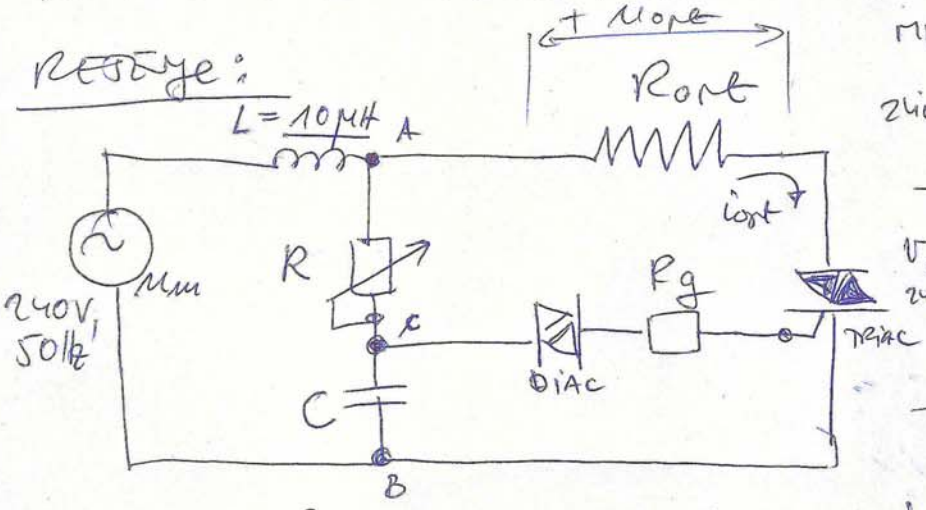
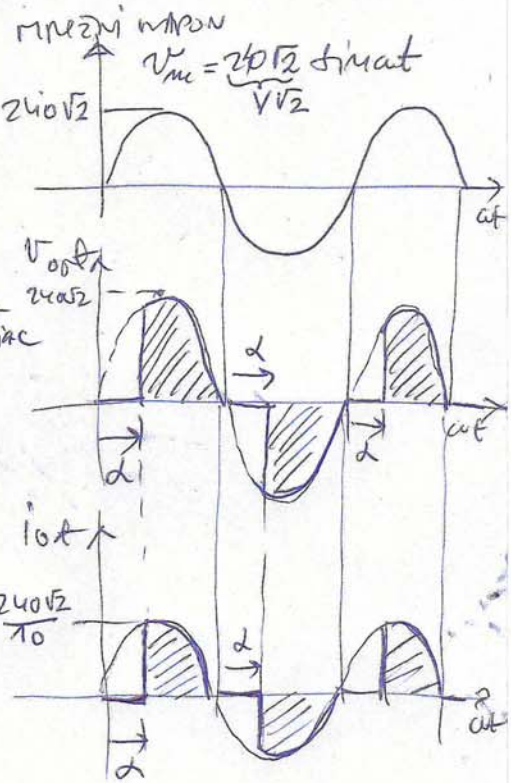
ZADATAK

Elektronskim sklopom sa triakom se vrši podešavanje snage (kontinuirano) grejača čija je omska otpornost $R_{opt} = 10\,\Omega$. Ostali parametri kola sa slike su $R = 1\,k\Omega \ldots 22\,k\Omega$, $C = 47\,nF$. Odrediti opseg promene snage koja se kreira na grejaču za date parametre u kolu. Prag okidanja diaka je $\pm 40\,V$

REŠENJE:





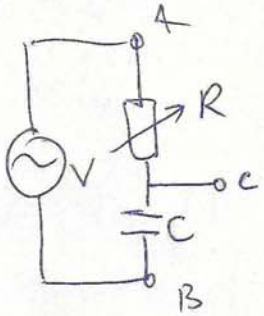
$$P_{opt} = \frac{V_{opt\,ef}^2}{R} \qquad V = 240\,V \text{ (efektivna vrednost)} \qquad U_m = V\sqrt{2} \text{ (max. vrednost})$$

$$V_{opt\,ef} = V\left[1 - \frac{\alpha}{\pi} + \frac{\sin 2\alpha}{2\pi}\right)^{1/2}$$

$$P_{opt} = \frac{V^2}{R}\left[1 - \frac{\alpha}{\pi} + \frac{\sin 2\alpha}{2\pi}\right]$$

$$X_L = j\omega L = j \cdot 2\pi \cdot 50 \cdot 10 \cdot 10^{-6} = 3{,}14\,m\Omega$$

$X_L \ll R,\ X_C,\ R$



$$\underline{U}_C = \frac{\underline{Z}_C}{\underline{Z}_C + R}\,\underline{U}_M = \frac{\frac{1}{j\omega C}}{\frac{1}{j\omega C} + R}\,\underline{U}_M = \frac{1}{j\omega CR + 1}\cdot \underline{U}_M$$

$$\underline{U}_M = V\angle 0^\circ \quad (\text{smatramo da je } u_m = V\sqrt{2}\sin\omega t)$$

$$\underline{U}_C = \frac{1}{1 + j\omega RC}\cdot V = \frac{1}{j\omega RC + 1}\cdot\frac{1 - j\omega RC}{1 - j\omega RC}\cdot V$$

$$\underline{U}_C = \frac{1 - j\omega RC}{1 + (\omega RC)^2}\cdot V$$

$$\underline{U_c} = \frac{V}{1+(\omega RC)^2} - j\,\frac{\omega RC}{1+(\omega RC)^2}\cdot V$$

A) $\omega = 2\pi f = 2\pi \cdot 50 = 314\ rad/s$. $R = 1k\Omega$. $C = 47mF$

$RC = 1000 \cdot 47 \cdot 10^{-9} = 47 \cdot 10^{-6}\ s = 47\mu s$

$\omega RC = 314 \cdot 47 \cdot 10^{-6} = 0,01476\ rad$

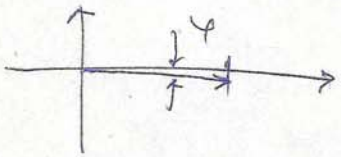
$1+(\omega RC)^2 = 1,000217 \approx 1$

$\underline{U_c} = V - j\,0,01476\,V = (1 - j\,0,01476)\cdot V\angle 0$

$\underline{U_c} = V \cdot \angle -0,845°$

$$\boxed{u_c(t) = V\cdot\sqrt{2}\,\sin(\omega t - 0,845°)}$$

$\boxed{1 - j\,0,01476}$



$tg\,\varphi = \frac{0,01476}{1} \Rightarrow \varphi = 0,845°$

B) $R = 22k\Omega$.

$\omega RC = 0,3247\ rad$. $\underline{U_c} = (1 - j\omega RC)\,\frac{V}{1+(\omega RC)^2}$

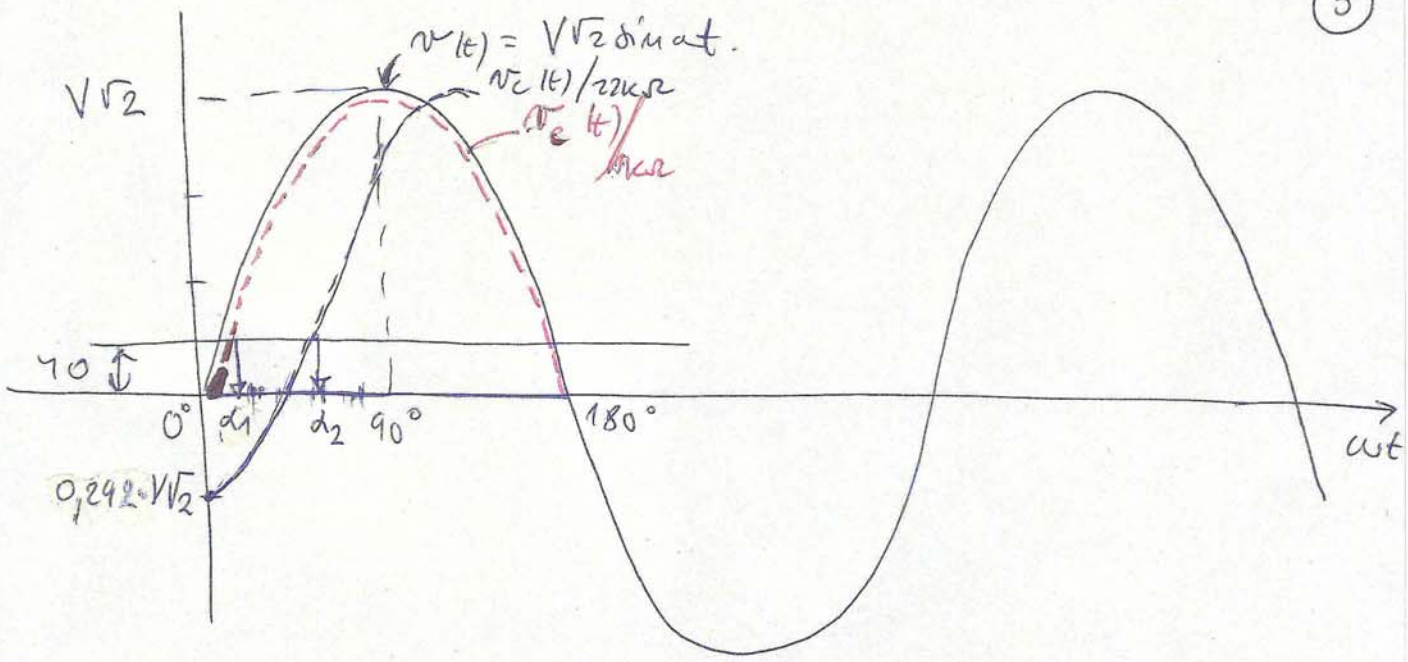
$1+(\omega RC)^2 = 1,10544$ $\underline{U_c} = 0,9\cdot V\,(1 - j\omega RC)$

$\underline{U_c} = 0,9\cdot V(1 - j\cdot 0,3247) = 0,9\,(1 - j\,0,3247)\cdot V\angle 0°$

$\underline{U_c} = 0,9\cdot\sqrt{1^2 + 0,3247^2}\,V\angle -17,988°$ $tg\varphi = \frac{0,3247}{1} \Rightarrow \varphi = 17,988°$

$\underline{U_c} = 0,946\,V\angle -17,988°$

$u_c(t) = 0,946\,V\cdot\sqrt{2}\cdot\sin(\omega t - 17,988°)$



Ugualo α_1:

$$u_c(t) = V\sqrt{2}\sin(\omega t - 0{,}845°) = 40V$$

$$\sin(\omega t_1 - 0{,}845°) = \frac{40}{240\sqrt{2}} = 0{,}1182$$

$\pi : 180 = X : 7{,}63$ $\quad \underbrace{\omega t_1}_{\alpha_1} = \arcsin 0{,}1182 + 0{,}845°$

$X = \frac{7{,}63\pi}{180}$

$$\alpha_1 = 6{,}788 + 0{,}845° = 7{,}63° \Rightarrow \alpha_1 = 0{,}133\ rad$$

Ugualo α_2:

$$u_c(t) = 0{,}946\, V\sqrt{2}\sin(\omega t - 17{,}988°) = 40V$$

$$\sin(\omega t_2 - 17{,}988°) = \frac{40}{0{,}946 \cdot 240\sqrt{2}} = 0{,}125$$

$$\underbrace{\omega t_2}_{\alpha_2} - 17{,}988° = 7{,}178°$$

$$\alpha_2 = 17{,}988 + 7{,}178 \approx 25° \Rightarrow 0{,}436\ rad$$

$$P_{out}(\alpha_1) = \frac{V^2}{R}\left[1 - \frac{\alpha_1}{\pi} + \frac{\sin 2\alpha_1}{2\pi}\right]$$

$$P_{out}(\alpha_1) = \frac{240^2}{10}\left[1 - \underbrace{\frac{0{,}133}{\pi}}_{0{,}0423} + \underbrace{\frac{0{,}263}{2\pi}}_{0{,}0419}\right] \approx \frac{240^2}{10} \approx 5{,}76\,kVA$$

$$P_{out}(\alpha_2) = \frac{V^2}{R}\left[1 - \frac{0{,}436}{\pi} + \frac{0{,}766}{2\pi}\right]$$

$$= \frac{V^2}{R}\left[1 - 0{,}1388 + 0{,}1219\right]$$

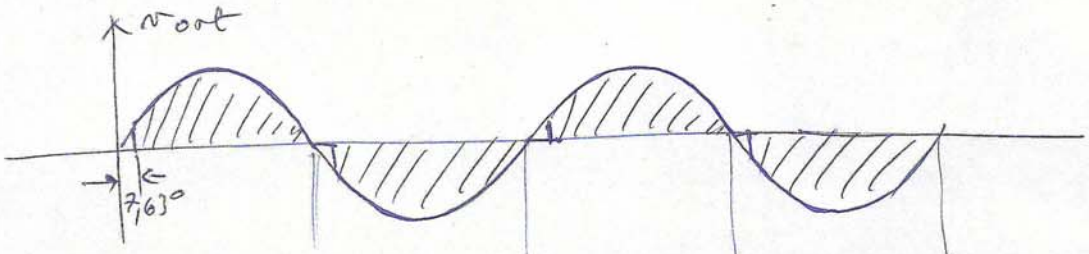
$$= 0{,}983\,\frac{V^2}{R} = 5{,}663\,kVA$$

Za ovog proizvoljni otpornik $R = 1k\Omega \ldots 22k\Omega$

ovog proizvoljni trebe ze

$$5{,}76kVA \geq P \geq 5{,}66kVA \qquad \Delta P \approx 0{,}1kVA$$

Za $\alpha_1 = 7{,}63°$



Za $\alpha_2 = 25°$