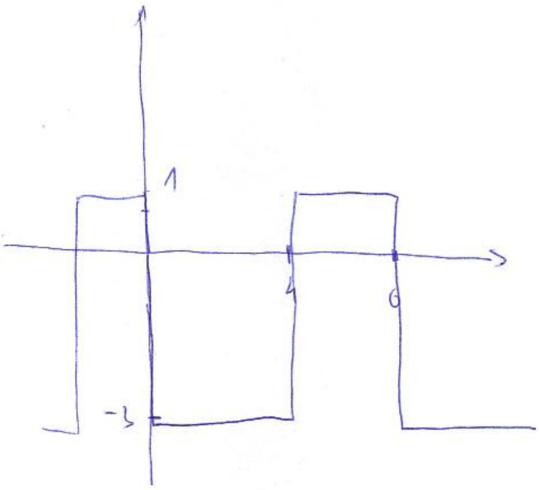
T

ELE 15. 14/11/11

CR MREŽA

IZLAZ NA R $\tau_1 << \tau_2$



KAKO SE ODNOSE SREDNJI VRI JEDNOSTI NAPO NA OTPORNIKU

U_{SR1} , U_{SR2}

$U_{SR1} = U_{SR2} = 0$

BEZ OBZIRA NA τ

→ $U_{ULSR} = U_{CSR}$ PA JE $U_{RSR} = 0$

→

RC MREŽA , IZLAZ NA C $\tau_1 << \tau_2$

? U_{SR1} U_{SR2}

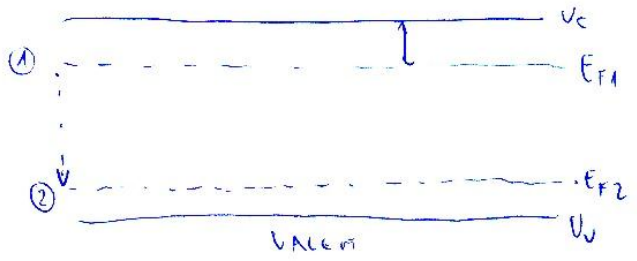
na C ostaje DC komponenta

$U_{SR1} = U_{ULSR}$
$U_{SR1} = U_{UL\,SR}$ } $U_{SR1} = U_{SR1}$

ECE16 14/11/11

Si jo 1 TIPOM $N_1 = N_D$

E_F 0,2 eV od dna Vodljivog po



Koji tip i koik koncent da E_F zauzme na 0,2 od vrha valentnog pojasa

$N_1 \rightarrow E_{F1} \rightarrow$ NTIP VODIČ 1 (DONORI)

$p_2 = n_1 = N_D$ – nakon dodavanja primjese promjeni se sti

→ DODAJEM AKCEPTOR $p_2 = N_A$ neto $= N_A - N_D$

$N_A = p_2 + N_D = 2 N_D$

POČIEA Si DOPIRAN N_{D1}, SPECIFIČNA VODLJIVOST σ_1

koji TIP i KONCENTRACIJ TREBA DODAT DA SI PROM-

TIP VODLJIVOST A DA SPEC. VODLJI NAKON 2. $\sigma_2 = \sigma_1$

n-tip

→ nakon dopir. p-tip, dodaje akceptore – $N_x = N_A$

$\sigma = g \mu_n \cdot N_D$

$\sigma = g N_p N_{A\,neto} = g \mu_p (N_A - N_D)$ |:

$\frac{\sigma_1}{\sigma_2} = \frac{\mu_n}{\mu_p} \cdot \frac{N_D}{N_A - N_D} = 1 \rightarrow \frac{N_A - N_D}{N_D} = \frac{\mu_n}{\mu_p} \rightarrow \frac{N_A}{N_D} - 1 = \frac{\mu_n}{\mu_p} \rightarrow$

$N_A = N_D \left(1 + \frac{\mu_n}{\mu_p}\right)$ $\frac{\mu_n}{\mu_p} > 1$ ~ $N_A \sim > 2 N_D$

→ DODATI AKCEPTOR $N_{A2} > 2 N_{D1}$

Elc 17 14/11/11

Si OP DOPIR DONORI $N_D = 10^{16}$ T_1 300 → $T_2 = 350K$

PRI TOME ZA KONCENTRU elektron i šupljin p UKUPNO

$n_i(350) << 10^{16}$ → Si ekstrinzičan

$n_{on} = N_D = 10^{16}\ cm^{-3}$ → koncentraciju elektrona se ne mijenja

$p_{on} = \frac{n_i^2}{n_{on}} = \frac{n_i^2}{N_D}$ } T↑ n_i↑ → p raste ↑

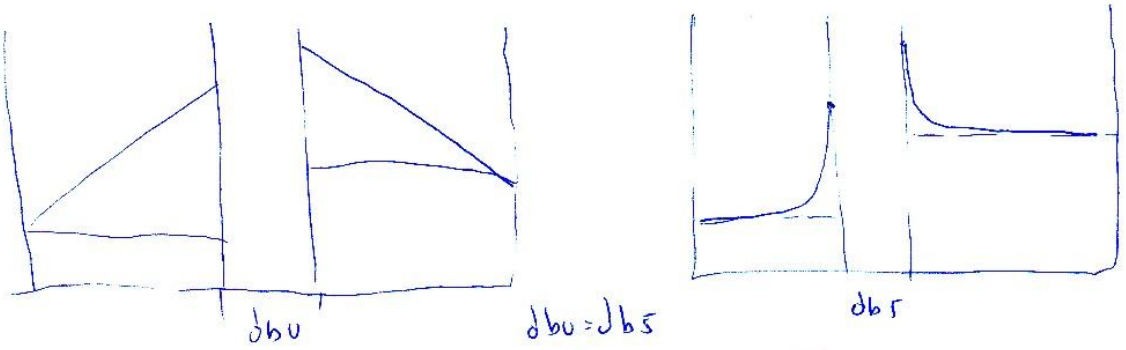
⇒ hostuje prib. isti, p raste

---

2 PN SPOJA IMAJU JEDNAK KONCENT PRIMJESA PRI

PN_1 ima uske strane PN_2 ima široke strane ZA

STRUJE ZAR I_S i KAPACITE OSIROMAŠE SLOJEM UKUPNO



USKE

$C = \varepsilon \frac{S}{db}$

ŠIROKE

→ KAPACITET IST $C_{BU} = C_{BŠ}$

$I_{SU} \sim \left(D_n \frac{n_{op}}{W_p} + D_p \frac{p_{on}}{W_n} \right)$ $\quad I_{SŠ} \sim \left(D_n \frac{n_{op}}{L_n} + D_p \frac{p_{on}}{L_p} \right)$

$W_p << L_n$, $W_n << L_p$ ⟷

$I_{SU} >> I_{SŠ}$

Elc MI 14/11/11

PN DIODA SA ŠIROKIM STRANAMA IM N STRANA JEČE DOPIRANA OD P STRANE

n strana		p strana
N_D	>>	N_A
n_{on}	>>	p_{op}

$U_D = 0{,}7\,V$ → propusno polarizirana

Manjinski koncentracija na P STRANI

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

n_{on} p_{on}

→ SLABIJE DOPIRANA STRANA ODREĐUJE STRUJU

$I_S \sim n_{op}$

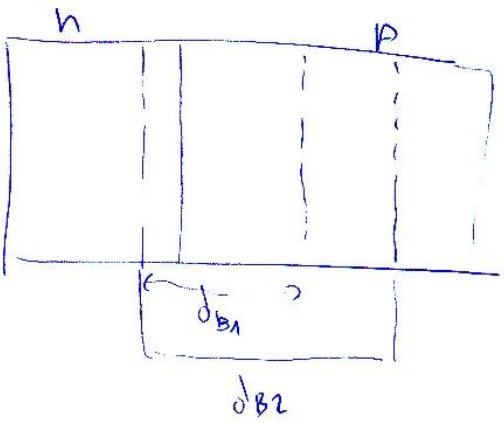
$I_{S1} \sim n_{op1}$ $I_{S2} \sim n_{op2}$

AKO $N_{A2} < N_{A1}$

$p_{op2} < p_{op1}$

$n_{op2} > n_{op1}$

$I_{S2} > I_{S1}$ → STRUJA $I_{D2} > I_{D1}$



$E_x \sim \frac{1}{d_B}$

$F_2 < F_1$

→ STRUJA KROZ DIODU ĆE BITI MANJA A POLJE SMANJITI

ELE 1a 14.11.11

ZA PN SPOJ PRIKLJ NA NAPON IZNOSA $U = 0,55$ V

S KONS. $N_A = 10^{15}\ cm^{-3}$ $N_D = 10^{16}\ cm^{-3}$ TE ŠIROKIM STRANAMA

UZ $\mu_n = 2\mu_p$ i istim $\tau_n = \tau_p$ USPOREDI

I_{SN} I_{SP} i PROPUSNI ILI ZAPORNI

$U = 0,55 > 0$ } PROPUSNO POLARIZIRAN SPOJ

$$I_{SN} \sim D_n \frac{n_{0p}}{L_n} = \mu_n U_T \frac{n_{0p}}{L_n} = D_n \frac{n_{0p}}{\sqrt{D_n \tau_n}} = n_{0p}\sqrt{\frac{D_n}{\tau_1}} = n_{0p}\sqrt{\frac{\mu_n U_T}{\tau_1}}$$

$$I_{SP} \sim D_p \frac{p_{0n}}{L_p} = \mu_p U_T \frac{p_{0n}}{L_p} = p_{0n}\sqrt{\frac{\mu_p \cdot U_T}{\tau_p}}$$

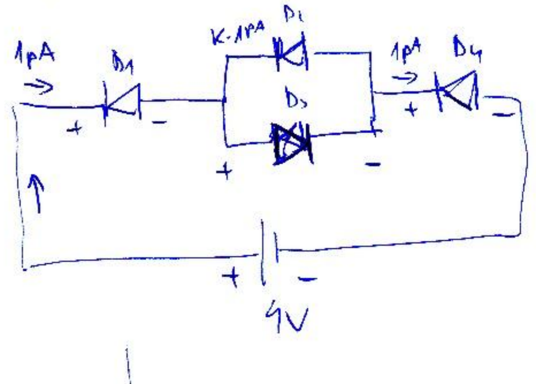
$$\frac{I_{SN}}{I_{SP}} = \sqrt{\frac{\mu_n}{\mu_p}} \cdot \frac{n_{0p}}{p_{0n}} = \sqrt{\frac{\mu_n}{\mu_p}} \cdot \frac{\frac{n_i^2}{N_A}}{\frac{n_i^2}{N_D}} = \sqrt{\frac{\mu_n}{\mu_p}} \cdot \frac{N_D}{N_A} = \sqrt{2} \cdot 10 = 14,1$$

$$I_{SN} > I_{SP}$$

- STRUJU NAPONSKE KARAKTERISTIKE NA SLICI MOGU SE OPISATI SHOCKLEY...

KOJA STRUJA TEČE U MREŽI $I_{S1} = 1\,pA$ $I_{S2} = I_{S3} = 2\,pA$ $I_{S4} = 3\,pA$

NA KOJOJ DIODI JE NAJVEĆI PAD NAPONA

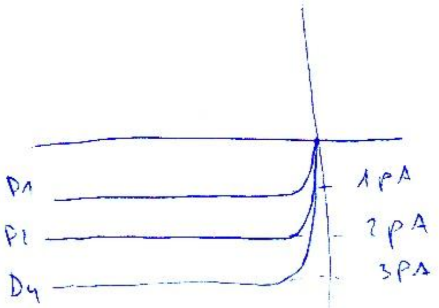


D1 = ZAPORNO POLARIZI

D2 = -||- -||-

D3 = PROPUSNO -||-

D4 = ZAPORNO -||-



→ LIMITIRA STRUJU JER PROPUŠTA NAJMANJU STRUJU

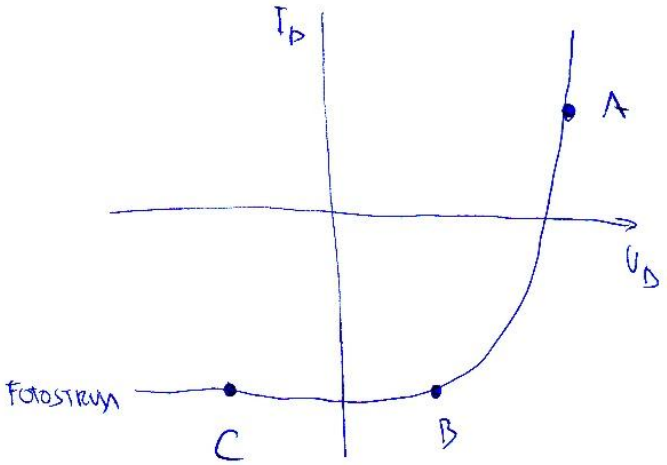
UZAPORU D1 $I_s <$

NA D1 najveći PAD NAPONA

4V − 0,15 − 0,15

ELE 20 14/11/111

→ NAMJENA SUNČANIH ČELIJE NAJEKA RADNA TOČKA (B)



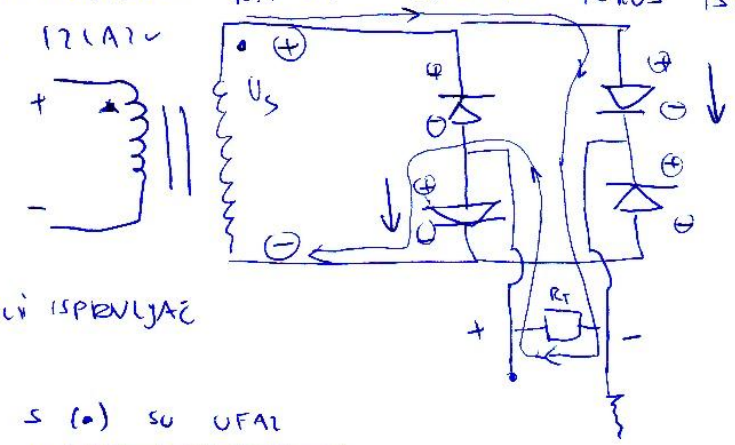
→ PRETVORNIK SUNČEVOG ZRAČENJA U ELE. ENERGIJU

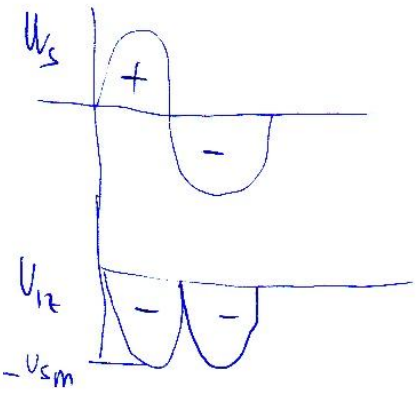
→ KORISTI U TOČKI B (IV)

→ U (A) SE NE KORISTI

→ U (C) SU KAO DETEKTOR FOTO DIODA

ZA ISPRAVLJAČ KA SI OBJASNI IZLAZ ISTOSMJERNOG NAPONA NA IZLAZU





→ PUNOVALNI ISPRAVLJAČ

- NAPOM S (+) SU UFAZ

$$U_{IZ} = -2U_{Sm}/\pi$$