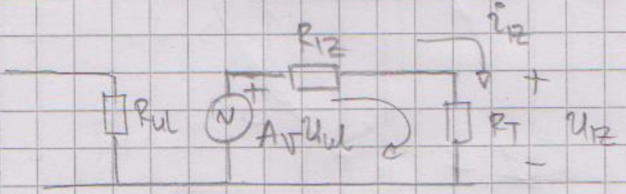
MASS – PROF. BARIĆ

A – 2010

(1)



$$A_V = \frac{u_{IZ}}{u_{UL}} = \underbrace{\frac{A_V \cdot u_{UL}}{R_{IZ}+R_T}}_{i_{IZ}} \cdot R_T \frac{1}{u_{UL}}$$

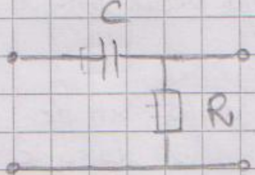
$$\frac{A_V}{A_V}(R_{IZ}+R_T) = R_T$$

$$\frac{100}{150} R_{IZ} = R_T\left(1-\frac{10}{15}\right)$$

$$3 \cdot \frac{10}{15} 2 = R_T \frac{1}{3} \Big|\Big| 3 \qquad \Rightarrow R_T = 4\,k\Omega$$

$$A_I = \frac{i_{IZ}}{i_{UL}} = \frac{u_{IZ}}{u_{UL}} \frac{R_{UL}}{R_T} = 100 \frac{1}{4} = 25$$

(2)

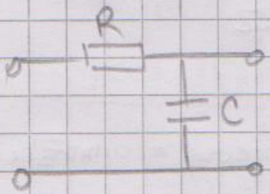


– srednja vrijednost ima kvalitetu istosmjernog napona

↳ izlazni naponi su jednaki 0

⟶ kondenzator ubija srednju vrijednost na izlazu

(3)



– bit će neka srednja vrijednost na izlazu. Kolika?

– ista je kao srednja vrijednost na ulazu signala

$$\frac{U_{SR1}}{U_{SR2}} = 1$$

(4)

→ ako dodamo isti broj akceptora kao i donora, završit ćemo na sredini

– dodajemo toliko ima donora (da ih neutraliz. i još toliko da bude taman)

(5)

$$\frac{N_{D1},\ \sigma_1}{\sigma_2 = \sigma_1}$$

$$\sigma = q(n\mu_p + p\mu_p)$$

$$\sigma_1 = q n \mu_n$$

$$\sigma_2 = q p \mu_p$$

$$\not{q} n \underline{\mu_n} = \not{q} p \underline{\mu_p}$$

nisu isti

$$\mu_p < \mu_n$$

i to više od $2N_D$

$$N_A > 2N_D$$

moramo neut. donore i

$p = N_A$ još jednom dodati toliko akcep., ali to nije dovoljno zbog toga mora biti više

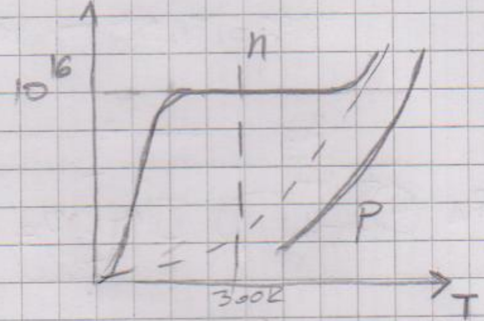
(6.) $N_D = 10^{16}\ cm^{-3}$

$T_1 = 300K$, $T_2 = 350K$

u - tip

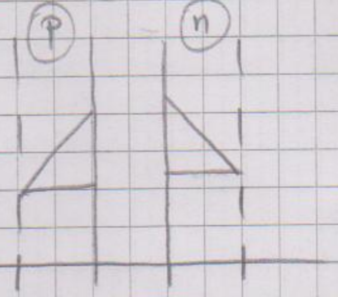
$n = N_D = 10^{16} \gg n_i$

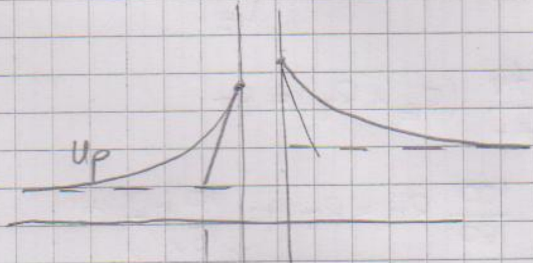
$p = \frac{n_i^2}{n}$



n ostaje približno isti
p raste

(7)





nagib definira struju zasićenja, i struju općenito

$J_{Dn} = q D_n \frac{dn}{dx}$

uske strane imaju veću struju zasićenja

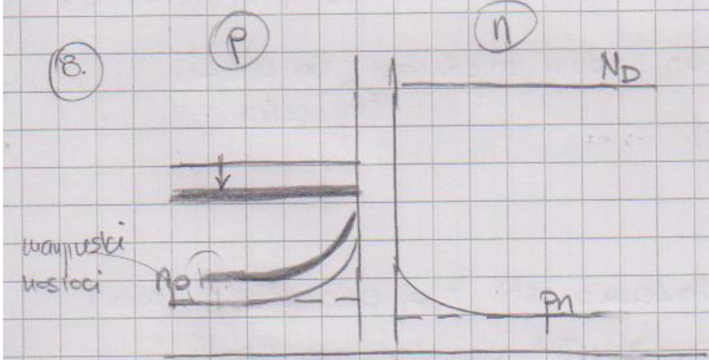
$C_B = \varepsilon \frac{S}{d_B}$

$d_B = \sqrt{\frac{2\varepsilon}{q}\left(\frac{1}{N_A} + \frac{1}{N_D}\right)(U_K - U)}$

-> širina osiromaš. sloja bit će jednaka u oba dva slučaja

(a) $I_{S1} > I_{S2}$, $C_{B1} = C_{B2}$

(8.)



umnožak na lijevoj = umnošku na desnoj

$U_D = 0{,}5V$ -> propusna p.

- smanjenjem raste broj nosilaca

- struja kroz diodu će se povećati

$F_{max} = \left|\frac{2(U_K - U)}{d_B}\right|$ -> mijenja se

$d_B = \sqrt{\frac{2\varepsilon}{q}\left(\frac{1}{N_A} + \frac{1}{N_D}\right)(U_K - U)}$

-> N_A je pao -> d_B raste -> F pada (smanji se)

(9.) propusno polarizirano

$$I = I_S\left[\exp\left(\frac{U}{U_T}\right) - 1\right]$$

$$I_S = q \cdot S\left(\frac{n_{op} D_N}{L_n} + \frac{p_{on} D_p}{L_p}\right) =$$

p-strana:

većinski $p_{op} = N_A$

manjinski $n_{op} = \frac{n_i^2}{N_A}$

n-strana:

$n_{on} = N_D$

$p_{on} = \frac{n_i^2}{N_D}$

$L_n = \sqrt{D_n \tau_n}$

$$= q S n_i^2 \left(\underbrace{\frac{D_n}{N_A\sqrt{D_n \tau}}}_{\text{duža strana}} + \underbrace{\frac{D_p}{N_D\sqrt{D_p \tau}}}_{\text{kraća}}\right)$$

$$\frac{I_{Sn}}{I_{Sp}} = \frac{\frac{D_n}{N_A\sqrt{D_n \tau_n}}}{\frac{D_p}{N_D\sqrt{D_p \tau_p}}} = \frac{N_D}{N_A}\sqrt{\frac{D_n}{D_p}}$$

$$= \frac{N_D\sqrt{\mu_n U_T}}{N_A\sqrt{\mu_p U_T}} = 10\sqrt{2}$$

$I_{Sn} > I_{Sp}$ (c)

(10) D_3 je propusno polarizirana

D_1 ograničava struju $I_{S1} = 1pA$

- ako jedna dioda ograničava uk. struju, onda je na njoj najveći pad napona

- D zadatke je samo komentirao

2MI - 2010 →

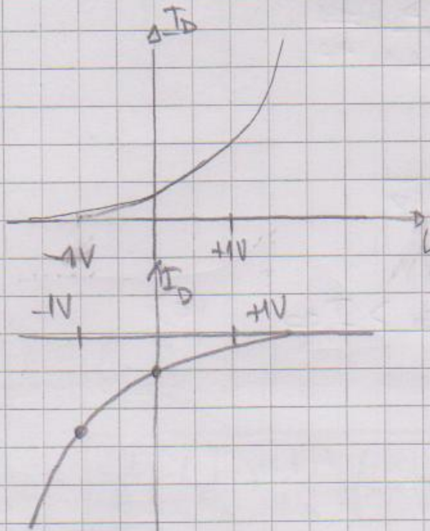
1. točka A → radna točka za običnu diodu

točka B → sunčana ćelija

2. $U_{rz} = \frac{-2U_{sm}}{\pi}$

3. Izvor promj. napona u početnom trenutku k 0V

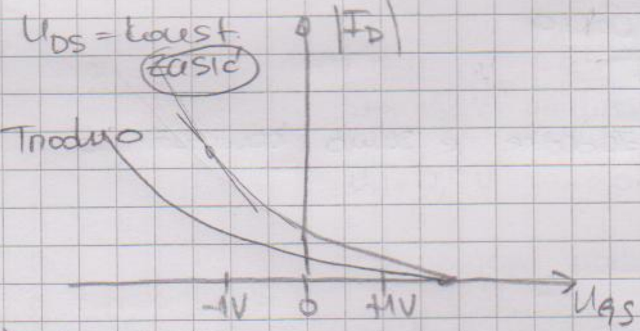
4.



osiromašeni tip - struja teče i kada je $U_{GS}=0$

strmina - promjena struje kroz promjenu napona U_{GS}
→ najveća u zasićenju, a u triodnom području smanjuje se

$$g = \frac{\partial I_D}{\partial U_{GS}} = \frac{\Delta I_D}{\Delta U_{GS}}$$



- u triodnom području rada struja je manja

5. b) i e) n-kanalni mosfet

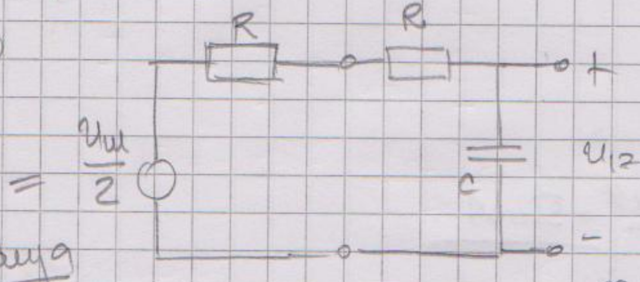
d) nije jer

c) teče u A i B ista struja

a)

1. MI - 2009

(1.)



$\tau = 2R \cdot C = 20 \cdot 10^3 \cdot 10^{-9} = 2 \cdot 10^{-5}$

$= 20\,\mu s = 0{,}02\,ms$

τ je kraći od 1ms

↳ srednja vrijednost je 2V (graf)

b) kada je τ puno veći od 1ms

c) kada je τ sumjerljiv sa 1ms

(2) $\tau = 20 \cdot 10^3 \cdot 100 \cdot 10^{-6} = 2\,s$

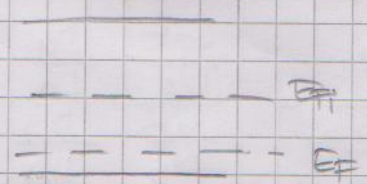
minimalno 1V jer je τ veći od 1ms

(3)

temp. raste

→ dodati donore, povisimo temp. i E_F se približi vodljivom pojasu

(4) $\sigma = q\,(n\mu_n + p\mu_p)$



→ dodavanjem se smanjuje pokretljivost, pada
→ dominiraju [illegible]

(5.) $N_D > N_A$ → n-tip

$p + N_D^+ = n + N_A^-$

$$\boxed{N_D - N_A = n - p}$$

(6.) $N_D = 10 N_A$ jednako široke strane

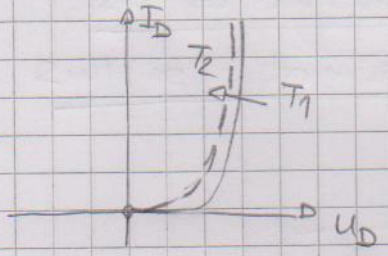
− osiromašeni sloj se širi na slabije dopiranu
↳ u ovom zadatku se širi na p-stranu

− struja se računa preko manjinskih nosioca (na strani koja je slabije dopirana) (→ preko elektrona)
→ više ovisi o N_D i

(7) $r_d = \frac{\Delta U_D}{\Delta I_D} = \frac{u_d}{i_d} =$

$= \frac{5 \cdot 10^{-3}}{1 \cdot 10^{-3}} = 5\Omega$

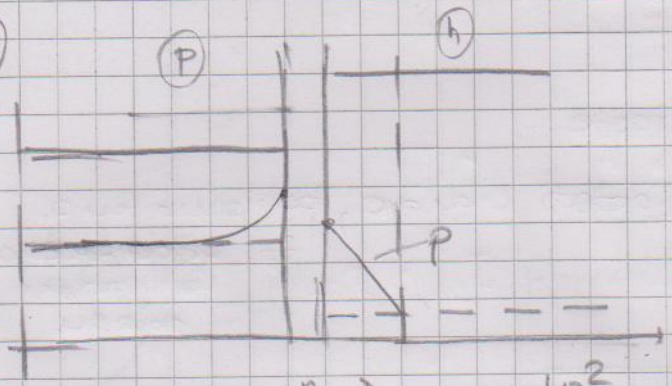
$r_d = \frac{U_T}{I_D} \Rightarrow I_D = \frac{U_T}{5} = \frac{25mV}{5} = 5mA$



$T_2 > T_1$

- graf bježi ulijevo ako temp raste

(8)



$$\frac{I_{sn}}{I_{sp}} = \frac{\frac{n_{po} D_n}{L_n}}{\frac{p_{no} D_p}{W_n}} = \frac{\frac{U_T^2}{N_A} \cdot \frac{D_n}{L_n}}{\frac{U_T^2}{N_D} \cdot \frac{D_p}{W_n}} = \frac{L_n}{40}$$

$$= \frac{N_D}{N_A} \frac{\frac{L_n}{40} D_n}{L_n D_p} = \frac{N_D}{N_A} \frac{1}{40} \frac{\mu_n U_T}{\mu_p U_T} = \frac{N_D}{N_A} \cdot \frac{1}{40} \cdot 2 = \frac{100}{20} = 5 //$$