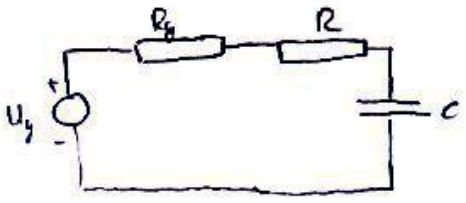
(1) ELE 1 9.10.10

ZA RC MREŽU IZRAČUNATI ODZIV USTALJENOG STANJA NA SLICI $R_g = 50\,\Omega$

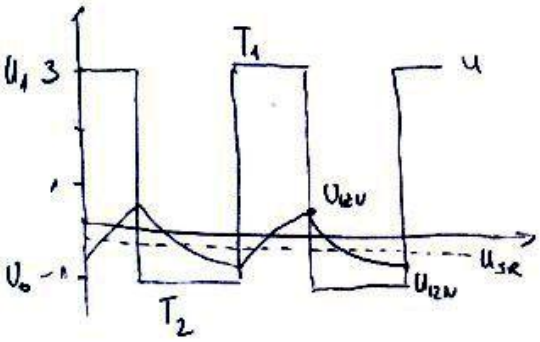


$R = 100\,\Omega$

$C = 100\,nF$

$T_2 = 20\,\mu s$

$T_1 = 5\,\mu s$



$U_{IZV} = ?$

$U_{IZV} = ?$

$$U_{SR} = \frac{T_1 \cdot U_1 + T_2 U_0}{T_1 + T_2} = \frac{5 \cdot 3 + 20(-1)}{5+20} = -0{,}2\,V$$ SREDNJA VRIJEDNOST NAP. na C

$$U_C(t) = U_{CP} + [U_{CK} - U_{CP}]\left[1 - \exp\left(-\frac{t}{\tau}\right)\right] \qquad \tau = R \cdot C = C(R + R_g)$$

U_{CP} POČETNI, U_{CK} KRAJNJI, U_{CP} POČETNA

$= 100\,10^{-9}(50+100) = 15\,\mu s$

(1) $$U_{IZV} = U_{IZN} + [U_1 - U_{IZN}]\left[1 - \exp\left(-\frac{t_1}{\tau}\right)\right] \Rightarrow$$

(2) $$U_{IZN} = U_{IZV} + [U_0 - U_{IZV}]\left[1 - \exp\left(-\frac{t_2}{\tau}\right)\right] \Rightarrow$$

iz:

(3) $$U_{IZV} = U_1 \cdot \left[1 - \exp\left(-\frac{T_1}{\tau}\right)\right] + U_{IZN} \cdot \exp\left(-\frac{T_1}{\tau}\right)$$

(4) $$U_{IZN} = U_0\left[1 - \exp\left(-\frac{T_2}{\tau}\right)\right] + U_{IZV} \cdot \exp\left(-\frac{T_2}{\tau}\right)$$

(4)→(3) UVRSTIMO ....

$$U_{IZV} = \frac{U_1 + [U_0 - U_1]\exp\left(-\frac{T_2}{\tau}\right) - U_0 \exp\left(-\frac{T_1+T_2}{\tau}\right)}{1 - \exp\frac{-(T_1+T_2)}{\tau}}$$

$$= \frac{3 + (-1-3)\left[\exp\left(-\frac{5}{15}\right)\right] - (-1)\exp\left(-\frac{25}{15}\right)}{1 - \exp\left(-\frac{25}{15}\right)} = \ldots = 0{,}398\,V$$

$$U_{IZN} = 0{,}398 + [-1 - 0{,}398]\left(1 - \exp\left(-\frac{20}{15}\right)\right) = -0{,}631\,V$$

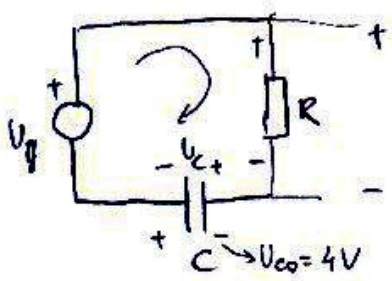
ELE 2 9.10.10

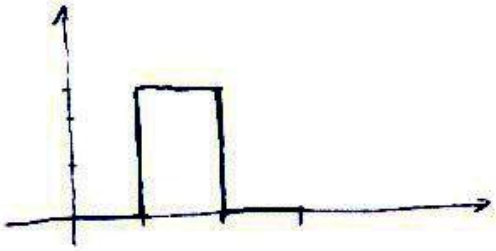
② NA ULAZ CR MREŽE NA SLICI DOVEDEN JE PRAVOKUTNI PRIKAZAN SLIKOM, ODREDI IZLAZNI NAPON AKO U_{C0} U $T=0$

$R = 2{,}2\ k\Omega$ $U_{C0} = 4V$ I IMA POLARITET PRIKAZAN NA SLICI

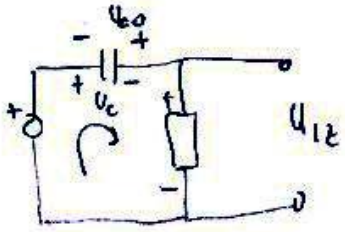
$C = 1\ \mu F$

IZRAČUNAJ U IZLAZU U $t=0 \ldots 2{,}4\,6$



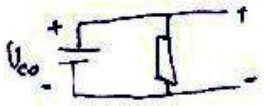


$U_g = U_R + U_C = U_0 + U_R$ ⟶



$\tau = R \cdot C = 2{,}2\ ms$

① $0 < t < 2$



$U_{IZ} = U_{C0} \exp\left(-\frac{T}{\tau}\right)$ → IZBIJANJE KONDENZATORA

$t=0$ $U_{IZ}(0) = U_{C0} = \underline{\underline{4V}}$

$t = 2^-$ – prijeloskom ulaznog napona

$U_{IZ}(2^-) = U_{C0} \exp\left(-\frac{2}{2{,}2}\right) = \underline{\underline{1{,}61V}}$

$t = 2^+$ → nakon skoka

$U_{IZ}(2^+) = U_{IZ}(2^-) + \Delta U_{UL} = 1{,}61 + 3 = \underline{\underline{4{,}61\ V}}$

② $2 < t < 4$

$U_{IZ}(t) = U_{IZ}(2^+) \cdot \exp\left(-\frac{T-2}{\tau}\right)$

$t = 4^- \Rightarrow U_{IZ}(4^-) = 4{,}61 \cdot \exp\left(-\frac{4-2}{2{,}2}\right) = \underline{\underline{1{,}86V}}$

$t = 4^+ \Rightarrow U_{IZ}(4^+) = U_{IZ}(4^-) + \Delta U_{UL} = 1{,}86 + (-3) = \underline{\underline{-1{,}14V}}$

B)

$t > 4$

$$U_{12}(t) = U_{12}(4^+) \cdot \exp\left(-\frac{(t-4)}{\tau}\right)$$

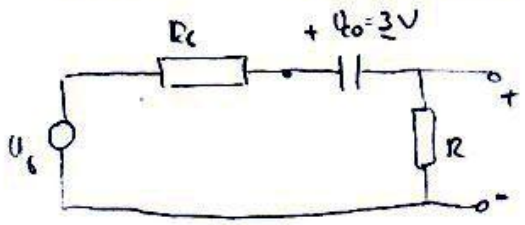
$$U_{12}(6) = -1{,}14 \cdot \exp\frac{-(6-4)}{2{,}1} = -0{,}46\,V$$

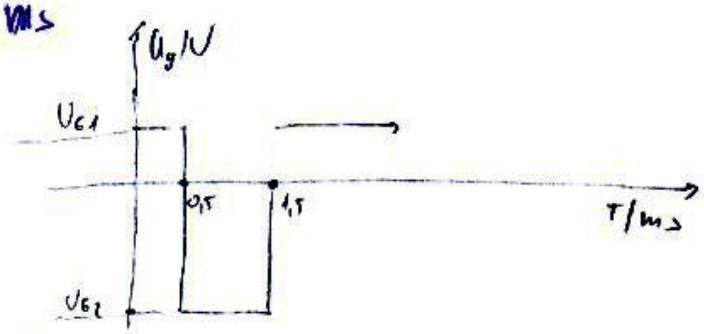
IZRAČUNATI SVE I PRVE I POSLIJE SKOKA tj T^- i T^+

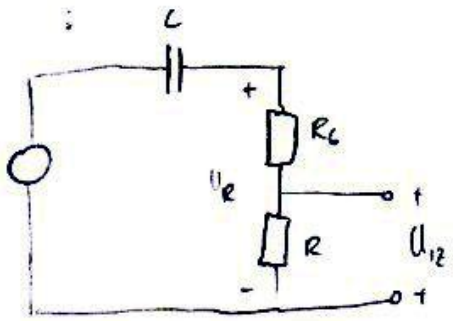
FIG 3 9.10.10

(3) NA ULAZ CR KRUGA DOVEDEN JE REALAN GENERATOR NAPONA OPTEREĆEN S OTPORA $R_G = 100\,\Omega$ IZRAČUNATI IZLAZNI NAPON $C = 1\,\mu F$ $R = 300\,\Omega$, POČETNI NAPON $U_{C0} = 3\,V$ I IMA POLARITET NA SL.

U_{IZ} ZA $t = 0 \ldots 0{,}5 \ldots 1{,}5 \ldots 2{,}0$ ms







→ NA OTPORNIKU SE UVIJEK ISTO SMJERNA KOMPONENTA
→ ISTOSM. KOMPONENTA "OSTAJE" NA C

$$U_{IZ} = k \cdot U_R(t)$$

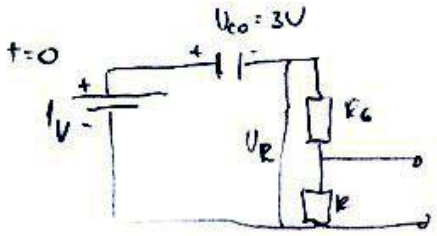
$$k = \frac{R}{R + R_G} = \frac{300}{300+100} = \frac{3}{4}$$

$$\tau = C(R + R_G) = 0{,}4\,ms$$

(1) $0 < t < 0{,}5$

$$U_{IZ}(t) = k\,U_R(t) = k\,U_R(0) \cdot \exp\left(-\frac{t}{\tau}\right)$$

$$= \underbrace{k\,(U_{G1} - U_{C0})}_{U_R(0)} \exp\left(\frac{T}{\tau}\right)$$



$$U_{IZ}(0{,}5^-) = \frac{3}{4}(1-3) \cdot \exp\left(-\frac{0{,}5}{0{,}4}\right) = -0{,}43\,V$$

$$U_{IZ} = k(U_{G1} - U_{C0}) = \frac{3}{4} \cdot 2 = -1{,}5\,V$$

$$U_{IZ}(0{,}5^+) = U_{IZ}(0{,}5^-) + k\,\Delta U_C = -0{,}43 + \frac{3}{4}(-5) = -4{,}18\,V$$

(2) $0{,}5 < t < 1{,}5$

$$U_{IZ}(t) = U_{IZ}(0{,}5^+) \cdot \exp - \frac{(t - 0{,}5)}{\tau}$$

$$U_{IZ}(1{,}5^-) = -4{,}18 \cdot \exp\frac{-(1{,}5 - 0{,}5)}{0{,}4} = -0{,}343\,V$$

$$U_{IZ}(1{,}5^+) = U_{IZ}(1{,}5^-) + k\,\Delta U_C = -0{,}343\,V + \frac{3}{4}(1+4) = 3{,}407\,V$$

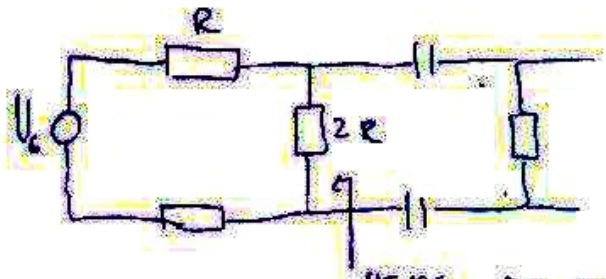
⑤ $\cdot 1{,}5 < t$

$$U_{12}(t) = U_{12}(1{,}5^+) \cdot \exp\left(\frac{t-1{,}5}{\tau}\right)$$

$$U_{12}(2) = 3{,}407 \cdot \exp\frac{-0{,}5}{0{,}4} = \underline{\underline{0{,}976\,V}}$$

GLE 4 9.10.10

ZAD 16. ZBIRKA

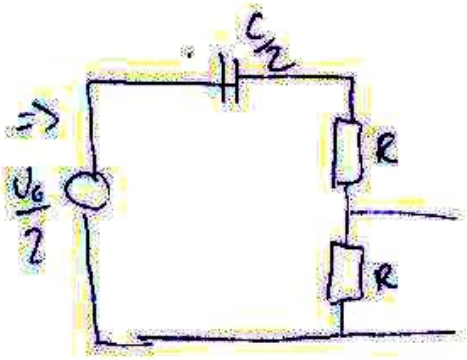


U_T, R_T PO THEVENINU ZAMJENIMO

$R_T = 2R \parallel 2R = R$

$C = C \parallel C = \frac{C}{2}$

$U_T = U_G \frac{2R}{2R+R+R} = \frac{U_G}{2}$



$\tau = \frac{C}{2} 2R = CR$

ELE 5. 9.10.P

④ SILICIJ JE DOPIRAN 1 TIPOM PRIMJESA KONCETRACIJ $T = 300\,K$

$p = 10^3\ cm^{-3}$ ODREDI TIP I KONCENTRACIJU PRIMJESE

KOJI TIP I KOJU KONCETRACIJ TREBA DODATI DA:

a) SPECIFICNA VODLJIVOST PORASTE 10x i Si NE PROMJENI TIP VODLJIVOSTI

b) SPECIČNA VODLJIVOST PADNE 10x i Si NE PROMJENI TIP VODLJIVOSTI

c) SPESIFIČ VODLJIVOST PADNE 10x i Si PROMJENI TIP VODLJIVOSTI

$\mu_n = 800\ cm^2/Vs$
$\mu_p = 250\ cm^2/Vs$ } PRETPOSTAVLJAMO DA SE NE MIJENJA DOPIRANJE

$T = 300\,K$ $n_i = 1{,}45 \cdot 10^{10}\ cm^{-3}$ $p = 10^3\ cm^{-3}$ (manjinski)

$n_1 = \frac{n_i^2}{p_1} = \frac{(1{,}45 \cdot 10^{10})^2}{p} = 2{,}1 \cdot 10^{17}\ cm^{-3}$ N-TIP, DOPIRANO DONORIMA $n > p$

$n >> p$ $\sigma = \sigma_n = q \cdot \mu_n \cdot n_1$

a) $\sigma_2 = 10 \cdot \sigma_1$ i ne mijenja TIP

$\sigma_2 = \sigma_{2n} = q \cdot \mu_n \cdot n_2$

$\frac{\sigma_2}{\sigma_1} = \frac{q \mu_n n_2}{q \mu_n n_1} = \frac{n_2}{n_1} = 1$ $n_2 = 10\, n_1 = \underline{2{,}1 \cdot 10^{17} \cdot 10^{-3}}$ $n_2 > n_1 \Rightarrow$

$\Rightarrow$ DODATI DONORE $\Rightarrow$ $n_2 >> n_1$ $n_2 = N_{D\,netto} = N_{D1} + N_{D2}$

$N_{D1} \approx n_1 = 2{,}1 \cdot 10^{17}$

$N_{D\,netto} = 2{,}1 \cdot 10^{18}$

$N_{D2} = N_{D\,netto} - N_{D1} = 1{,}9 \cdot 10^{19}\ cm^{-3}$

Ele 6. 9.10.10

④

b) $\sigma_2 = 0{,}1\,\sigma_1$ i ne mijenja TIP Tj N-TIP

$\sigma_2 = \sigma_{2N} = q\,\mu_n\,n_2$

$\frac{\sigma_2}{\sigma_1} = \frac{q\,\mu_n\,n_2}{q\,\mu_n\,n_1} = 0{,}1 \qquad n_2 = 0{,}1\,n_1 = 2{,}1\cdot 10^{16}\ cm^{-3}$

$n_2 < n_1$ kako smanjiti ... DODATI AKCEPTORE DA KOMPENZIRAMO DONORE

$N_{D\,neto} = n_2 = N_{D1} - N_{A2} \qquad N_{A2} = N_{D1} - N_{D\,neto} = 2{,}1\cdot 10^{17} - 2{,}1\cdot 10^{16} = \underline{1{,}79\cdot 10^{17}}\ cm^{-3}$

c) $\sigma_2 = 0{,}1\,\sigma_1$ mijenja tip u P-TIP - DA POSTANE PTIP DODATI AKCEPTORE DA KOMPENZIRA DONORE

$\sigma_2 = \sigma_{2P} = q\cdot\mu_p\cdot p_2$

$\sigma_1 = q\,\mu_n\cdot n_1$

$\frac{\sigma_2}{\sigma_1} = \frac{q\,\mu_p\cdot p_2}{q\,\mu_n\cdot n_1} = 0{,}1 \qquad p_2 = 0{,}1\cdot\frac{\mu_n\cdot n_1}{\mu_p} = 0{,}1\,\frac{800\cdot 2{,}1\cdot 10^{17}}{250} = 6{,}72\cdot 10^{16}\ m^{-3}$

$p_2 \gg n_i \qquad p_2 = N_{A\,neto} = N_{A2} - N_{D1}$

$N_{A2} = N_{A\,neto} + N_{D1} = 6{,}72\cdot 10^{16} + 2{,}1\cdot 10^{17} = 2{,}772\cdot 10^{17}\ cm^{-3}$

1 daju šupljine → kompenziraju donore

ELE 7 9.10.10.

① Si je dopiran PRIMJESOM na $T = 300\,K$ Ferm. Energija nalazi se 0,15 eV od DNA VODLJIVOG POJASA

DODAJE SE U Si DRUGA PRIMJESA SPECIFICNI OTPOR POVECAVA SE A E_g SE POMAKNE ZA 0,07 eV

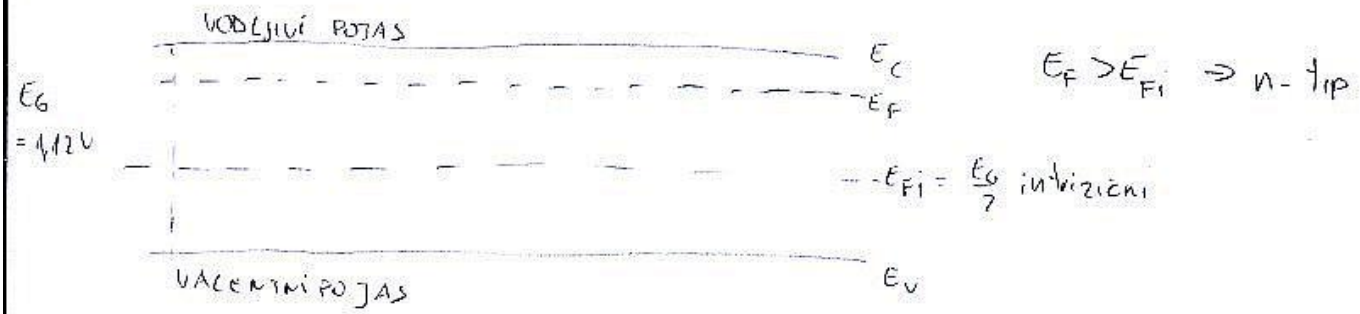
a) TIP i KONCENTRA 1. PRIMJESE

b) TIP i KONCENTRA 2. PRIMJESA

c) SPECIFICNI OTPOR NAKON 1. i 2. DOPIRANJA ALI

$\mu_n = 900\ cm^2/Vs$

$\mu_p = 300\ cm^2/Vs$



$E_F > E_{Fi} \Rightarrow$ n-tip

$$n_0 = N_C \exp\frac{E_F - E_C}{E_T}$$

$E_C - E_F = 0,17\,eV \Rightarrow n_0 = N_C \exp\frac{-(E_C - E_F)}{E_T}$

$N_C = C\,T^{3/2} = 2,07\cdot 10^{17}\,(300)^{3/2} = 3,67\cdot 10^{19}\ cm^{-3}$

$n_0 = = 1,11\cdot 10^{17}\ cm^{-3}$

$n_0 \gg n_i \qquad N_D = n_0 = 1,11\cdot 10^{17}\ cm^{-3}$

ELE 2 9.10.10

⑤ $\rho = \frac{1}{\sigma} = \frac{1}{q \mu_n \cdot n}$ $\rho \uparrow \Rightarrow n \downarrow$ ili postat P-tip

→ DODATI AKCEPTORE

→ E_F se pomiče prema VALENCIJOM

t_1 biti će 0,2 eV od VODLJIVOG POJASA

$E_C - E_{F2} = 0,2\ eV$ $E_{F2} > \frac{E_G}{2}$ → nakon drugog dopiranja i DALJE N-TIP

$\rho \uparrow \Rightarrow n \downarrow$

$n_{02} = N_c \exp - \left(\frac{E_C - E_{F2}}{E_T}\right) = 3,67 \cdot 10^{15} \cdot \exp \frac{-0,2}{\frac{300}{11600}} = 1,61 \cdot 10^{16}\ cm^{-3}$

$n_{02} \gg n_i$

$n_{02} = N_{D neto} = N_{DA} - N_{A2} \Rightarrow N_{A2} = N_{DA} - N_{D neto} = 9,5 \cdot 10^{16}\ cm^{-3}$

c) $\rho_1 = \frac{1}{q \cdot \mu_n \cdot n_1} = \frac{1}{1,6 \cdot 10^{-19} \cdot 900 \cdot 1,11 \cdot 10^{17}} = 62,6\ m\Omega cm$

$\rho_2 = \frac{1}{q \cdot \mu_n \cdot n_2} = \frac{1}{1,6 \cdot 10^{-19} \cdot 900 \cdot 1,61 \cdot 10^{16}} = 0,43\ \Omega cm$

AKO U N TIP DODAJEMO POVEĆAVAO VODLJIVOST

AKCEPTORE SMANJUJEM VODLJIVOST

Ele 9 9.10.10

⑥ RASPODJELA MANJINSKI NOSIOCA ZA PN SPOJ → SLIKA

DA DAMETI MANJINSKI NOSIOCI

$\mu_n = 800\ cm^2/Vs$ $\tau_p = 0{,}5\ \mu s$

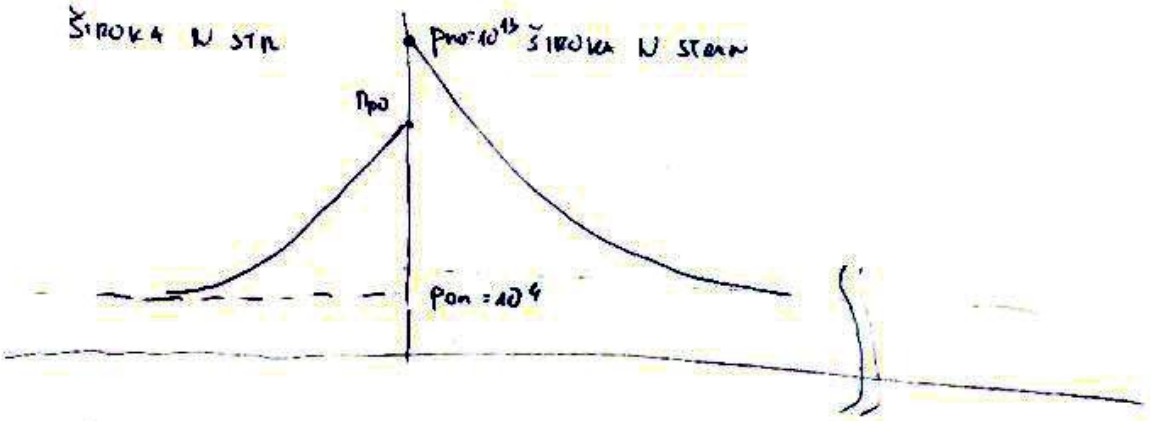
$\mu_p = 300\ cm^2/Vs$ $\tau_n = 0{,}2\ \mu s$

POVRŠINA $S = 0{,}5\ mm^2 = 0{,}5 \cdot 10^{-2}\ cm^2$ $T = 300\ K$

a) RUBNE KONCENTRACIJE ELEKTRONA

b) KOLIKI JE NAPON PRIKLJUČEN NA PN SPOJ

c) ILUSTRIRATI STRUJU KROZ DIODU



a) SPOJ – PROPUSNO POLARIZIRAN

$$1\ \ p_{no} = p_{on} \exp \frac{U_D}{U_T}$$

$$2\ \ n_{po} = n_{op} \exp \frac{U_D}{U_T}$$

$$\frac{n_{po}}{p_{no}} = \frac{n_{op}}{p_{on}} \Rightarrow n_{po} = \frac{n_{op}}{p_{on}} p_{no} = \frac{5 \cdot 10^2}{10^4} 10^{13} = \underline{\underline{5 \cdot 10^{11}\ cm^{-3}}}$$

b) $(1) \rightarrow U_D = U_T \ln \frac{p_{no}}{p_{on}} = \frac{300}{11600} \ln \frac{10^{13}}{10^4} = \underline{\underline{0{,}536\ V}}$

ETE 10 9.10.10

6. c) STRUJA KROZ DIODU

$$I_S = I_{SN} + I_{SP} = qS\left[D_N \frac{n_{OP}}{L_n} + D_P \frac{p_{ON}}{L_P}\right]$$

I_{SN} – ELEKTRONSKA KOMPONENTA – RAČUNAMO NA P-STRANI

I_{SP} – ŠUPLJINSKA KOMP – RAČUNAMO NA N-STRANI

L_n – ŠIROKA P

L_P – ŠIROKA N

$L = \sqrt{D \cdot \tau}$; $D = \mu \cdot U_T$ SLUŽBENI SAL. — I.—

$$\Rightarrow qS\left[n_{OP}\sqrt{\frac{D_n}{\tau_n}} + p_{ON}\sqrt{\frac{D_P}{\tau_P}}\right]$$

$$= q \cdot S\sqrt{U_T}\left[n_{OP}\sqrt{\frac{\mu_n}{\tau_n}} + p_{ON}\sqrt{\frac{\mu_P}{\tau_P}}\right]$$

$$= 1{,}6\cdot 10^{-19} \cdot 0{,}5\cdot 10^{-2}\left(\frac{300}{11600}\right)^{1/2}\left[5\cdot 10^{2}\sqrt{\frac{800}{0{,}2\cdot 10^{-6}}} + 10^{4}\sqrt{\frac{300}{0{,}5\cdot 10^{-6}}}\right]$$

$$I_S = 3{,}56\cdot 10^{-14}\ A$$

$$I = I_S\left[\exp\left(\frac{U_0}{U_T}\right) - 1\right] = 3{,}56\cdot 10^{-14}\left[\exp\frac{0{,}516}{\frac{300}{11600}}\right] = 35{,}7\ \mu A$$

ALTERNATIVA 2

RAČUNAMO DIFUZIJSKE STRUJE IZ RASPODJELA MANJINSKIH NOSIOCA

$$I = I_{dn} + I_{dp} = qS\cdot\left[D_n\frac{n_{po}}{L_n} + D_p\frac{p_{no}}{L_p}\right] = qS\sqrt{U_T}\left[n_{po}\sqrt{\frac{\mu_n}{\tau_n}} + p_{no}\sqrt{\frac{\mu_n}{\tau_p}}\right] = 35{,}7\ \mu A$$

ALT 3

IZ EKCESNOG NABOJA (LAKRSALNOG NABOJA) MANJINSKIH NOSIOCA

$$Q_n = qS[n_{po} - n_{OP}]L_n \qquad I_n = \frac{Q_n}{\tau_n}$$

$$Q_P = qS[p_{no} - p_{ON}]L_P \qquad I_P = \frac{Q_P}{\tau_P} \qquad I_D = I_n + I_P$$

ELE 11 9.10.10

⑥ BDD slučajevi

$$I = I_{sN} + I_{sP}$$

Široka N, uska P

$$I_s = \rho S \left[D_n \frac{n_{op}}{W_p} + D_p \frac{p_{on}}{L_p} \right]$$

Široka P, uska N

$$I_s = \rho \cdot S \left[D_N \frac{n_{op}}{L_n} + D_p \frac{p_{on}}{W_n} \right]$$

⇒ Uvijek se gledaju manjinski nosioci pri izboru formule

Elc A1 4.10.10.

7. DIODA IMA KONCENTRACIJE NA STRANAMA

$N_D = 10^{16}\ cm^{-3}$ $N_A = 5\cdot10^{13}\ cm^{-3}$

PARAMETRI SU

$\mu_n = 750\ cm^2/Vs$ $\tau_n = 0{,}2\ \mu s$

$\mu_p = 300\ cm^2/Vs$ $\tau_p = 0{,}5\ \mu s$

ŠIRINE STR.: $W_n = 250\ \mu m$ $W_p = 0{,}8\ \mu m$

$S = 2\ mm^2 = 2\cdot10^{-2}\ cm^2$

$T = 300\ K$

a) STRUJA KROZ DIODU AKO SE SPOJI PROPUSNI NAPON $U_D = 0{,}6\ V$

b) NACRTATI RASPODJELU MANJINSKIH NOSIOCA, IZRAČUNATI RUBNE KONCENTRACIJE I OTAM

c) IZRAČUNATI DIFERENCIJALNI OTPOR UZ ZADANI NAPON

RAČUNAMO DIFUZIJSKE DUŽINE P STRANE

$$L_n = \sqrt{D_n \cdot \tau_n} = \sqrt{\mu_n U_T \tau_n} = \ldots = 19{,}7\cdot10^{-4}\ cm = 19{,}7\ \mu m$$

$W_p \ll L_n \rightarrow$ USKA STRANA P STRANA

N STRANA

$$L_p = \sqrt{\mu_p U_T \tau_p} = \ldots = 19{,}7\ \mu m$$

$W_n \gg L_p \rightarrow$ ŠIROKA N STR

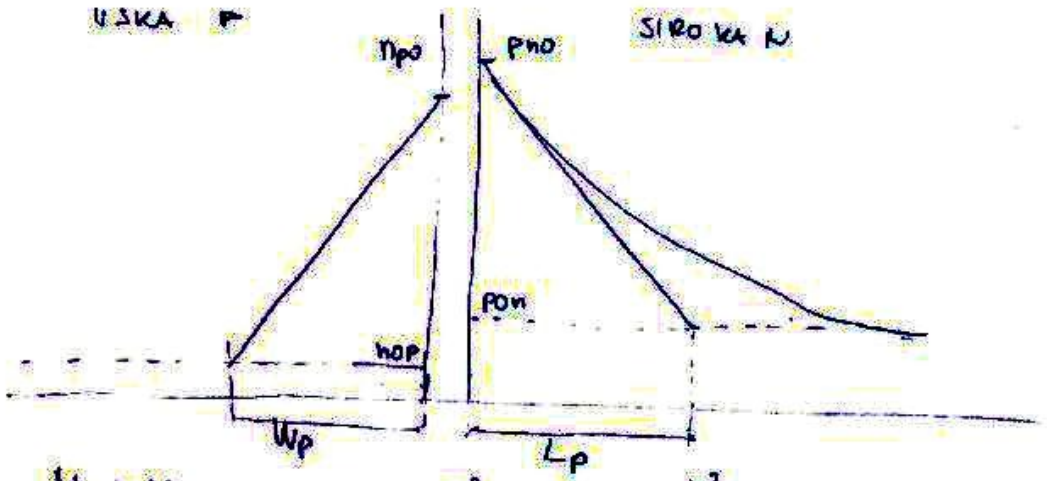
$$I_S = qS\left[D_n \frac{n_{0p}}{W_p} + D_p \frac{p_{0n}}{L_p}\right] \Big| \quad D = \mu U_T \quad n_{0p} = \frac{n_i^2}{N_A} \quad p_{0n} = \frac{n_i^2}{N_D} \Big/ \ldots =$$

$$= qS n_i^2 U_T \left[\frac{\mu_n}{N_A W_p} + \frac{\mu_p}{N_D L_p}\right] = 1{,}6\cdot10^{-19}\cdot 2\cdot10^{-2}\left(1{,}45\cdot10^{10}\right)^2 \cdot \frac{300}{1160}\left[\frac{750}{5\cdot10^{13}\cdot 0{,}8\cdot10^{-4}} + \frac{300}{10^{16}\cdot 19{,}7}\right]$$

$$\ldots = 5{,}91\cdot10^{-13}\ A$$

$$I_D(0{,}6) = 5{,}91 \cdot 10^{-13}\left[\exp\left(\frac{0{,}6}{\frac{300}{1160}}\right)-1\right) \ldots = 7{,}04\ mA$$

7) b) Raspodjele



$N_A > N_D$

$n_{op} = \frac{n_i^2}{N_A}$ ∠ $p_{on} = \frac{n_i^2}{N_D}$

$n_{op} = \frac{n_i^2}{N_A} = \ldots 4{,}2 \cdot 10^{2}\ cm^{-3}$

$p_{on} = \frac{n_i^2}{N_D} = \ldots 2{,}1 \cdot 10^{4}\ cm^{-3}$

$n_{po} = n_{op} \cdot \exp \frac{U_D}{U_T} = \ldots = 5 \cdot 10^{12}\ cm^{-3}$

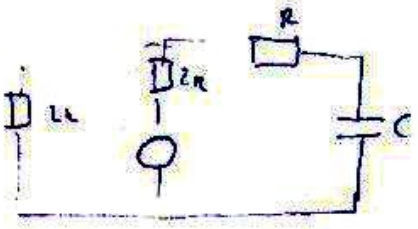
$p_{no} = p_{on} \cdot \exp \frac{U_D}{U_T} = \ldots = 2{,}5 \cdot 10^{14}\ cm^{-3}$

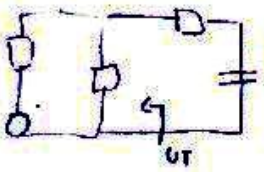
c) $r_d = \frac{dU_d}{dI_d} = \frac{1}{\frac{dI_d}{dU_d}} = \frac{U_T}{I_D + I_C} \doteq \frac{U_T}{I_D} = \frac{\frac{200}{11600}}{7{,}04 \cdot 10^{-3}} = 3{,}67\ \Omega$

ELE 14 9.10.10

TEORIJA 09/10

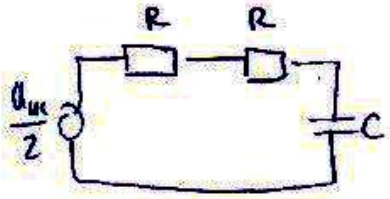
① $R = 10\ k\Omega$
$C = 1\ nF$



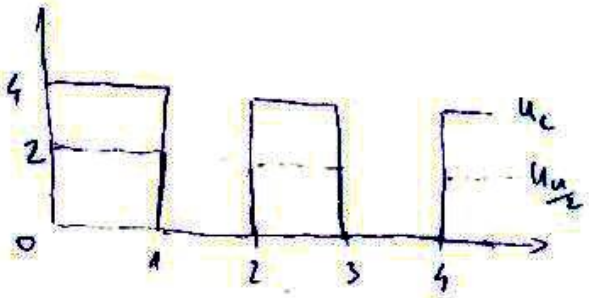


$R_T = 2R \| 2R = R$

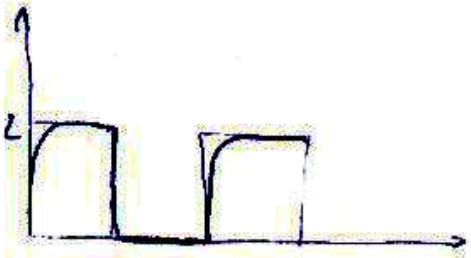
$U_T = \frac{2R}{2R+2R} U_0 = \frac{U_{ul}}{2}$



$\tau = 2R \cdot C = 20\ \mu s$



$\frac{T}{2} = 1\ ms \gg \tau = 20\ \mu s \gg 5\tau$



2 AKO SE C ZAMJENI SA $C = 100\ \mu F$ $\tau = 2R \cdot C = 2\ s$

$\frac{T}{2} = 1\ ms \ll \tau = 2\ s$

kratko će se nabijati i izbijati i „titrat" oko U_{sr2} $\left(U_{sr} = \frac{U_c}{2} = 1V \right)$

ELE 16 § 10.10

5) VODIČ DOPIRAN N_D i AKCEPTORIMA N_A $N_D > N_A$

TOČKO JE $\Rightarrow$ N-TIP

$$q(p + N_D^+) = q(n + N_A^-) \quad \dots \quad n - p = N_D - N_A$$

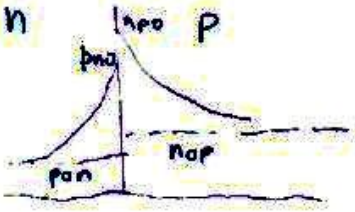
6. ZA KOLEC. Si SPOJA SA JEDNAKO ŠIROM

$N_D = 10\, N_A$ KOJA JE DOM

$\rightarrow$ ŠIRI SE NA SLABIJE DOPIRANU ... $N_D > N_A$ | $p_{no} < p_{po}$

↳ SLABIJE DOPIRANI

NA P STRANU SE ŠIRI



$n_{po} > p_{no}$

$\rightarrow$ dominantna komponenta $\rightarrow$ elektronska

$$I_d = I_{dn} + I_{dp} \quad \sim \quad I_{dn} \sim \frac{n_{po}}{L_n} \qquad I_{dp} \sim \frac{p_{no}}{L_p}$$

$$\frac{I_{dn}}{I_{dp}} \doteq \frac{n_{po}}{p_{no}}$$

Etc. A. 6.10.10

7. Dioda $U_T = 25mV$

$u_D = U_D + 5\sin\omega t \quad mV$

$i_d = I_d + 1\sin\omega t \quad mA$

$r_d = \frac{U_{dm}}{I_{dm}} = \frac{5_m}{1_m} = 5\,\Omega$

$r_d = \frac{U_T}{I_D} \qquad I_D = \frac{U_T}{r_d} = \frac{25mV}{5\,\Omega} = 5\,mA$

T↑ φ_T↑ POVEĆE, RASTE INTRIZIČNA, I_S RAST, I_D → RASTE

8. $N_A = 10^{17}\,cm^{-3}$ $\qquad U = 0{,}55\,V$

$N_D = 10^{14}\,cm^{-3}$ → ŠIROKA P

→ USKA N

$\mu_n = 2\mu_p \qquad W_n = \frac{1}{40} L_n$

$I_{SN} = q \cdot S\, D_n \cdot \frac{n_{op}}{L_n} \qquad I_{SP} = q \cdot S\, D_p \frac{p_{on}}{W_n}$

$\frac{I_{Sn}}{I_{SP}} = \frac{\mu_n n_{op}}{\mu_p p_{on}} \cdot \frac{W_n}{L_n} \ldots = \frac{\mu_n}{\mu_p} \cdot \frac{W_n}{L_n} \cdot \frac{N_D}{N_A} = 2 \cdot \frac{1}{40} \cdot 100 = 5$

$I_{SN} = 5 \cdot I_{SP}$

DIFUZIJSTR