a)



(b)

3. l'ondulation de courant Δi_L et l'ondulation de la tension Δu_C

Ondulation de courant

$$\Delta i_L = I_{L\max} - I_{L\min}$$

$$\int_0^{\alpha T} \frac{di_L}{dt} dt = \int_0^{\alpha T} \frac{V_e - V_s}{L} dt \Rightarrow i_L(\alpha T) - i_L(0) = \frac{V_e - V_s}{L} \alpha T \Rightarrow \Delta i_L = \frac{\alpha(1-\alpha)V_e}{Lf_h}$$

L'ondulation de tension

Le courant et tension aux bornes du condensateur

$0 < t < \alpha T$

$$i_C(t) = i_L - I_s = i_L - \frac{V_s}{R}$$

$$V_s = V_c = \frac{1}{C}\int i_C(t)\,dt$$

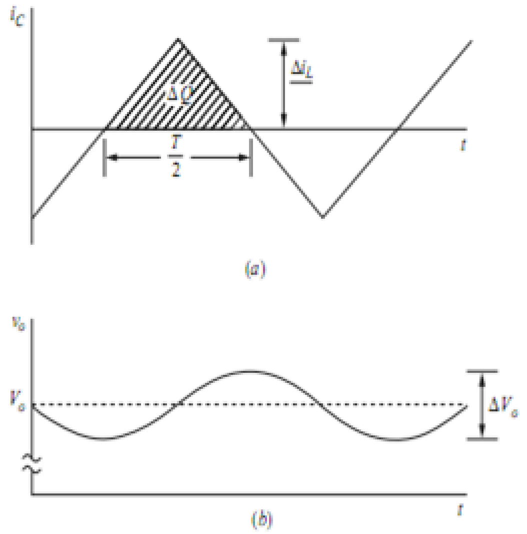
$$V_s(t) = \begin{cases} \frac{1}{C}\int\left(i_L - \frac{V_s}{R}\right)dt = \frac{1}{C}\int\left(\frac{V_e - V_s}{L}t + I_{L\min} - \frac{V_s}{R}\right)dt \\ = \frac{1}{C}\left(\frac{V_e - V_s}{L}t^2 + \left(I_{L\min} - \frac{V_s}{R}\right)t + V_{c\max}\right) \end{cases}$$

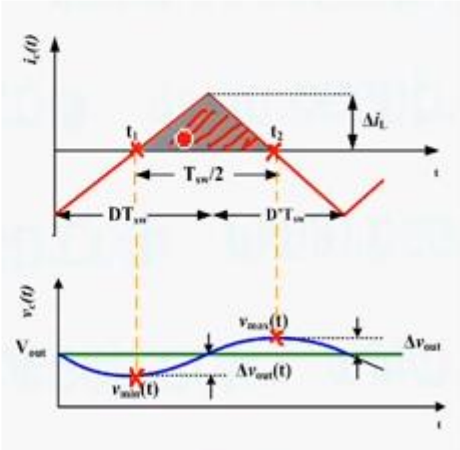
$\alpha T < t < T$

$$i_C(t) = i_L - I_s = i_L - \frac{V_s}{R}$$

$$V_s = V_c = \frac{1}{C}\int i_C(t)\,dt$$

$$V_s(t) = \begin{cases} \frac{1}{C}\int\left(i_L - \frac{V_s}{R}\right)dt = \frac{1}{C}\int\left(\frac{V_e - V_s}{L}t + I_{L\min} - \frac{V_s}{R}\right)dt \\ = \frac{1}{C}\left(\frac{V_e - V_s}{L}t^2 + \left(I_{L\min} - \frac{V_s}{R}\right)t + V_{c\max}\right) \end{cases}$$



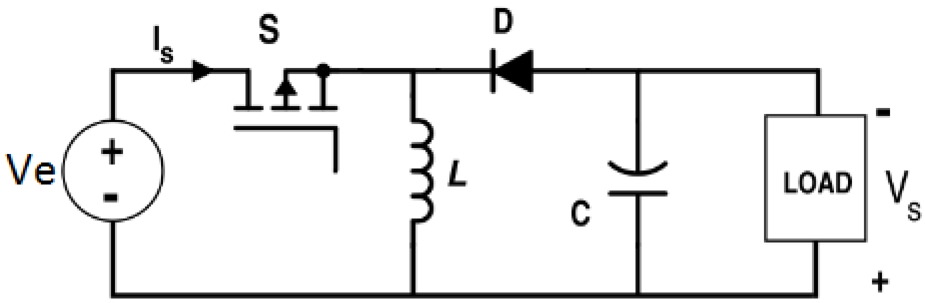


L'ondulation de tension ΔV_s

$$C\frac{dV_s(t)}{dt}=i_c(t)\Rightarrow dV_s(t)=\frac{i_c(t)}{C}dt\Rightarrow$$

$$\int_{t_1}^{t_2}dV_s(t)=\frac{1}{C}\int_{t_1}^{t_2}i_c(t)dt\Rightarrow \Delta V_s=\frac{1}{C}\left(\frac{\Delta i_L}{2}\frac{T}{2}\right)\Rightarrow \Delta V_s=\frac{\Delta i_L}{4Cf}=\frac{\alpha(1-\alpha)V_e}{4CLf^2}$$

Exercice 2



$[0,\alpha T]: H: \textit{fermé}; D: \textit{blquée}$ $\qquad$ $[\alpha T,T]: H: \textit{ouvert}; D: \textit{passante}$

$$\begin{cases}v_H=0\\ v_d=-E-v_s\end{cases}\Rightarrow\begin{cases}i_H=i_L\\ i_d=0\end{cases}\Rightarrow v_L=E \qquad \begin{cases}v_H=E+v_s\\ v_d=0\end{cases}\Rightarrow\begin{cases}i_H=0\\ i_d=i_L\end{cases}\Rightarrow v_L=-v_s$$

$$U_{Lmoy}=\frac{1}{T}\left(\int_0^{\alpha T}(E)dt+\int_{\alpha T}^{T}-v_s dt\right)=\alpha(E)-v_s(1-\alpha)=0$$

$$\Rightarrow v_s=\frac{\alpha}{1-\alpha}E$$

$$\alpha=\frac{1}{2}\Rightarrow v_s=E \qquad \alpha\le\frac{1}{2}\Rightarrow v_s\le E\ \textit{dévolteur} \qquad \alpha\ge\frac{1}{2}\Rightarrow v_s\ge E\ \textit{survolteur}$$

Donc c'est un hacheur survolteur, dévolteur.

Le courant parcourant la bobie

$[0, \alpha T]$ $[\alpha T, T]$

$v_L = L\dfrac{di_L}{dt} = E$ $v_L = L\dfrac{di_L}{dt} = -v_s$

$i_L(t) = \dfrac{E}{L}t + I_{\min}$ $i_L(t) = \dfrac{-v_s}{L}t + I_{\max}$

L'ondulation de courant :

$$i_L(\alpha T) = \frac{E}{L}\alpha T + I_{\min} = I_{\max} \Rightarrow I_{\max} - I_{\min} = \frac{E}{L}\alpha T$$

$$\Delta i_s = I_{\max} - I_{\min} = \frac{\alpha E}{L}T = \frac{\alpha E}{Lf}$$