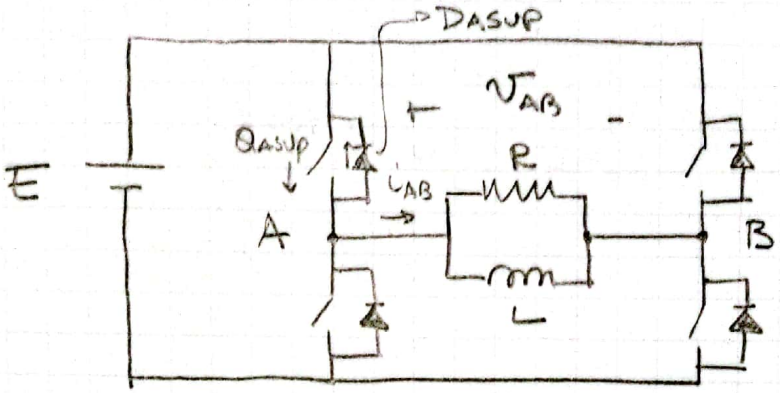
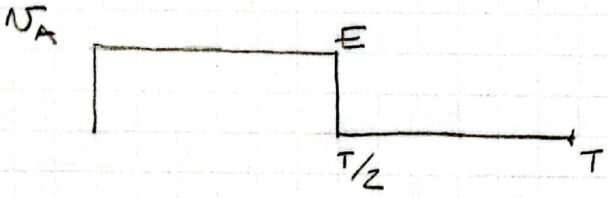
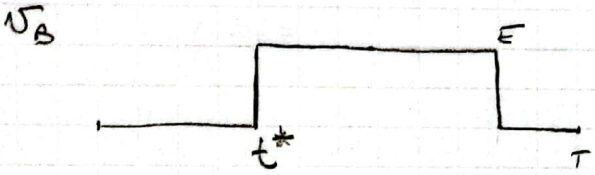
EXAMEN JULIO 2023

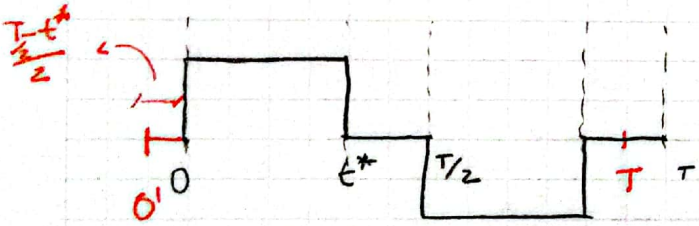
PROBLEMA 2



a) Desfasaje t^* para anular el armónico 3 en V_{AB}







$\frac{2\pi}{T} \cdot t^* = \alpha$

↳ Corro el origen para tener una función impar y desarrollar en senos.

$$b_n = \frac{4}{\pi} \int_{\frac{\pi-\alpha}{2}}^{\pi/2} E \cdot \operatorname{sen}(n\theta)\, d\theta = \frac{4E}{\pi n} \left(\cos\left(n\frac{(\pi-\alpha)}{2}\right) - \underbrace{\cos\left(n\frac{\pi}{2}\right)}_{=0 \text{ para } n \text{ impar}} \right)$$

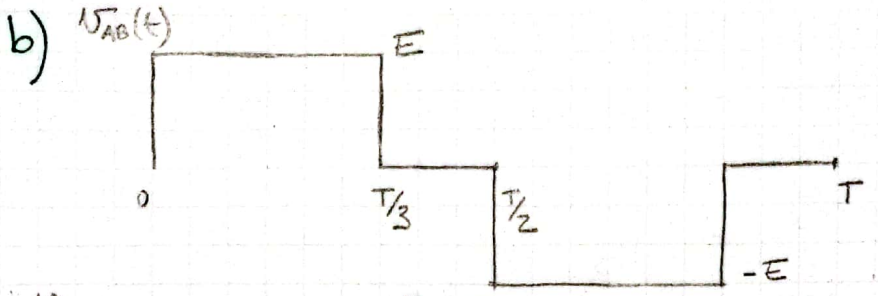
$$b_n = \frac{4E}{\pi n} \left(\underbrace{\cos\left(\frac{n\pi}{2}\right)}_{=0} \cdot \cos\left(-\frac{n\alpha}{2}\right) - \operatorname{sen}\left(\frac{n\pi}{2}\right) \cdot \operatorname{sen}\left(-\frac{n\alpha}{2}\right) \right)$$

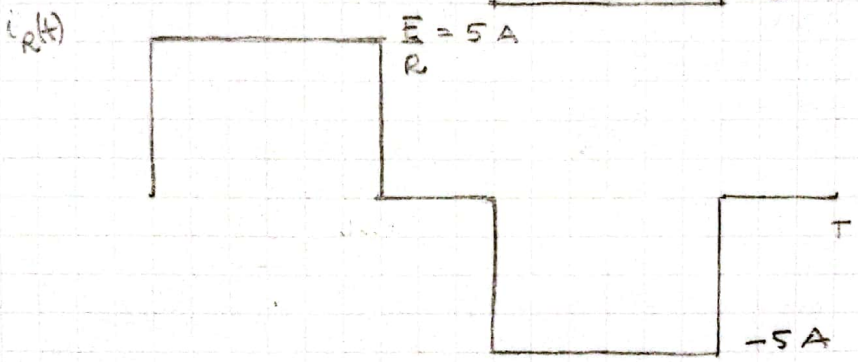
$$b_n = \frac{4E}{\pi n} \cdot \operatorname{sen}\left(\frac{n\pi}{2}\right) \cdot \operatorname{sen}\left(\frac{n\alpha}{2}\right)$$

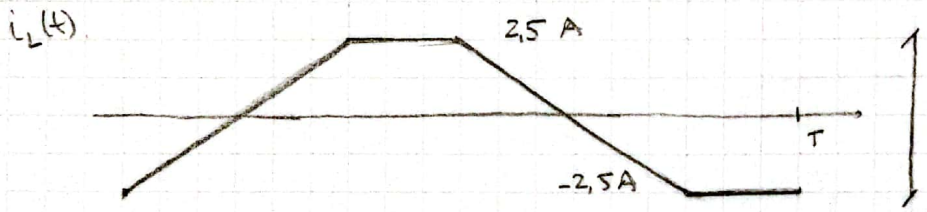
↳ $b_3 = -\frac{4E}{3\pi} \cdot \operatorname{sen}\left(\frac{3\alpha}{2}\right) = 0 \Rightarrow \boxed{\alpha = \frac{2\pi}{3}}$

$\boxed{t^* = \frac{T}{3}}$

b)

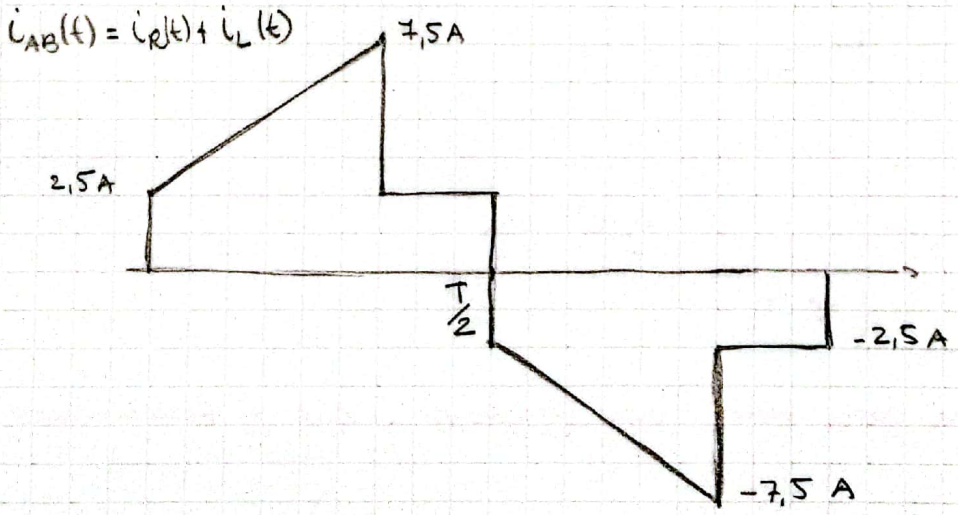






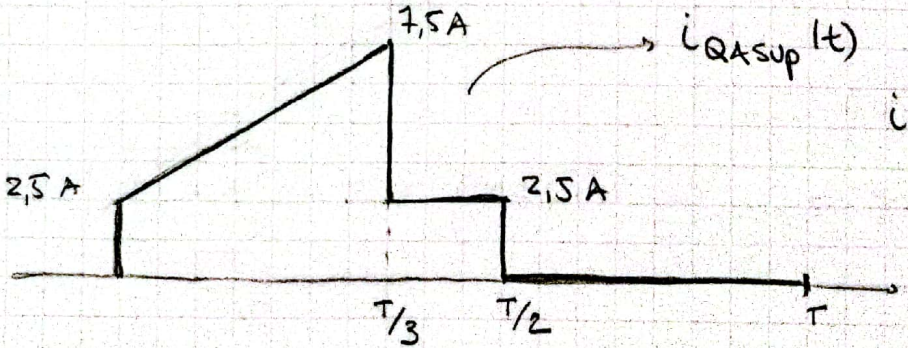
$$\Delta i_L = \frac{E}{L} \cdot \frac{T}{3} = \frac{150V \cdot 20\mu s}{200\mu H \cdot 3}$$

$$= 5A$$



Corriente por llave y diodos superiores de la rama A.

Lo Pueden conducir entre 0 y $T/2$, como la corriente es positiva solo conduce la llave.



c) Pérdidas en la llave Q_{ASUP}.

$$P_{ON} = \frac{1}{T}\cdot\frac{1}{2} E\, I_{mín}\, t_r$$

$$P_{OFF} = \frac{1}{T}\cdot\frac{1}{2} E\, I_{mín}\, t_f$$

$$P_{COND} = R_{DSON}\cdot I^2_{Qef}$$

Hoja de datos

$t_r = 59\ ns$

$t_f = 58\ ns$

$R_{DSON} = 0{,}27\,\Omega \cdot 2{,}25 = 0{,}61\,\Omega$

↓

Gráfica con $T_J = 0{,}9 \times 150°C = 135°C$

Corriente en conducción:

$$i_{QASUP}(t) = \begin{cases} I_{mín} + \frac{t}{T}\cdot\frac{3}{T}\cdot(I_{máx}-I_{mín}),\ t\in[0,T/3] \\ I_{mín},\ t\in(T/3,T/2] \\ 0,\ t\in(T/2,T] \end{cases}$$

$$I^2_{Qef} = \frac{1}{T}\int_0^T i^2_{QASUP}(t)\,dt = \frac{1}{T}\left\{\int_0^{T/3}\left(I_{mín} + t\frac{3}{T}\underbrace{(I_{máx}-I_{mín})}_{\Delta I}\right)^2 dt + \int_{T/3}^{T/2} I_{mín}^2\,dt\right\}$$

$$I^2_{Qef} = \frac{1}{T}\left\{\int_0^{T/3}\left(I_{mín}^2 + 2I_{mín}\Delta I\frac{3t}{T} + 9\frac{t^2}{T^2}\Delta I^2\right)dt + \int_{T/3}^{T/2} I_{mín}^2\,dt\right\}$$

$$= \frac{1}{T}\left\{I^2_{mín}\cdot\frac{T}{3} + I_{mín}\Delta I\frac{3}{T}\left(\frac{T}{3}\right)^2 + \frac{9}{T^2}\Delta I^2\frac{1}{3}\left(\frac{T}{3}\right)^3 + I_{mín}^2\left(\frac{T}{2}-\frac{T}{3}\right)\right\}$$

$$= \frac{I^2_{mín}}{3} + \frac{I_{mín}}{3}\Delta I + \frac{\Delta I^2}{9} + \frac{I^2_{mín}}{6} = \frac{(2{,}5A)^2}{3} + \frac{2{,}5A\cdot 5A}{3} + \frac{(5A)^2}{9} + \frac{(2{,}5A)^2}{6}$$

$$I^2_{Qef} = 10{,}07\,A^2$$

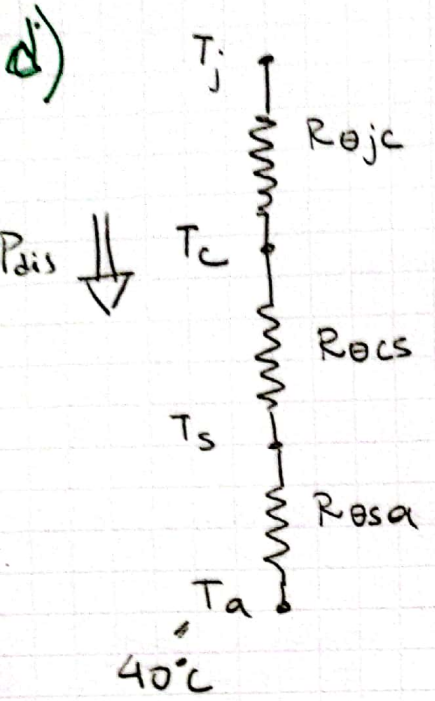
$$P_{ON} = \frac{1}{20\mu s}\cdot\frac{1}{2}\cdot 150V\cdot 2{,}5A\cdot 59ns = 0{,}55\,W$$

$$P_{OFF} = \frac{1}{20\mu s}\cdot\frac{1}{2}\cdot 150V\cdot 2{,}5A\cdot 58ns = 0{,}54\,W$$

$$P_{COND} = 0{,}61\,\Omega\cdot 10{,}07\,A^2 = 6{,}14\,W$$

$P_{disipada} = 7{,}23\,W$

d)



Hoja de datos → $\begin{cases} R_{\theta jc} = 0{,}45\ °C/W \\ R_{\theta cs} = 0{,}24\ °C/W \end{cases}$

$$T_j = T_a + P_{dis}\left(R_{\theta jc} + R_{\theta cs} + R_{\theta sa}\right) \leq 135\ °C$$

$$R_{\theta sa} \leq \frac{(135\ °C - T_a)}{P_{dis}} - R_{\theta jc} - R_{\theta cs}$$

$$\leq \frac{135\ °C - 40\ °C}{7{,}23\ W} - 0{,}45\ °C/W - 0{,}24\ °C/W$$

$$R_{\theta sa} \leq 12{,}45\ °C/W$$