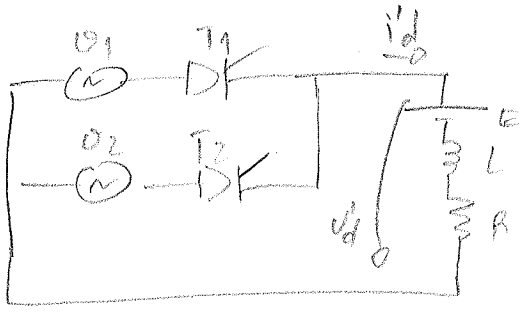
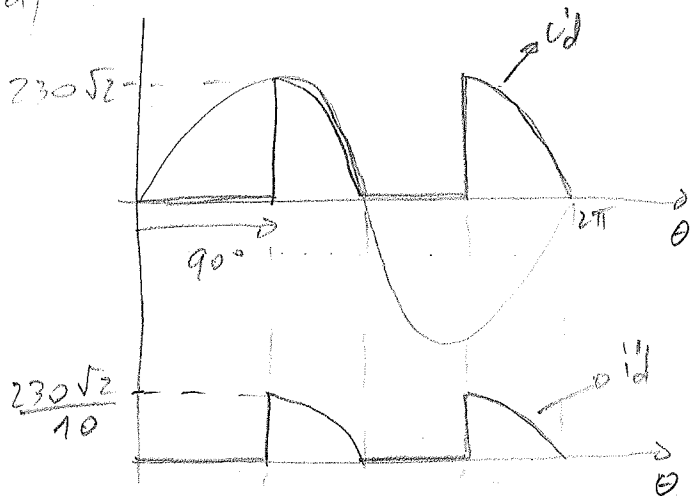
1

i) $R = 10\,\Omega$
$E = 0$
$L = 0$
$\alpha = 90°$



a)



b) $V'd_{AV} = \frac{2}{2\pi}\int_{\frac{\pi}{2}}^{\pi} 230\sqrt{2}\,\sin\theta\,d\theta$

$= \frac{230\sqrt{2}}{\pi}\left[-\cos\theta\right]_{\frac{\pi}{2}}^{\pi} = 103{,}5\ V$

$i'd_{AV} = \frac{103{,}5}{10} = 10{,}35\ A$

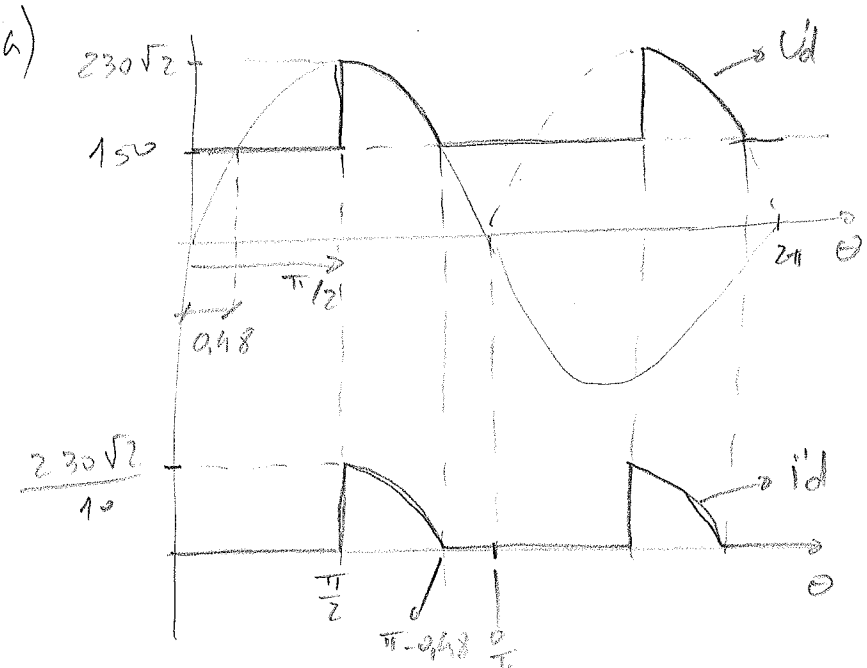
c) $i'd_{rms} = \sqrt{\frac{2}{2\pi}\int_{\frac{\pi}{2}}^{\pi}\left(\frac{230\sqrt{2}}{10}\sin\theta\right)^2 d\theta} = 16{,}76\ A$ $\quad P = 10 \times 16{,}76^2 = 2644\ W$

ii) $R = 10\,\Omega$
$E = 150\ V$
$L = 0$
$\alpha = 90°$

$i'd > 0 \Rightarrow v_1 > E \quad 150 = 230\sqrt{2}\sin\theta \Leftrightarrow \theta = 0{,}48\ rad$

$\alpha = \frac{\pi}{2} > 0{,}48 \Rightarrow$ os tiristores conduzem

a)



b) $V'd_{AV} = \frac{2}{2\pi}\int_{\frac{\pi}{2}}^{\pi-0{,}48} 230\sqrt{2}\,\sin\theta\,d\theta + \frac{2}{2\pi}\int_{0}^{\pi/2+0{,}48} 150\,d\theta$

$= 189{,}7\ V$

$i'd_{AV} = \frac{189{,}7 - 150}{10} = 3{,}97\ A$

c) $$i'd_{rms} = \left[\frac{2}{2\pi} \int_{\frac{\pi}{2}}^{\pi - 0,43} \left(\frac{230\sqrt{2}\sin\theta - 150}{10} \right)^2 d\theta \right]^{1/2} = 7,43\ A$$

$$P = 10 \times 7,43^2 + 150 \times 3,97 = 1147\ W$$

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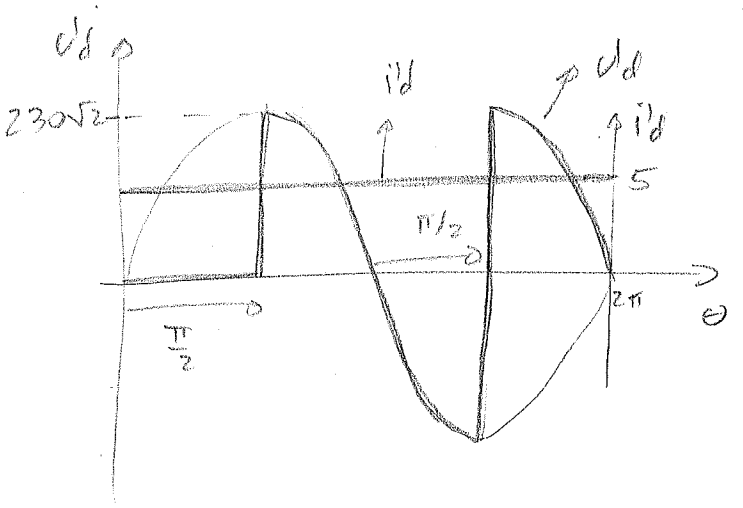
iii) $R = 10\ \Omega$

$E = -50\ V$

courant constant

$\alpha = 90°$



b) $$v'd_0 = V_{d0} \cdot \cos\alpha$$

$$\alpha = \frac{\pi}{2} \Rightarrow v'd_0 = 0\ V$$

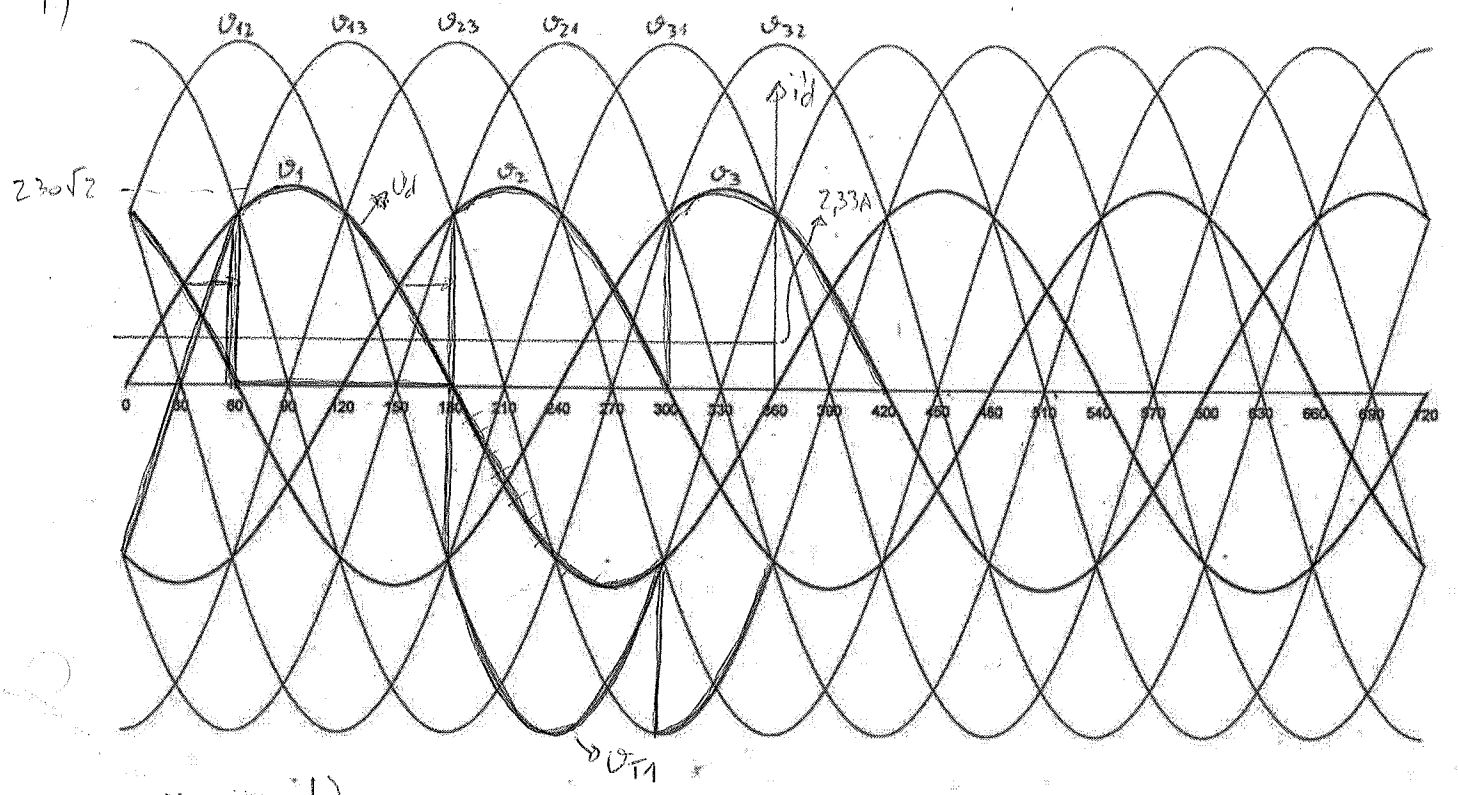
$$i'd_{AV} = \frac{v'd_0 - E}{R} = \frac{0 + 50}{10}$$

$$= 5\ A$$

c) $$P = \frac{1}{T} \int_0^T v_d \times i'd\ dt = I_d \times \frac{1}{T} \int_0^T v'd\ dt = I_d \times v'd_0 = 5 \times 0 = 0\ W$$

(2)

i)



$\alpha = \frac{\pi}{6}$

$R = 100\,\Omega$

corrente constante

b) $V_{do} = \frac{3}{\pi}\sqrt{2}\,230\,\operatorname{sen}\frac{\pi}{3}\cos\frac{\pi}{6} = 233{,}0\,V$

$i'_{dmedio} = \frac{233}{100} = 2{,}33\,A$

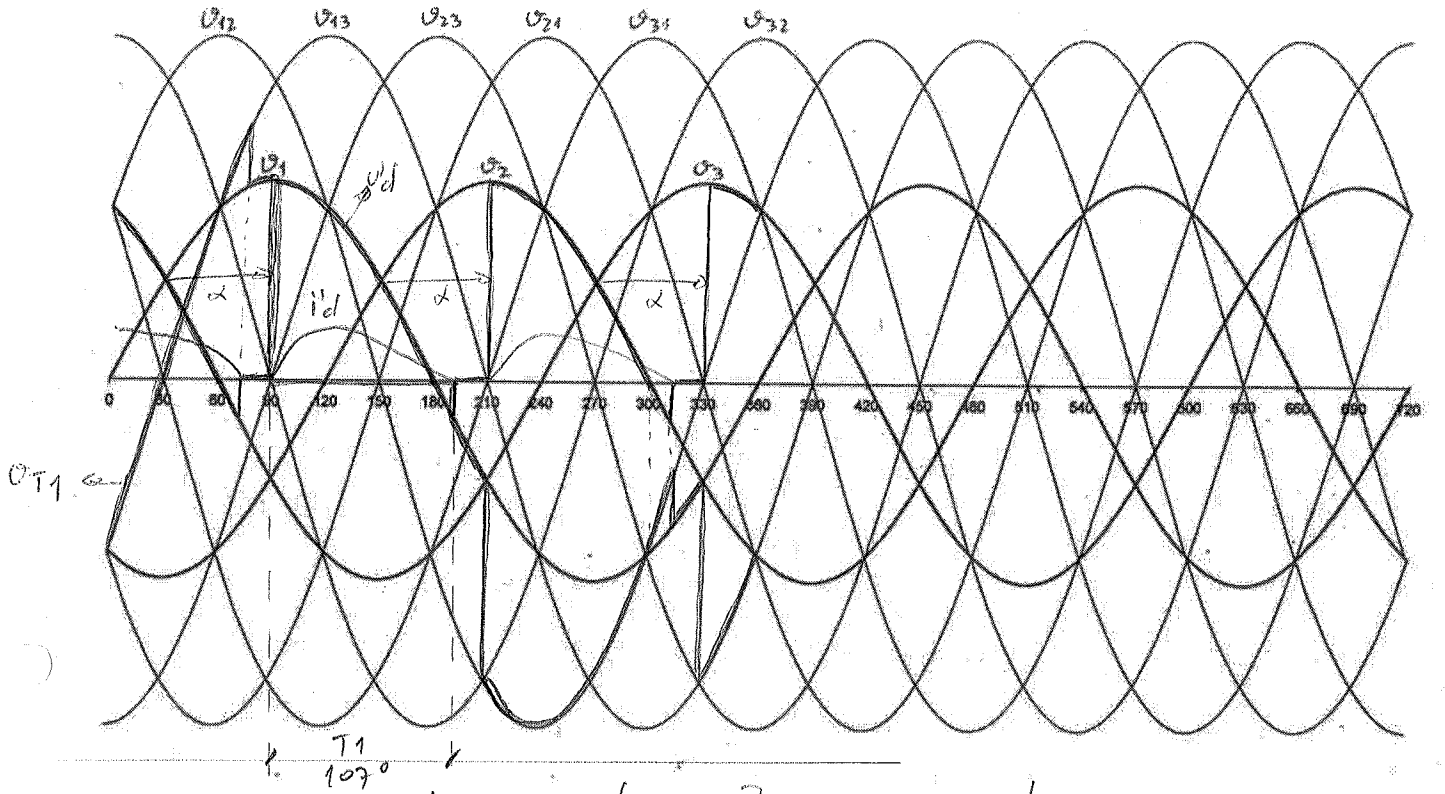
c) $i'_{d_{rms}} = 2{,}33\,A \qquad P = 100 \times 2{,}33^2 = 542{,}9\,W$

d) $i'_{s_{rms}} = \frac{2{,}33}{\sqrt{3}} \qquad S = 3\,V_{s_{rms}} \cdot i'_{s_{rms}}$

$= 3 \cdot 230 \cdot \frac{2{,}33}{\sqrt{3}} = 928{,}2\,VA$

$FP = \frac{P}{S} = \frac{542{,}9}{928{,}2} = 0{,}585$

(2) ii)



$\alpha = \frac{\pi}{3}$ Condução contínua? $\varphi = \arctg\left(\frac{WL}{R}\right) = 0,3$ rad

$R = 100\,\Omega$

$L = 0,1$ H

P3 $\alpha' = \alpha + \frac{\pi}{6}$

$|Z| = \sqrt{R^2 + (\omega L)^2} = 104,8\,\Omega$

$$i'_d(\theta) = \frac{230\sqrt{2}}{104,8}\left[\operatorname{sen}\left(\theta + \frac{\pi}{3} + \frac{\pi}{6} - 0,3\right) - \operatorname{sen}\left(\frac{\pi}{3} + \frac{\pi}{6} - 0,3\right) e^{-\frac{R}{WL}\theta}\right]$$

$i'_d(\theta) = 0 \Rightarrow \theta = 1,87$ rad $= 107° < 120° \Rightarrow$ condução descontínua

b) $V'_{do} = \frac{3}{2\pi}\int_{\pi/2}^{\pi/2+1,87} 230\sqrt{2}\operatorname{sen}\theta\, d\theta = 148,3$ V $\quad i'_{dmedio} = \frac{148,3}{100} = 1,48$ A

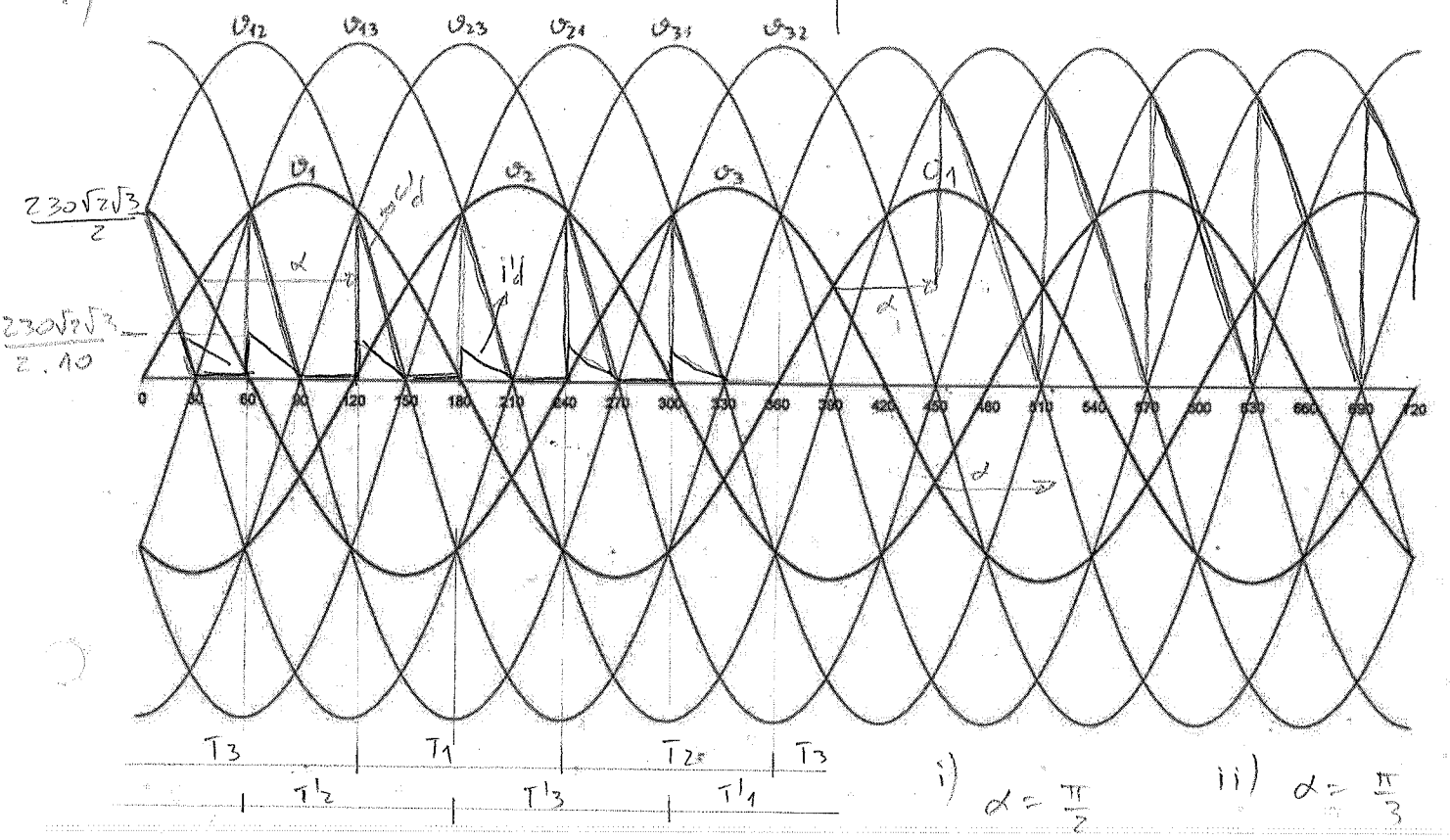
c) $i'_{drms} = \sqrt{\frac{3}{2\pi}\int_0^{1,87} i'_d(\theta)^2 d\theta} = 1,73$ A $\quad P = 100 \times 1,73^2 = 299,3$ W

d) $i_{sRms} = \sqrt{\frac{1}{2\pi}\int_0^{1,87} i'_d(\theta)^2 d\theta} = 1,0$ A $\quad S = 3 \cdot 230 \times 1 = 690$ VA

$FP = \frac{P}{S} = \frac{299,3}{690} = 0,434$

(3)

i)



ii)

i) $\alpha = \frac{\pi}{2}$ $R = 10\,\Omega$ $L = 0$

ii) $\alpha = \frac{\pi}{3}$ $R = 10\,\Omega$ Corrente continua

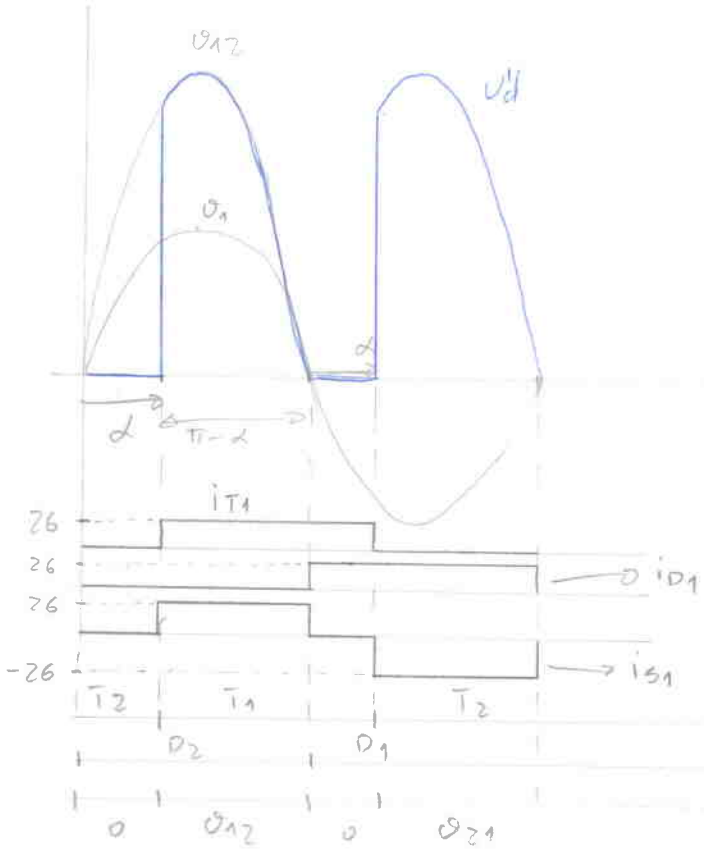
i)

b) $v'_{do} = \frac{6}{2\pi} \int_{\frac{5\pi}{6}}^{\pi} 230\sqrt{2}\sqrt{3} \sin\theta \, d\theta = 72,1\ V$ $\quad i'_{d\,AV} = \frac{72,1}{10} = 7,21\ A$

ii) b) $v'_{do} = \frac{2,3\sqrt{2}\,230}{\pi} \sin\frac{\pi}{3} \cos\frac{\pi}{3} = 269,0\ V$ $\quad i'_{d\,AV} = \frac{269}{10} = 26,9\ A$

iii) igual a i)

4)



$\alpha = \frac{\pi}{3}$ $\quad R = 10\,\Omega$ $\quad E = 50\,V$

$v_1 = -v_2 = 230\sqrt{2}\,\sin(100\pi t)$

conversão controlada

a) $V'_{d0} = 2 \cdot \frac{2}{\pi} \sqrt{2}\, 230 \sin\frac{\pi}{2} \left(\frac{1 + \cos \pi/3}{2} \right) = 310,6\,V$

$i'_{dAV} = \frac{V'_{d0} - E}{R} = \frac{310,6 - 50}{10} = 26,06\,A$

c) $i_{S1AV} = 0 \qquad i_{S1ef} = \sqrt{\frac{2}{2\pi} \int_0^{\pi - \alpha} (i'_{dAV})^2 d\theta} = 26 \sqrt{\frac{\pi - \pi/3}{\pi}} = 21,2\,A$

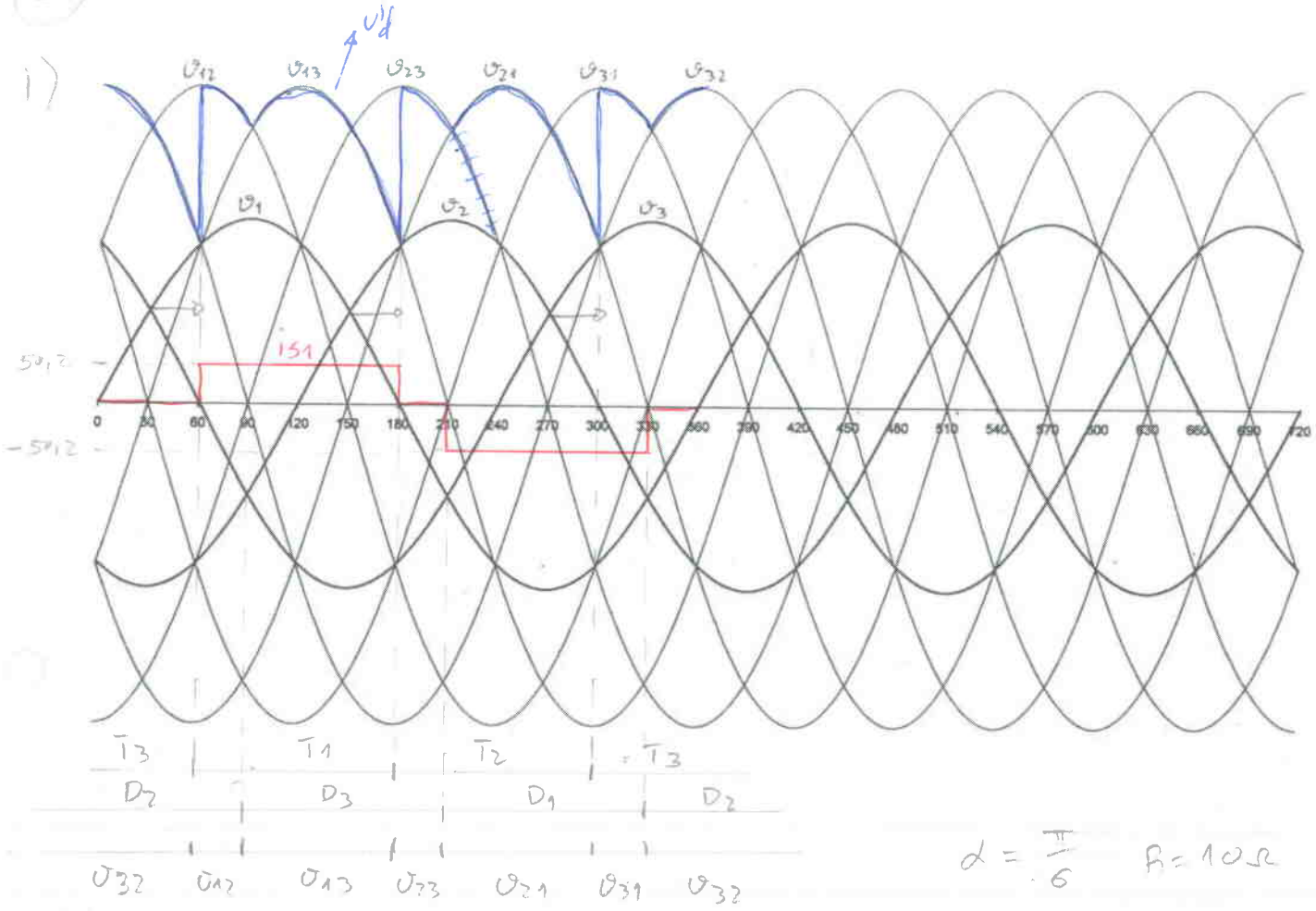
d) $i'_{dAV} = 15 = \frac{V'_{d0} - 50}{10} \iff V'_{d0} = 200\,V$

$100 = 2 \cdot \frac{2}{\pi} \sqrt{2}\, 230 \sin\frac{\pi}{2} \left(\frac{1 + \cos\alpha}{2} \right)$

$\iff \cos\alpha = -0,034 \Rightarrow \alpha = 92°$

5)

i)



$\alpha = \frac{\pi}{6}$ $R = 10\,\Omega$

corrente contínua

a)

$$V_{do} = 2 \cdot \frac{3}{\pi} \sqrt{2}\, 230 \sin\frac{\pi}{3} \left(\frac{1 + \cos \pi/6}{2}\right) = 502{,}0\ V$$

$$i_{dAV} = \frac{502}{10} = 50{,}2\ A$$

c) $i_{S1AV} = 0\ A$

$$i_{S1ef} = \sqrt{\frac{2}{2\pi} \int_0^{\pi/3} 50{,}2^2\, d\theta} = \sqrt{2} \cdot \frac{50{,}2}{\sqrt{3}} = 41{,}0\ A$$

ii) $L = 5\ mH$

$R = 10\,\Omega$

$\alpha = \frac{\pi}{6}$

$V_d(t) > 0 \Rightarrow i_d(t) > 0 \Rightarrow$ condução contínua

ou

$\gamma = 120°$