AMD - STB

STB - 2...

$$\frac{u_{TV}}{u_{DV}} = \frac{1}{\omega^2 LC}$$ (vidi razmatranje u prethodnom zad.)

$$r_T = \frac{u_{TV}}{u_{TAV}} = \frac{u_{TV}}{u_{DAV}} = \frac{u_{TV}}{u_{D2Rms}} \frac{\sqrt{2}}{3} = \frac{u_{TV}}{u_{DV}} \frac{\sqrt{2}}{3}$$

$$\Rightarrow \quad r_T = \frac{\sqrt{2}}{3} \frac{1}{\omega^2 LC}$$

$$C \geq C_{min} = \frac{\sqrt{2}}{3} \frac{1}{\omega^2 L r_T} = \frac{\sqrt{2}}{3} \frac{1}{(2\pi 100)^2 \, 3{,}71 \cdot 0{,}0286}$$

$$\boxed{C \geq 11{,}3\,\mu F}$$

- uz izbor $\boxed{L = 5\,H}$ ($> L_{min}$)

$$\Rightarrow \quad C_{min} = 8{,}4\,\mu F \rightarrow \boxed{C = 10\,\mu F}$$

STB - 3

$U_{Z\phi} = 15\,V$

$\Delta U_Z = \pm 0{,}1 U_{Z\phi}$

$I_{Zmin} = 5\,mA$

$r_\phi = 10\,\Omega$

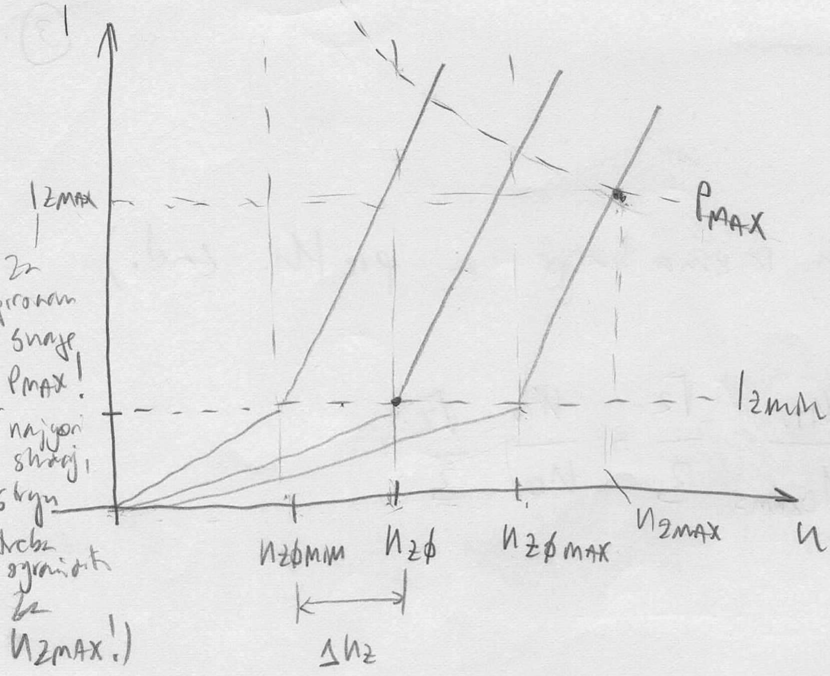
$P_{MAX} = 0{,}5\,W$

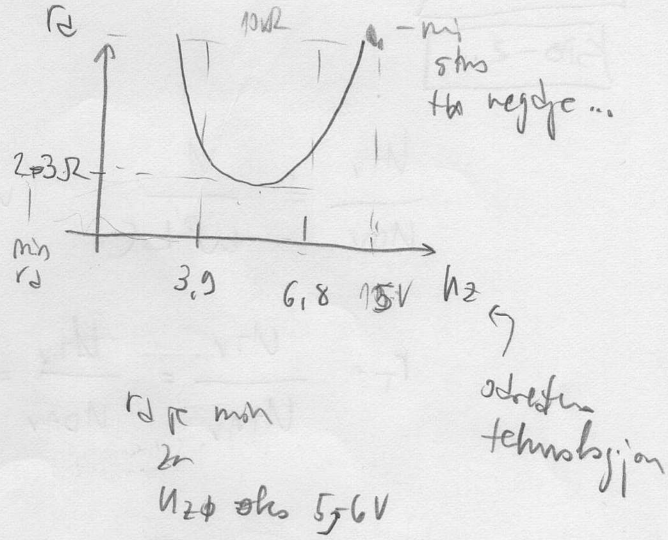
a) $R_{SMAX} = ?$ $\quad U_{UL} = 20\,V$, $R_T = 3\,k\Omega$

b) uz R_{SMAX}

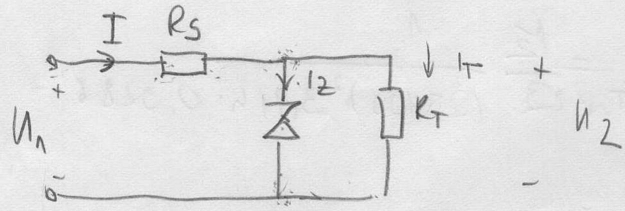
$U_{1MAX} = ?$

c) K_u, K_i (iz a))





r_d je min za U_{Z0} oko 5–6 V



typ. izgled stab. s zenerovom diodom

$\boxed{R_{SMAX}}$ određen s I_{Zmin} (da bi uopće ZD proradila)

→ najmanja struja I (max R_S, max U_Z, uz $U_1 = konst$) mora biti dovoljna za max $I_T = \frac{max\,U_Z}{R_T = konst}$ i barem min I_Z

R_{Smin} određen sa I_{Zmax} →

→ razlika max I (min R_S) i min I_T (min U_Z) $R_T = konst$ ne smije biti veća od max I_Z (određen s P_{MAX} uz U_{Zmax})

a) PRORAČUN R_s

općenito $U_{1min} = R_{SMAX}(I_{Zmin} + I_{TMAX}) + U_{Z0MAX}$

(konst u ovom slučaju)

$$\rightarrow \boxed{R_{SMAX}} = \frac{U_{1min} - U_{Z0MAX}}{I_{Zmin} + \frac{U_{Z0MAX}}{R_T}} = \frac{20 - 1{,}1 \cdot 15}{5 + \frac{1{,}1 \cdot 15}{3}} = \boxed{0{,}333K}$$

b) PRORAČUN U_{1max}

$U_Z = U_{Z0} + r_d(I_Z - I_{Zmin})$ (pravac na U–I karakt. ZD)

$P_{MAX} = I_{ZMAX} U_{ZMAX}$

$U_{ZMAX} = U_{Z0MAX} + r_d(I_{ZMAX} - I_{Zmin})$

} kvadratna j-džba po I_{ZMAX}

AUD - STB[3]

$$P_{MAX} = I_{ZMAX}\left[U_{Z\phi MAX} + r_d\left(I_{ZMAX} - I_{Zmin}\right)\right]$$

$$P_{MAX} - I_{ZMAX}\,U_{Z\phi MAX} - I_{ZMAX}^2\,r_d + r_d\,I_{ZMAX}\,I_{Zmin} = \phi$$

$$\vdots$$

$$I_{ZMAX\,1,2} = \frac{U_{Z\phi MAX} - r_d I_{Zmin} \pm \sqrt{\left(U_{Z\phi MAX} - r_d I_{Zmin}\right)^2 + 4P_{MAX} r_d}}{-2r_d}$$

$$= \frac{16{,}5 - 10 \cdot 5 \cdot 10^{-3} \pm \sqrt{16{,}45^2 + 4 \cdot 0{,}5 \cdot 10}}{-2 \cdot 10}$$

$$I_{ZMAX\,1,2} = \frac{16{,}45 \pm 17{,}047}{-2 \cdot 10}$$

$$\boxed{I_{ZMAX} = 29{,}85\,mA}$$ (neg. rj. nema fiz. smisla!)

– u slučaju da su tol. napona $U_{Z\phi}$ zanemarive tj. $U_{Z\phi MAX} \gg r_d\left(I_{ZMAX} - I_{Zmin}\right)$ može se račun pojednostaviti:

$$P_{MAX} = I_{ZMAX} \cdot U_{Z\phi MAX}$$

$$\Rightarrow I_{ZMAX} = \frac{P_{MAX}}{U_{Z\phi MAX}} = \underline{\underline{30{,}3\,mA}} \quad (\approx 29{,}85\,mA)$$

$$U_{MAX} = R_S\left(I_{ZMAX} + I_{Tmin}\right) + U_{Z\phi MAX}$$

$U_{Z\phi MAX} = P_{MAX} / I_{ZMAX} = 16{,}75\,V$

U_1 je promjenjiv u tol!

$I_{Tmin} = \phi$ (teret nije priklj!)

$$\Rightarrow \boxed{U_{1MAX}} = 0{,}33 \cdot 29{,}85 + 16{,}75 = \boxed{26{,}7\,V}$$

(VIDI DODATAK 4.1*)

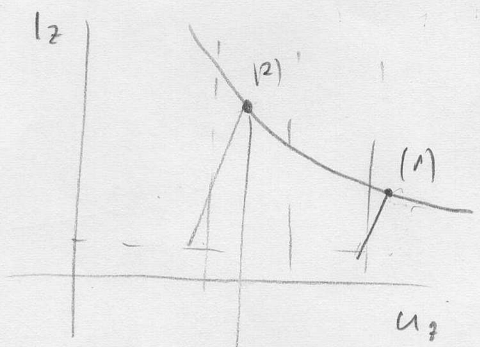
(5) – nastavak

– iako ima logike da se $R_{S\,max}$ određuje iz $I_{Z\,MIN}$ ($U_{Z\,MAX}$) kada se traži $R_{S\,min}$ ide se suprotnim putem (zbog disipacije kao kriterija, a ne mogućnosti rada); tada se uzima $U_{Z\,min}$ i $I_{Z\,MAX}$

– drugim riječima, kvadratna j-džba za P_{MAX} uz pretpostavku $U_{Z0\,MAX} = U_{Zd}$ da je povoljnije rješenje, tj. veći U_1 uz dani R_S!

– ako se postavi:

$$\begin{cases} P_{max} = U_{Z\,MAX} \cdot I_{Z\,MAX} \\ U_{Z\,max} = U_{Z0,\,MIN} + r_d\,(I_{Z\,max(min)} - I_{Z\,min}) \end{cases}$$



dobije se:

$$\Rightarrow U_{Z\,max} = \frac{P_{MAX}}{I_{Z\,max}} = 13{,}81\,V$$

$I_{Z\,MAX} = 36{,}2\,mA$ ($I_{Z\,max} = 29{,}85\,mA$)

→ uz takve uvjete (odabrani ZD s $U_{Z0\,min}$), max. dozv. napon na ulazu je (uz konst R_S):

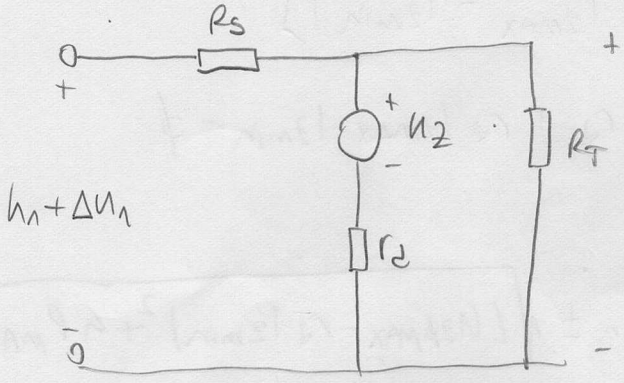
$$U_{1\,max} = R_S\,(I_{Z\,max} + \underbrace{0}_{I_{T\,MIN}}) + \overset{13{,}81\,V}{U_{Z\,max}} =$$

$$= R_S\; 0{,}33\,k\Omega \cdot 36{,}2\,mA + 0{,}5 \cdot 15\,V =$$

$$= \boxed{25{,}86\,V}$$ → to je max. dozv. napon

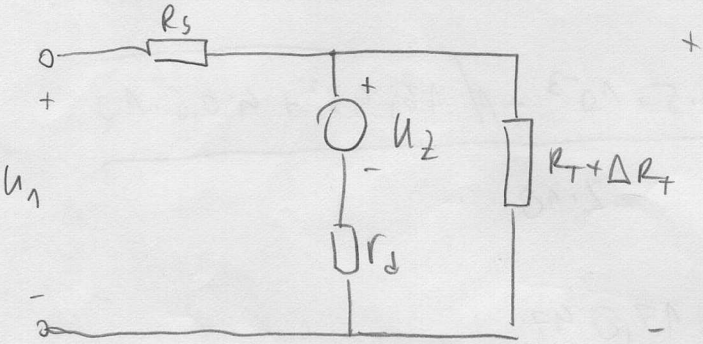
c) definicije faktora stabilizacije

NAPONSKA STAB.



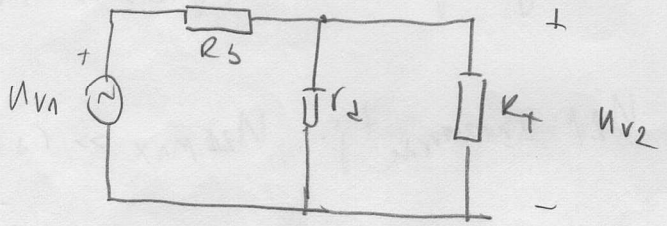
$$K_u = \frac{\frac{dU_1}{U_1}}{\frac{dU_2}{U_2}}$$

STRUJNA STAB.



$$K_i = \frac{\frac{dR_T}{R}}{\frac{dU_2}{U_2}}$$

GUŠENJE NAPONA VALOVITOSTI



$K_V =$ 

$$K_u = \frac{\frac{\Delta U_1}{U_1}}{\frac{\Delta U_2}{U_2}}$$ – koliko puta relativna promj. stabilizirane izl. napona U_2 manja od promj. ulaznog napona U_1

$K_u = 2$

(1) $$\frac{U_1 - U_2}{R_S} = \frac{U_2 - U_2}{r_d} + \frac{U_2}{R_T} \quad / \downarrow \ (\text{tot. dif.}) \ (U_1, U_2 \text{ var})$$

$$\frac{dU_1}{R_S} - \frac{dU_2}{R_S} = \frac{dU_2}{r_d} + \frac{dU_2}{R_T}$$

STB - 3...

$$\frac{\Delta u_1}{R_S} = \Delta u_2 \left(\frac{1}{r_d} + \frac{1}{R_T} + \frac{1}{R_S} \right)$$

$$\frac{\Delta u_1}{\Delta u_2} = \left(1 + \frac{R_S}{r_d} + \frac{R_S}{R_T} \right) \Big/ \frac{u_2}{u_1}$$

$$K_u = \frac{\frac{\Delta u_1}{u_1}}{\frac{\Delta u_2}{u_2}} = \frac{u_2}{u_1} \left(1 + \frac{R_S}{r_d} + \frac{R_S}{R_T} \right) = \frac{15}{20} \left(1 + \frac{333}{10} + \frac{333}{3000} \right) =$$

$$= \boxed{25{,}81}$$

$$K_i = \frac{\frac{\Delta R_T}{R_T}}{\frac{\Delta u_2}{u_2}}$$ – koliko % rel. promj. struje; tj. napona puta manja od rel. promj. otpora (R_T)

$\Rightarrow$ (1) / d (tot. dif.) (u_2, R_T var.)

$$-\frac{\Delta u_2}{R_S} = \frac{\Delta u_2}{r_d} + \frac{\Delta u_2 R_T - u_2 \Delta R_T}{R_T^2}$$

$$\Delta u_2 \left(\frac{1}{r_d} + \frac{1}{R_S} + \frac{1}{R_T} \right) = \frac{u_2}{R_T^2} \Delta R_T$$

$$K_i = \frac{\frac{\Delta R_T}{R_T}}{\frac{\Delta u_2}{u_2}} = \frac{R_S R_T}{R_S} \left(\frac{1}{r_d} + \frac{1}{R_S} + \frac{1}{R_T} \right) =$$

$$= \frac{R_T}{R_S} \left(1 + \frac{R_S}{r_d} + \frac{R_S}{R_T} \right)$$

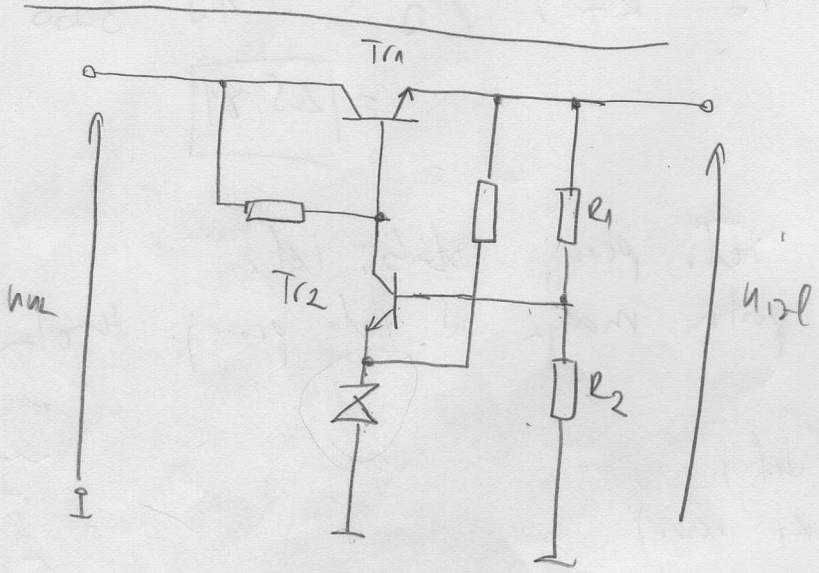
$$= \frac{3000}{333} \left(1 + \frac{333}{10} + \frac{333}{3000} \right) = \boxed{310}$$

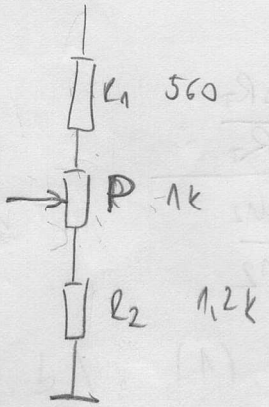
STB-4

Serijski stab. napona prikazan slikom koristi ZD nazivnog napona 5,6V kao izvor ref. napona.

a) Odredite omjer R_1/R_2 da bi U_{IZL} bio 8V

b) odredite max i min vrijednost izlaznog napona ako se na bazu tranzistora Tr_2 dovede napon s klizača potenciometra $P = 1k\Omega$, sporednog otpora $R_1 = 560\Omega$ i $R_2 = 1,2k$





$$U_{IZL} = U_Z + U_{BE_2} + \frac{R_1}{R_1+R_2} U_{IZL}$$

$$U_{IZL} = \frac{U_Z + U_{BE2}}{1 - \frac{R_1}{R_1+R_2}} = \frac{(U_Z + U_{BE2})(R_1+R_2)}{R_2}$$

a) $$\frac{R_2}{R_1+R_2} = \frac{U_Z + U_{BE2}}{U_{IZL}}$$

$$\boxed{\frac{R_1}{R_2}} = \frac{U_{IZL}}{U_Z+U_{BE2}} - 1 = \frac{8}{5,6+0,7} - 1 = \boxed{0,27}$$

b) $$\boxed{U_{IZL\,MAX}} = (U_Z + U_{BE2})\frac{R_1+R_2+P}{R_2} = \boxed{14,99V}$$

$$\boxed{U_{IZL\,min}} = (U_Z + U_{BE2})\frac{R_1+R_2+P}{R_2+P} = \boxed{7,9V}$$