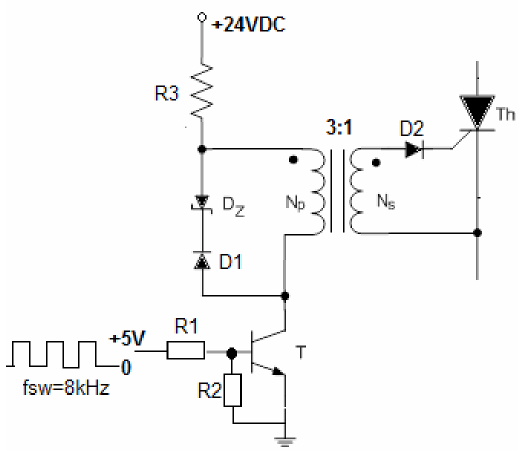
VISER- Master studije(elektrotehničko inženjerstvo) **ISPIT – JAN 2018**
predmet: Projektovanje El.En. Pretvarača -PEEP 2017/2018 **REŠENJA ZADATAKA**

1.ZADATAK: Monofazni AC/AC pretvarač sa anti-paralelnom spregom služi za regulaciju snage otpornog potrošača koji se napaja iz mreže 400V±10%, 50Hz. Na raspolaganju su: tiristorski moduli SKKT460 čiji su podaci dati u Tabeli 1 i hladnjaci P16/200 sa ventilatorom SKF16B čije su karakteristike date u prilogu. **(a)**Koliku minimalnu a koliku maksimalnu trajnu prividnu snagu je moguće ostvariti ovim pretvaračem, ako se usvoji da je maksimalno dozvoljena temperatura silicijuma 100°C, a temperatura okoline se menja u opsegu -25°C...+40°C? Koliki je opseg promene temperatura hladnjaka pri ovim uslovima?
(b) Dimenzionisati zaštitno kolo „di/dt“ za tiristore.



(c) Dimenzionisati pobudno kolo tiristora prikazano na slici (R1, R2, R3, Vz) , uz pretpostavku da je u kolu gejta tiristora potrebno ostvariti struju od 1.5A pri naponu gejt-katoda od 3V.
NAPOMENE:
Usvojiti da je pad napona na diodama 0.6V, napon Vbes=0.75V, napon Vces=0.2V, pojačanje tranzistora hfe=400. Induktivnost magnećenja impulsnog transformatora je 100mH, dok je njegova rasipna induktivnost zanemarljiva.

2. ZADATAK:

Potrebno je nacrtati električnu šemu i projektovati AC/DC električni neizolovani pretvarač napona za koji su dati ulazni podaci za projektovanje:

-Nominalni ulazni napon 3x380V±10%, 50Hz
-Izlazni napon 220VDC
-Izlazna snaga 2.2kW
-Talasnost struje prigušnice ≤ 20%
-Talasnost izlaznog napona ≤ 0.5%
-Radna učestanost 50kHz

-Dimenzionisati prekidačke elemente prema struji i naponu (prema MAX naponu koji moraju izdržati i prema srednjoj vrednosti struje)
-Zanemariti padove napona i komutacione gubitke na prekidačkim elementima, kao i unutrašnje otpornosti pasivnih elemenata.Smatrati da je opterećenje na izlazu približno konstantno

3. ZADATAK: Neizolovani DC/DC pretvarač (naponski podizač) snage 300W radi na konstantnoj učestanosti 100kHz. Ulazni napon iznosi 24V. Smatrati da je kapacitivnost izlaznog kondenzatora dovoljno velika i zanemariti talasnost izlaznog napona. Pretvarač radi u kontinualnom režimu. Prekidačke elemente u pretvaraču smatrati idealnim.Vremenski interval provođenja diode je 5µs. (a)Odrediti srednju vrednost struje diode, (b) Dimenzionisati prigušnicu L ako se zahteva da talasnost struje ("peak-peak") kroz nju bude manja od 5%, (c) Odrediti minimalnu i maksimalnu vrednost struje prigušnice.

4.ZADATAK:
U kolu u zadatku 3 potrebno je LEM strujnim modulom meriti trenutnu vrednost struje prekidačkog tranzistora na osciloskopu. Na raspolaganju su LEM strujni senzori prenosnog odnosa 1:5000, napona napajanja ± 15V DC, ali različitih propusnih opsega 1MHz, 10MHz, 50MHz i 100MHz i opsega struja0-5A, 10A, 25A, 50A, 100A. Povraćeno naelektrisanje diode kod isključenja je $Q_{rr} = 1\mu C$. Vreme oporavka diode je t_{rr}=50ns. Odabrati potreban LEM senzor, nacrtati šemu merenja struje i dimenzionisati merni otpornik na izlazu LEM modula tako da se na njemu obezbedi naponski signal 0-5VDC koji se vodi na ulaz osciloskopa radi merenja. Vršnu vrednost struje diode (tzv.”strujni pik”) računati prema formuli $I_{RM} \approx 2Q_{rr}/t_{rr}$.

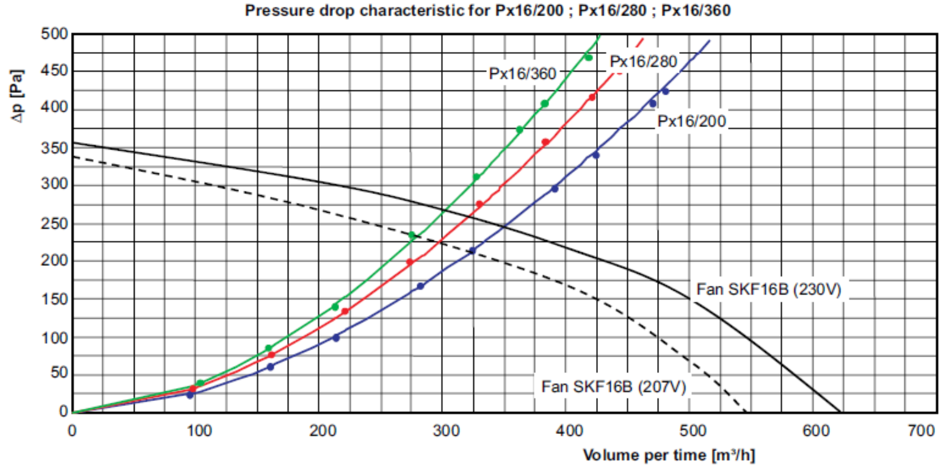
PRILOG ZA ZADATAK 01:

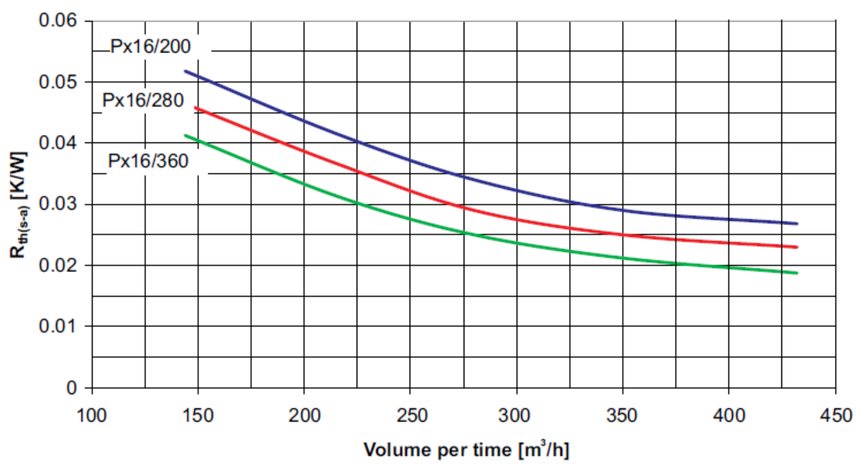
Tabela 1-Karakteristike tiristorskog modula SKKT460

Symbol	Conditions	Values	Units
I_{TAV}	sin. 180; T_c = 85 (100) °C;	460 (335)	A
I_{TSM}	T_{vj} = 25 °C; 10 ms	18000	A
	T_{vj} = 130 °C; 10 ms	15500	A
i^2t	T_{vj} = 25 °C; 8,3 .. 10 ms	1620000	A²s
	T_{vj} = 130 °C; 8,3 ... 10 ms	1200000	A²s
V_T	T_{vj} = 25 °C; I_T = 1400 A	max. 1,6	V
$V_{T(TO)}$	T_{vj} = 130 °C	max. 0,88	V
r_T	T_{vj} = 130 °C	max. 0,45	mΩ
I_{DD}; I_{RD}	T_{vj} = 130 °C; $V_{RD} = V_{RRM}$; $V_{DD} = V_{DRM}$	max. 240	mA
t_{gd}	T_{vj} = 25 °C; I_G = 1 A; di_G/dt = 1 A/µs	1	µs
t_{gr}	V_D = 0,67 * V_{DRM}	2	µs
$(di/dt)_{cr}$	T_{vj} = 130 °C	max. 250	A/µs
$(dv/dt)_{cr}$	T_{vj} = 130 °C	max. 1000	V/µs
t_q	T_{vj} = 130 °C ,	100 .. 200	µs
I_H	T_{vj} = 25 °C; typ. / max.	150 / 500	mA
I_L	T_{vj} = 25 °C; R_G = 33 Ω; typ. / max.	300 / 2000	mA
V_{GT}	T_{vj} = 25 °C; d.c.	min. 3	V
I_{GT}	T_{vj} = 25 °C; d.c.	min. 200	mA
V_{GD}	T_{vj} = 130 °C; d.c.	max. 0,25	V
I_{GD}	T_{vj} = 130 °C; d.c.	max. 10	mA
$R_{th(j-c)}$	cont.; per thyristor / per module	0,072 / 0,035	K/W
$R_{th(j-c)}$	sin. 180°; per thyristor / per module	0,074 / 0,037	K/W
$R_{th(j-c)}$	rec. 120°; per thyristor / per module	0,078 / 0,039	K/W
$R_{th(c-s)}$	per thyristor / per module	0,02 / 0,01	K/W
T_{vj}		- 40 ... + 130	°C
T_{stg}		- 40 ... + 125	°C

Karakteristike hladnjaka i ventilatora

Pressure drop characteristic for Px16/200 ; Px16/280 ; Px16/360



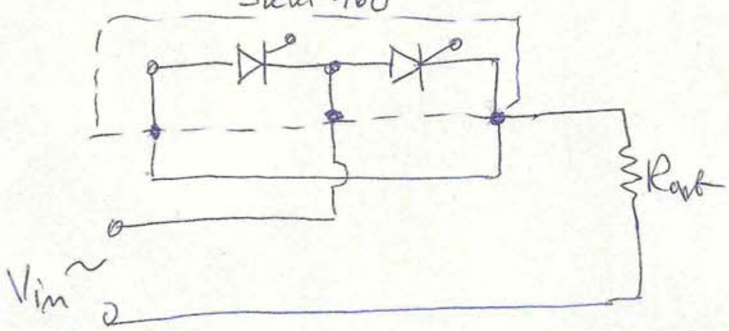


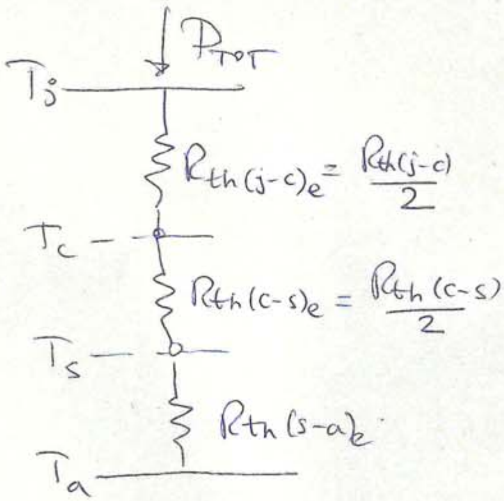
①

1 ZADATAK

$V_{in} = 400V \pm 10\%$

50Hz





$$P_{tot} = \frac{T_j - T_a}{\Sigma R_{th}}$$

$$P_{tot} = \frac{T_j - T_a}{R_{th(j-c)e} + R_{th(c-s)e} + R_{th(s-a)e}}$$

$$R_{th(j-c)e} = \frac{0{,}074}{2} = 0{,}037 \frac{K}{W}$$

$$R_{th(c-s)e} = \frac{0{,}02}{2} = 0{,}01 \frac{K}{W}$$

$$R_{th(s-a)} = ?$$

ZA HLADNJAK P16/200 PRI 207V~ → PROTOK $325 \frac{m^3}{h}$

ZA $325 \frac{m^3}{h}$ → $R_{th(s-a)} = 0{,}03 \frac{K}{W}$

$$P_{tot1} = \frac{100 - (-25)}{0{,}037 + 0{,}01 + 0{,}03} = 1623{,}3\ W = 1{,}62\ kW$$

$$P_{tot2} = \frac{100 - 40}{0{,}037 + 0{,}01 + 0{,}03} = 779{,}2\ W \rightarrow 0{,}78\ kW.$$

PO JEDNOM TIRISTORU $P_{tot_1}^{(1)} = V_{T0} \frac{I_{m1}}{\pi} + r_d \frac{I_{m1}^2}{4} = \frac{P_{tot1}}{2} = 811{,}65\ W$

IZ TABELE 1:

$V_{T0} = 0,9$

$r_d = 0,45\,m\Omega$

$P^{(1)}_{tot_1} = 811,65\,W$

$$P^{(1)}_{tot_1} = V_{T0} \cdot \frac{I_{m1}}{\pi} + r_d \frac{I_{m1}^2}{4} \quad / \cdot \frac{4}{r_d}$$

$$\frac{4}{r_d} \cdot P^{(1)}_{tot_1} = \frac{4 V_{T0} I_{m1}}{\pi r_d} + I_{m1}^2$$

$$I_{m1} = -\frac{2V_{T0}}{\pi r_d} \pm \sqrt{\frac{4V_{T0}^2}{(\pi r_d)^2} + \frac{16 P^{(1)}_{tot_1}}{4 r_d}}$$

$$I_{m1} = -\frac{2 \cdot 0,9}{\pi \cdot 0,45} \cdot 10^3 \pm \sqrt{\frac{4 \cdot (0,9)^2}{(\pi \cdot 0,45)^2} \cdot 10^6 + \frac{16 \cdot 811,65}{4 \cdot 0,45} \cdot 10^3}$$

$$= -1,274 \cdot 10^3 \pm \sqrt{1,6228 \cdot 10^6 + 7,214 \cdot 10^6}$$

$$= -1,274 \cdot 10^3 \pm 2,973 \cdot 10^3 \Rightarrow I_{m1} = 1699\,A = \underline{1700\,A}$$

EFEKTIVNA vrednost struje opterećenja:

$$I_{eff_{opt_1}} = \frac{1700}{\sqrt{2}} = \underline{\underline{1200\,A}}$$

$$I_{TAV_1} = \frac{I_{m1}}{\pi} = 540\,A > \boxed{I_{TAV\,DOZV.} = 460\,A \text{ NA } +80^\circ C \\ = 335\,A \text{ NA } +100^\circ C}$$

IZ TABELE 1 ZA TIRISTORE — DOZV. VREDNOSTI

$$S_{opt} = \underbrace{\frac{\pi \cdot 335\,A}{\sqrt{2}}}_{I^*_{eff_{opt}} = 743,7\,A} \cdot 440\,V = \underline{327,2\,kW}$$

$$I^*_{eff_{opt}} = 743,7\,A \longrightarrow P^*_{tot_1} = V_{T0} \frac{I^*_{m1}}{\pi} + r_d \frac{I_{m1}^2}{4}$$

$$= 0,9 \cdot 335 \cdot \pi + 0,45\,m\Omega \cdot \frac{(335\pi)^2}{4} = 1071\,W$$

$$T_{h} = R_{th(s-a)} \cdot P^*_{tot_1} + T_{a_1} = 0,03 \cdot 1073 + (-25^\circ C) = 7,13^\circ C$$

* ZA $I_{TAV} = 460\,A$ $\quad I_{m1} = \pi \cdot 460 = 1450\,A \Rightarrow I_{eff} = \frac{I_{m1}}{\sqrt{2}} = 1024\,A$

$I_{eff_{opt}} = 1024\,A \rightarrow S_{opt} = 1024 \cdot 440 = 450\,kW$

* ZA $I_{TAV} = 540\,A$ $\quad I_{m1} = \pi \cdot 540 = 1696\,A \Rightarrow I_{eff} = \frac{I_{m1}}{\sqrt{2}} = 1200\,A$

$I_{eff_{opt}} = 1200\,A \rightarrow S_{opt} = 1200 \cdot 440 = 530\,kW$

(3)

$$P_{tot2}^{(1)} = \frac{P_{tot2}}{2} = \frac{780}{2} = 390W$$

$$P_{tot2}^{(1)} = V_{T0}\frac{I_{m2}}{\pi} + r_d\frac{I_{m2}^2}{4} \qquad I_{m2} = -\frac{2V_{T0}}{\pi r_d} \pm \sqrt{\frac{4V_{T0}^2}{(\pi r_d)^2} + \frac{16P_{tot2}^{(1)}}{4r_d}}$$

$$I_{m2} = -\frac{2\cdot 0{,}9}{\pi\cdot 0{,}45}\cdot 10^3 \pm \sqrt{\frac{4\cdot(0{,}9)^2}{(\pi\cdot 0{,}45)^2}\cdot 10^6 + \frac{16\cdot 390}{4\cdot 0{,}45}\cdot 10^3}$$

$$I_{m2} = -1{,}274\cdot 10^3 \pm \sqrt{1{,}6278\cdot 10^6 + 3{,}466\cdot 10^6}$$

$$= -1{,}274\cdot 10^3 \pm 2{,}255\cdot 10^3$$

$$I_{m2} = 0{,}982\,kA = 982A$$

$$I_{eff\,opt\,2} = \frac{I_{m2}}{\sqrt{2}} = \frac{982}{1{,}41} = 696A.$$

$$I_{TAV} = \frac{I_{m2}}{\pi} = \underline{312A}$$

$$S_{opt} = 696A\cdot 440V = 306{,}2\,kW.$$

Temp. hladnjaka u ovom slučaju

$$T_{S2} = R_{th(s-a)}\cdot P_{tot2} + T_{a2}$$

$$= 0{,}03\frac{K}{W}\,780W + 40°C$$

$$= 63{,}4°C.$$

$$23{,}69°C \le T_S \le 63{,}4°C$$

$$S_{max} = P_{max} = 320\,kW$$

MAX. snaga
mora se
moguće ostvariti.

b)

$$\left.\frac{di_T}{dt}\right|_{t=0} = \frac{U_m}{L_k} \leq 250\frac{A}{\mu s} \Rightarrow L_k \geq \frac{U_m}{250\frac{A}{\mu s}}$$

$$U_m = 400 \cdot 1{,}1 \cdot \sqrt{2} = 620{,}4\,V$$

$$L_k \geq \frac{620{,}4}{250\frac{A}{\mu s}} = 2{,}48\,\mu H \rightarrow L_k = 3\,\mu H$$

za $L_k^* = 3\,\mu H \rightarrow \frac{di_T}{dt} = \frac{U_m}{L_k^*} = \frac{620{,}4\,V}{3\,\mu H} = 206{,}6\frac{A}{\mu s} < 250\frac{A}{\mu s}$

c)

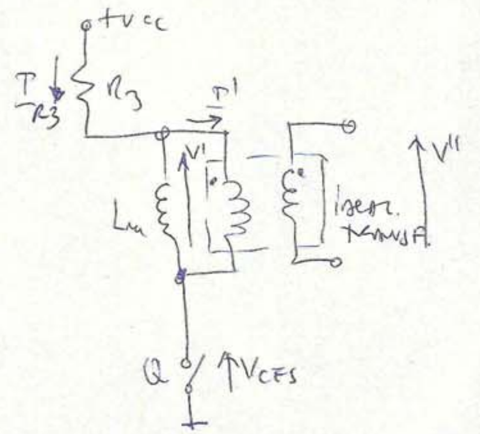
$$T_{sw} = \frac{1}{f} = \frac{1}{8\,kHz} = 125\,\mu s$$

$$V'' = V_{gk} + V_D = 3 + 0{,}6 = 3{,}6\,V$$

$$V' = \frac{N'}{N''} \cdot V'' = m \cdot V'' = 3 \cdot V'' = 3 \cdot 3{,}6 = 10{,}8\,V$$

$$I'' = I_g = 1{,}5\,A \qquad I' = \frac{I''}{3} = \frac{1{,}5}{3} = 0{,}5\,A$$

$t_{on} = t_{off} \qquad t_{on} + t_{off} = 2 \cdot 62{,}5\,\mu s \Rightarrow t_{on} = t_{off} = \frac{1}{2}T = 62{,}5\,\mu s.$



$$V_{CC} = R_3 I' + V' + V_{CES}$$

$$R_3 = \frac{V_{cc} - V' - V_{ces}}{I'} = \frac{24 - 10{,}8 - 0{,}2}{0{,}5} = 26\,\Omega$$

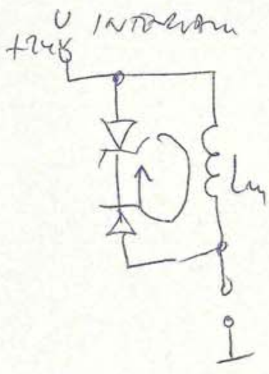
$$I'_{eff} = \frac{I'}{\sqrt{2}} = \frac{0{,}5}{1{,}41} = 0{,}35\,A$$

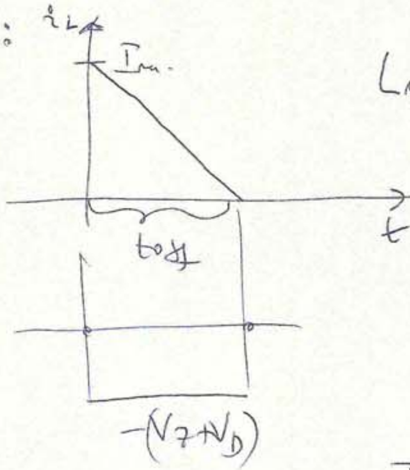
$$P_{R3} = R_3 I'^2_{eff} = 26 \cdot 0{,}35^2 = 3{,}185\,W$$

$$R_3 = 27\,\Omega / 5\,W$$

(J)

U INTERVALU t_{off} :





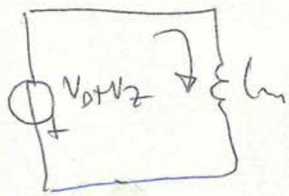
$L_m \Delta i = V' t_{on}$

$\Delta i = I_m$

$I_m = \frac{V' t_{on}}{L_m}$

$I_m = \frac{10{,}8 \cdot 62{,}5\mu}{100 \cdot 10^{-3}}$

$I_m = 6{,}7 mA.$



$L_m \cdot \Delta i = (V_D + V_Z)\, t_{off}.$

$t_{off} \leq 62{,}5 \mu s.$

$t_{off} = \frac{L_m \Delta i}{V_D+V_Z} \leq 62{,}5 \mu s.$

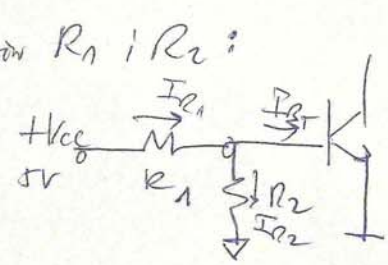
$V_D + V_Z \geq \frac{L_m \Delta i}{62{,}5 \mu s} = 11{,}17 V \quad V_D = 0{,}6$

$V_Z = 11{,}7 - 0{,}6 = 10{,}57 V \longrightarrow V_Z^{*} = 11 V$

$P_{D_Z} = 11V \cdot 6{,}7 mA = 0{,}0737 \Rightarrow 11V / 0{,}125 W$

Usvajamo $R_2 = 10 k\Omega$

Proračun R_1 i R_2:



$I_{R2} = \frac{V_{BES}}{R_2} = \frac{0{,}75}{10 \cdot 10^3} = 0{,}075 mA$

$I_C' = I' = 0{,}5 A$

$I_{BT} = \frac{0{,}5}{400} \Rightarrow I_{BT} = 1{,}25 mA$

$I_{R1} = I_{BT} + I_{R2} = 0{,}075 mA + 1{,}25 mA = 1{,}325 mA$

$V_{CC} = R_1 I_{R1} + V_{BES} \Rightarrow R_1 = \frac{V_{CC} - V_{BES}}{I_{R1}} = \frac{5 - 0{,}75}{1{,}325} \cdot 10^3$

$R_1 = 3{,}21 k\Omega \xrightarrow{\text{usvojimo}} 3{,}3 k\Omega$

6

$P_{R1} = R_1 I_{R1}^2 = 3{,}3\cdot 10^3 \cdot 1{,}375^2 \cdot 10^{-6} = 6\,mW$

$P_{R2} = R_2 I_{R2}^2 = 10\cdot 10^3 \cdot 0{,}075^2 \cdot 10^{-6}$

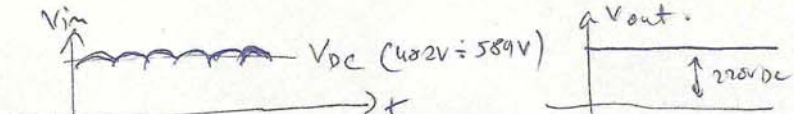
$P_{R2} = 0{,}05\,mW$

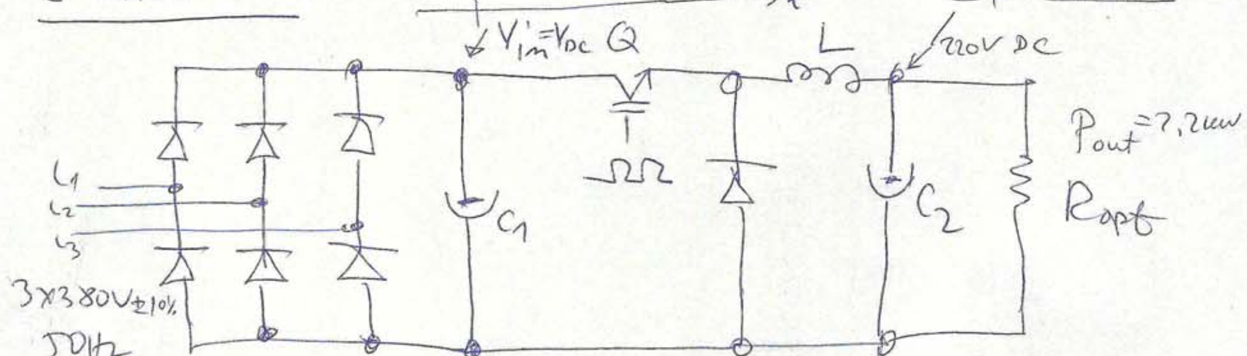
$R_1 = 3{,}3\,k\Omega / 10\,mW$

$R_2 = 10\,k\Omega / 1\,mW$

$R_3 = 27\,\Omega / 5\,W$

2 ZADATAK





$$\frac{\Delta V_{in}}{V_{in}} = \frac{\Delta V_{in}}{V_{DC}} = 2\cdot\frac{1}{12 f R_{ekv} C - 1} \Rightarrow 12 f R_{ekv} C - 1 = \frac{2}{\frac{\Delta V_{DC}}{V_{DC}}}$$

$$C_1 = \left(1 + \frac{2 V_{DC}}{\Delta V_{DC}}\right) \Big/ 12 f R_{ekv}.$$

$$C_1 = \frac{1 + \frac{2V_{DC}}{\Delta V_{DC}}}{12 f R_{ekv}} = \frac{1 + \frac{2V_{DC}}{\Delta V_{DC}}}{12 f \cdot \frac{V_{DC}}{I_{DC}}} = \frac{1 + \frac{2}{\frac{\Delta V_{DC}}{V_{DC}}}}{12 f \cdot \frac{V_{DC}}{I_{DC}}} \quad \frac{\Delta V_{DC}}{V_{DC}} \rightarrow 5\%\ (0{,}05)$$

$$C_1 \geq \frac{1 + \frac{2}{0{,}05}}{12\cdot 50\cdot \frac{500}{4{,}4}} = \frac{41}{68\,182} = 601{,}33\,\mu F$$

usvajamo $C^* = 680\,\mu F$. $\quad V_{in} \approx V_{DC} \approx U_{eff\,mreže}\cdot\sqrt{2}$

$$V_{in\,min} = V_{DC\,min} = (380 - 38)\sqrt{2} = 482{,}2\,V$$
$$V_{in\,max} = V_{DC\,max} = (380 + 38)\sqrt{2} = 589{,}38\,V$$

$\Rightarrow 482{,}2 \leq (V'_{in} = V_{DC}) \leq 589{,}38\,V$

$$482,2V \le V_{in} \le 589,38V$$

$$I_{Lsr} = I_{out} = \frac{220V}{22\Omega} = 10A \qquad R_{opt} = \frac{V_{out}^2}{P} = \frac{220^2}{2200} = 22\Omega$$

$$\Delta i_L = I_{Lsr}\frac{\Delta i_L\%}{100} = \frac{10 \cdot 20}{100} = 2A$$

$$\delta_{min} \cdot V_{inmax} = 220$$

$$\delta_{min} = \frac{220}{589,38} = 0,373$$

$$\delta_{max} \cdot V_{inmin} = 220$$

$$\delta_{max} = \frac{220}{482,2} = 0,456$$

$$L \geq \frac{(V_{inmax} - V_{out})\,\delta_{min}}{f_{sw} \cdot \Delta i_L}$$

$$L \geq \frac{589,38 - 220}{50 \cdot 10^3 \cdot 2} = 3,7mH \rightarrow \underline{\underline{4mH}}$$

$$\underline{L^* = 4mH}$$

kada je ul. napon minimalan (482,2V) pri $L^* = 4mH$

$$\Delta i_L = \frac{V_{inmin} - V_{out}}{L^*} \cdot \frac{\delta_{max}}{f_{sw}} = \frac{(482,2 - 220)\,0,456}{4 \cdot 10^{-3} \cdot 50k} = 0,59A$$

tj. $\Delta i_L < 2A$.

$$C_2 = \frac{1 - \delta_{min}}{8 \cdot L^* \cdot f_{sw}^2 \underbrace{\left(\frac{\Delta V_{out}}{V_{out}}\right)}_{0,5\% \Rightarrow 0,005}} = \frac{1 - 0,373}{8 \cdot 4 \cdot 10^{-3} \cdot 50^2 \cdot 10^6 \cdot 0,005} = \frac{0,627}{400\,000}$$

$C_2 = 1,567\mu F \rightarrow$ usvajamo $\underline{\underline{C_2 = 2,2\mu F}}$ (u katalogu za 50kHz)

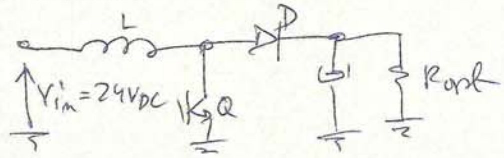
$$\omega_{rez} = \frac{1}{\sqrt{L^* C_2^*}} = \frac{1}{\sqrt{4 \cdot 10^{-3} \cdot 2,2 \cdot 10^{-6}}} = 10660\ rad/s$$

$$f_{rez} = \frac{\omega_{rez}}{2\pi} = 1,697kHz \ll f_{sw}$$

DIODA MORA DA PODNESE INV. NAPON OD 220V $\rightarrow$ USVAJAMO DIODU ZA 400V
NJENA SREDNJA VREDNOST STRUJE (MAX) $(1 - \delta_{min}) \cdot I_{out} = (1 - 0,373)\,10A = 6,27A$
USVAJAMO DIODU D: 10A/400V, ZA TRANZISTOR $I_{Tsr} = 0,456 \cdot 10 = 4,56A \rightarrow 10A$
DOK JE INVERZNI NAPON NA TRANZISTORU 600V $\rightarrow$ USVAJAMO TRAN. 10A/1000V

3. ZADATAK.

(8)



$P_{out} = 300\,W$

$f_{sw} = 100\,kHz \rightarrow T = 10\,\mu s.$

$t_{off} = 5\,\mu s \rightarrow t_{on} = 5\,\mu s$

$\delta = \frac{t_{on}}{T} = \frac{1}{2}$

$$V_{out} = \frac{V_{in}}{1-\delta} = \frac{V_{in}}{1-0{,}5} = 2V_{in} = 48\,V\,DC$$

$$R_{out} = \frac{48V}{I_{out}} \qquad I_{out} = \frac{P_{out}}{V_{out}} = \frac{300}{48} = 6{,}25\,A$$

$$R_{out} = \frac{48}{6{,}25} = 7{,}68\,\Omega$$

a) $I_{DSR} = I_{out} = 6{,}25\,A$

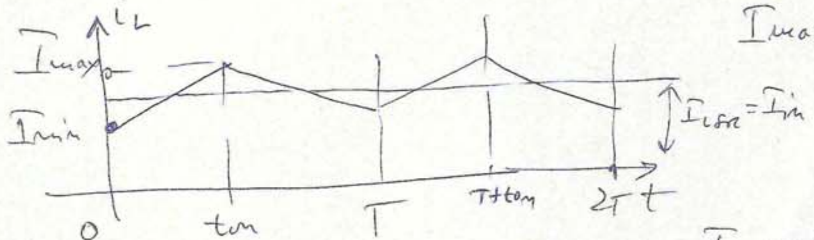
b) $V_{in} \cdot t_{on} = L\,\Delta i$ $\qquad \frac{\Delta i}{I_{in}} \cdot 100 \leq 5 \Rightarrow \Delta i = \frac{5 \cdot I_{in}}{100}$

$I_{in} = \frac{300W}{24V} = 12{,}5\,A$

$\frac{V_{in} \cdot t_{on}}{L} \leq 0{,}625\,A$ $\qquad \Delta i = \frac{5 \cdot 12{,}5}{100} = 0{,}625\,A$

$$L \geq \frac{V_{in} \cdot t_{on}}{0{,}625\,A} = \frac{24 \cdot 0{,}5 \cdot 10\,\mu s}{0{,}625\,A}$$

$L \geq 192\,\mu H \rightarrow$ uzimamo $L^* = 200\,\mu H$



$I_{max} + I_{min} = 2I_{in} = 25$

$I_{max} - I_{min} = 0{,}625$

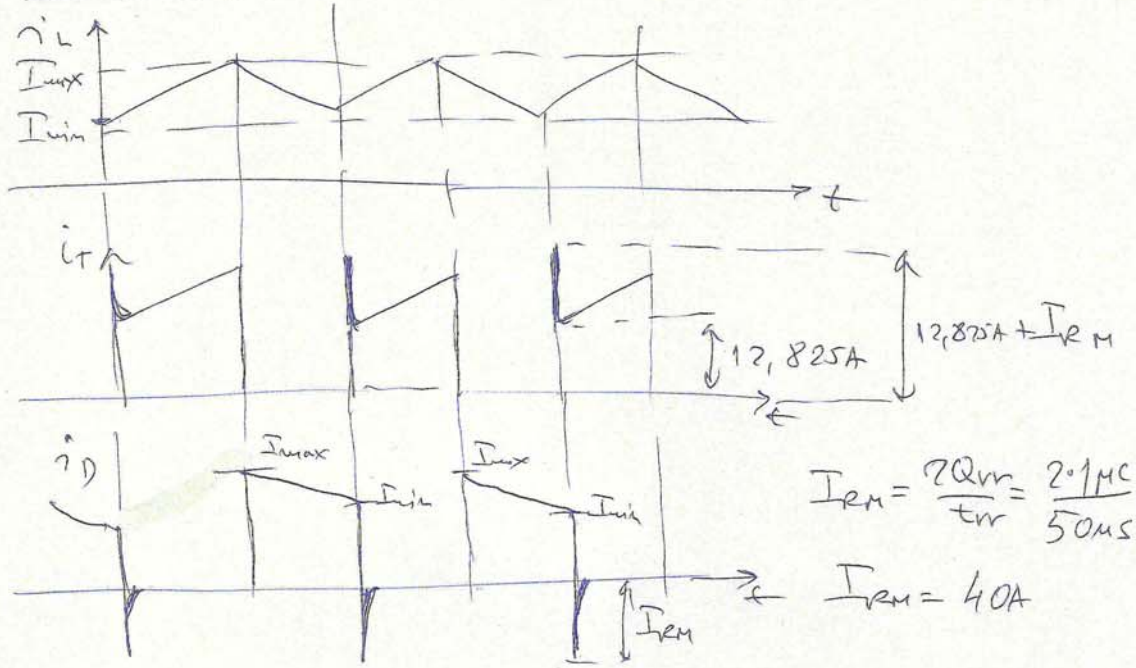
$2\,I_{max} = 25 + 0{,}625 \Rightarrow I_{max} = 12{,}825\,A$

$I_{min} = I_{max} - \Delta i = 12{,}825 - 0{,}625 = 12{,}2\,A.$

$I_{max} = 12{,}825\,A$

$I_{min} = 12{,}2\,A$

4 zadatak i



$$I_{RM} = \frac{2Q_{rr}}{t_{rr}} = \frac{2\cdot 1\mu C}{50ns}$$

$$I_{RM} = 40A$$

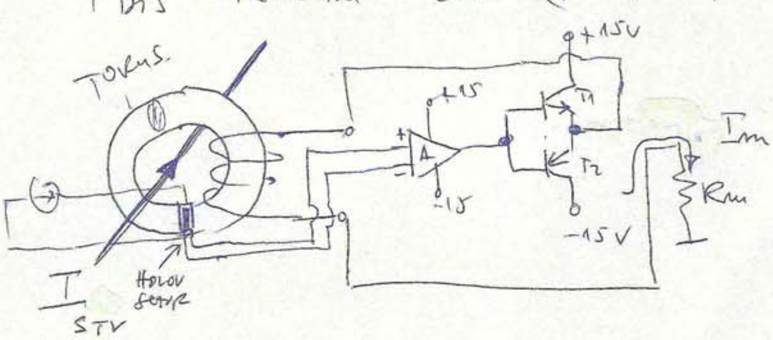
$I_{\text{MAX trenutna struja tranzistora}} = 12{,}825A + 40A = 52{,}825A$ → Biramo LEM za 100A

Obzirom da je $t_{rr} = 50ns$, $\frac{1}{t_{rr}} \approx 20MHz$ → LEM za [illegible] veći prop. opseg. 100MHz

$$R_m \cdot \frac{100A}{5000} = 5V \Rightarrow R_m = 250\Omega$$

Struja kroz merni otpornik $\frac{100A}{5000} = 20mA$

$$P_{dis} = R_m I_m^2 = 250 \cdot (0{,}02)^2 = 0{,}1W$$ ⇒ usvajamo merni otpor: 250Ω/0,25W



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