Zadaci:

17. $f = 175$ MHz

BFS22: $Z_1 = 3.8 + j2.1\ \Omega$ $\quad Y_L = 39.7 - j25.8$ mS

$P_{out} = 0.5$ W $\quad P_{in} = 4$ W

BLY87: $Z_1 = 2.6 + j2.6\ \Omega$ $\quad Y_L = 64.5 - j32.9$ mS

$P_{out} = 1$ W $\quad P_{in} = 8$ W

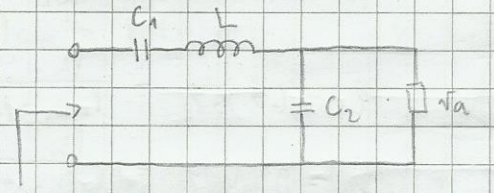
$U_{cc} = 13.5$ V

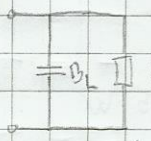
$r_a = 50\ \Omega \rightarrow P_{in} = 8$ W

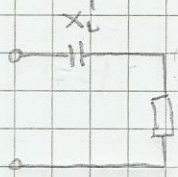
$Q_1 = 7$

$Q_2 = 10$

$C_1, C_2, L = ?$







$Y_L = 64.5 - j32.9$ mS

$X_L = \frac{1}{B_L} = \frac{1}{-0.0329}$

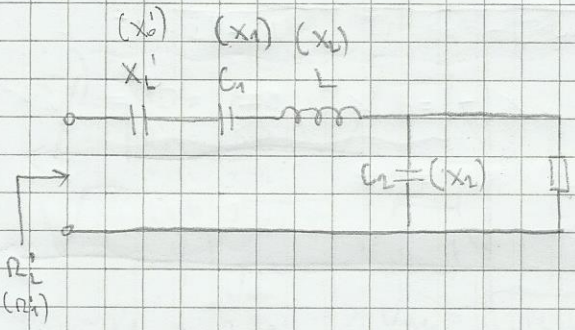
$X_L = -30.4\ \Omega$

$R_L = \frac{1}{G_L} = \frac{1}{0.0645}$

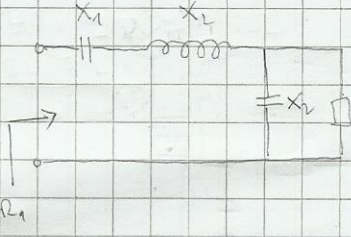
$R_L = 15.5\ \Omega$

$X'_L = \frac{R_L^2 X_L}{R_L^2 + X_L^2} = -6.27\ \Omega$

$R'_L = \frac{R_L X_L^2}{R_L^2 + X_L^2} = 12.3\ \Omega$



LS - četveropol:



$X_1 = QR'_1 - X'_L \Rightarrow X_1 = Q_1 R'_L - X'_L = 10 \cdot 12.3 - 6.27 = 116.73\ \Omega$

$X_1 = \frac{1}{2\pi f C_1} \Rightarrow C_1 = \frac{1}{2\pi f X_1} = \frac{1}{2\pi \cdot 175 \cdot 10^6 \cdot 116.73}$

$C_1 = 7.79$ pF

$X_2 = \frac{R_2}{\sqrt{\frac{R_1 R_2}{X_2^2} + \frac{R_2}{R_1} - 1}} \Rightarrow X_2 = \frac{r_a}{\sqrt{\frac{R_L r_a}{X_L^2} + \frac{r_a}{R_L} - 1}} = \frac{50}{\sqrt{\frac{15.5 \cdot 50}{(-30.4)^2} + \frac{50}{15.5} - 1}} = 28.56\ \Omega$

$X_2 = \frac{1}{2\pi f C_2} \Rightarrow C_2 = \frac{1}{2\pi f X_2} = \frac{1}{2\pi \cdot 175 \cdot 10^6 \cdot 28.56}$

$C_2 = 31.84$ pF

$X_L = QR'_1\left(1 + \frac{R_2}{QX_2}\right) \Rightarrow X_L = Q_2 \cdot R'_L\left(1 + \frac{r_a}{Q_2 \cdot X_2}\right) = 10 \cdot 12.3\left(1 + \frac{50}{10 \cdot 28.56}\right)$

$X_L = 144.53\ \Omega$

$X_L = 2\pi f L \Rightarrow L = \frac{X_L}{2\pi f} = \frac{144.53}{2\pi \cdot 175 \cdot 10^6}$

$L = 131.44$ nH

18.

$R_2 = 50\ \Omega$ $\quad C_s = 237.8\ nF$

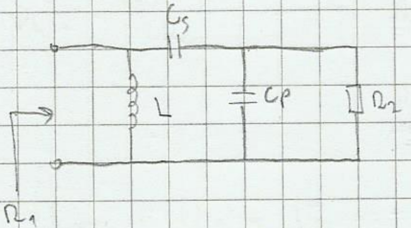
$P_{iz} = 8\ W$ $\quad C_p = 31.2\ nF$

$f = 900\ kHz$

$U_s = 1\ V$ $\quad U_{cc} = 9\ V$

$Q \geq 9$

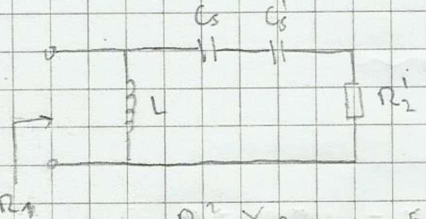
$n = ?$ $\quad Q = ?$ $\quad L = ?$



$R_1 = n^2 \cdot R_c$

$$P_{iz} = U_{iz} \cdot I_{iz} = U_{iz} \cdot \frac{U_{iz}}{R_c} = \frac{U_{iz}^2}{R_c} = \frac{\left(\frac{U_{cc} - U_s}{\sqrt{2}}\right)^2}{R_c} = \frac{(U_{cc}-U_s)^2}{2R_c} \Rightarrow R_c = \frac{(U_{cc}-U_s)^2}{2P_{iz}}$$

$$R_c = \frac{(9-1)^2}{2 \cdot 8} = 4\ \Omega$$



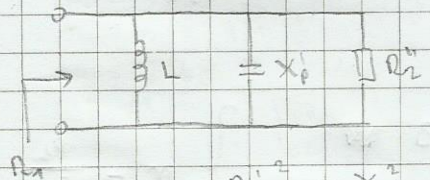
$$X_{cp} = -\frac{1}{2\pi f C_p} = -\frac{1}{2\pi \cdot 900 \cdot 10^3 \cdot 31.2 \cdot 10^{-9}} = -5.67$$

$$X_{cs} = -\frac{1}{2\pi f C_s} = -\frac{1}{2\pi \cdot 900 \cdot 10^3 \cdot 237.8 \cdot 10^{-9}} = -0.74$$

$$X_{cs}' = \frac{R_2^2\, X_{cp}}{R_2^2 + X_{cp}^2} = \frac{50^2 \cdot (-5.67)}{50^2 + (-5.67)^2} = -5.6\ \Omega$$

$$R_2' = \frac{R_2 \cdot X_{cp}^2}{R_2^2 + X_{cp}^2} = \frac{50 \cdot (-5.67)^2}{50^2 + (-5.67)^2} = 0.63\ \Omega$$

$$X_{uk} = X_{cs} + X_{cs}' = -0.74 - 5.6 = -6.34\ \Omega$$



$$X_p' = \frac{R_2'^2 + X_{uk}^2}{X_{uk}} = \frac{0.63^2 + (-6.34)^2}{-6.34} = -6.4\ \Omega$$

$$R_2'' = \frac{R_2'^2 + X_{uk}^2}{R_2'} = \frac{0.63^2 + (-6.34)^2}{0.63} = 64.43\ \Omega$$

* želimo dobiti čisti otpor $\Rightarrow B_{uk} = 0$

$$X_L = -X_p' = 6.4\ \Omega$$

$$X_L = 2\pi f L \Rightarrow L = \frac{X_L}{2\pi f} = \frac{6.4}{2\pi \cdot 900 \cdot 10^3}$$

$$L = 1.13\ \mu H$$

$$R_1 = R_2'' = 64.43\ \Omega$$

$$R_1 = n^2 R_c \Rightarrow n = \sqrt{\frac{R_1}{R_c}} = \sqrt{\frac{64.43}{4}}$$

$$n = 4$$

$$Q = \frac{R_1}{X_L} = \frac{n^2 R_c}{X_L} = \frac{4^2 \cdot 4}{6.4}$$

$$Q = 10$$

23. $f = 600$ kHz Inlaza D

$U_s = 1.2$ V

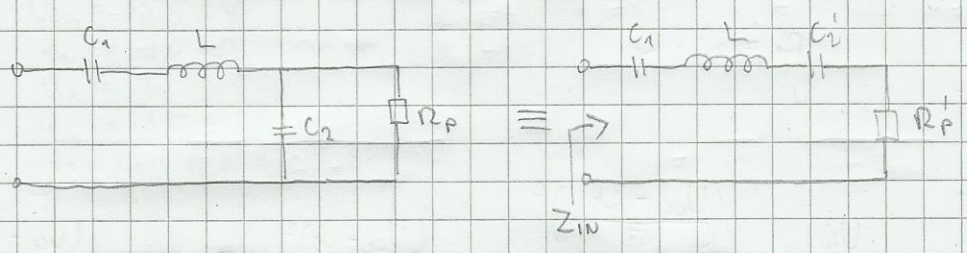
$U_{cc} = 18$ V

$C_1 = 2.6$ mF

$C_2 = 10$ mF

$R_p = 50\ \Omega$

$L = ?$	$P_h = ?$	$\eta = ?$	$U_m = ?$	$P_{dc} = ?$



$$X_{C_1} = -\frac{1}{2\pi f C_1} = -\frac{1}{2\pi \cdot 600 \cdot 10^3 \cdot 2.6 \cdot 10^{-3}} = -102.02\ \Omega$$

$$X_{C_2} = -\frac{1}{2\pi f C_2} = -\frac{1}{2\pi \cdot 600 \cdot 10^3 \cdot 10 \cdot 10^{-9}} = -26.53\ \Omega$$

$$X_{C_2}' = \frac{R_p^2 \cdot X_{C_2}}{R_p^2 + X_{C_2}^2} = \frac{50^2 \cdot (-26.53)}{50^2 + (-26.53)^2} = -20.7\ \Omega$$

$$R_p' = \frac{R_p \cdot X_{C_2}^2}{R_p^2 + X_{C_2}^2} = \frac{50 \cdot (-26.53)^2}{50^2 + (-26.53)^2} = 10.98\ \Omega$$

$$X_{IN} = 0 \Rightarrow X_L = -X_{C_1} - X_{C_2}' = 102.02 + 20.7 = 122.72\ \Omega$$

$$X_L = 2\pi f L \Rightarrow L = \frac{X_L}{2\pi f} = \frac{122.72}{2\pi \cdot 600 \cdot 10^3}$$

$$\underline{L = 32.55\ \mu H}$$

* Inlaza D, kvadratni mod

$$P_h = \frac{2}{\pi^2 R_p'}(U_{cc} - 2U_s)^2 = \frac{2}{\pi^2 \cdot 10.98}(18 - 2 \cdot 1.2)^2 = 4.49\ W$$

$$P_{cc} = \frac{2}{\pi^2 R_p'} U_{cc}(U_{cc} - 2U_s) = \frac{2}{\pi^2 \cdot 10.98} \cdot 18(18 - 2 \cdot 1.2) = 5.18\ W$$

$$\eta = \frac{P_h}{P_{cc}}$$

$$\eta = \frac{4.49}{5.18} = 0.867$$

$$\underline{\eta = 86.7\ \%}$$

$$P_h = \frac{U_m^2}{2R_p} \Rightarrow U_m = \sqrt{2 R_p P_h} = \sqrt{2 \cdot 50 \cdot 4.49}$$

$$\underline{U_m = 21.19\ V}$$

$$P_{dc} = P_{cc} - P_h = 5.18 - 4.49 = 0.69\ W$$

$$P_{dc_1} = P_{dc_2} = \frac{P_{dc}}{2} = \frac{0.69}{2}$$

$$\underline{P_{dc_1} = P_{dc_2} = 0.345\ W}$$

24. $U_{cc} = 15\ V$ — klasa A
$P_h = 1\ W$ — gr. pol. pracy $\Rightarrow \Theta = 180°$
$U_s = 2\ V$
$R_c = ?$ $U_{cmax} = ?$ $\eta = ?$
$I_{cmax} = ?$

$$P_h = \frac{(U_{cc} - U_s)^2}{2R_c} \Rightarrow R_c = \frac{(U_{cc} - U_s)^2}{2P_h} = \frac{(15-2)^2}{2 \cdot 1}$$

$$R_c = 84.5\ \Omega$$

$$U_{cmax} = U_{cc} + U_m = U_{cc} + (U_{cc} + U_s) = 2U_{cc} - U_s = 2 \cdot 15 - 2$$

$$U_{cmax} = 28\ V$$

$$P_h = \frac{I_{cm}^2 R_c}{2} \Rightarrow I_{cm} = \sqrt{\frac{2P_h}{R_c}} = \sqrt{\frac{2 \cdot 1}{84.5}} = 153.8\ mA$$

$$I_{cmax} = I_{cstm} \cdot f_1(\Theta) \Rightarrow I_{cstm} = \frac{I_{cm}}{f_1(\Theta)} = \frac{153.8}{0.5}$$

$$I_{cstm} = 307.6\ mA$$

$$P_{cc} = U_{cc} \cdot I_{cs} = U_{cc} \cdot I_{cstm} \cdot f_0(\Theta) = 15 \cdot 0.3076 \cdot 0.5 = 2.307\ W$$

$$\eta = \frac{P_h}{P_{cc}} = \frac{1}{2.307} \Rightarrow \eta = 43.35\ \%$$

25. $P_h = 100\ W$ — klasa B
$R_p = 50\ \Omega$ — gr. pol. pracy $\Rightarrow \Theta = 90°$
$n_1 : n_2 = 1 : 3$
$U_s = 2.65\ V$
$U_{cc} = ?$ $U_{cmax} = ?$ $\eta = ?$
$I_{cstm} = ?$

$$P_h = \frac{U_{ms}^2}{2R_p} \Rightarrow U_{ms} = \sqrt{2R_p P_h} = \sqrt{2 \cdot 50 \cdot 100}$$

$$U_{ms} = 100\ V$$

$$U_{mp} = \frac{n_1}{n_2} U_{ms} = \frac{1}{3} \cdot 100$$

$$U_{mp} = 33.33\ V$$

$$U_{cc} = U_{mp} + U_s = 33.33 + 2.65$$

$$U_{cc} = 36\ V$$

$$P_h = \frac{I_m^2 R_p}{2} \Rightarrow I_m = \sqrt{\frac{2P_h}{R_p}} =$$

$$I_{cmax} = \frac{n_2}{n_1} I_m = 3 \cdot 2 = 6\ A$$

$$U_{cmax} = U_{cc} + U_{mp} = 36 + 33.33$$

$$I_{cmax} = I_{cstm} \cdot f_1(\Theta) \Rightarrow I_{cm} = \frac{I_{cmax}}{f_1(\Theta)}$$

$$U_{cmax} = 69.33\ V$$

$$I_{cstm} = \frac{6}{0.5} = 12\ A$$

$$\eta = \frac{P_h}{P_{cc}} = \frac{P_h}{U_{cc} \cdot I_{cstm} \cdot f_0(\Theta)} = \frac{100}{36 \cdot 12 \cdot 0.318} = 0.728$$

$$\eta = 72.8\ \%$$

26. $P_{iz} = 300$ W   klasa D, naponski spoj

$f = 13.56$ MHz

$U_{DD} = 75$ V

$r_{DSon} = 0.085$ Ω

$C_D = 500$ pF

$U_{D\,max} = 100$ V

$I_{D\,max} = 25$ A

$R_p = ?$ $P_{d,uk} = ?$ $\eta = ?$ $\eta = ?$ ako $f' = 1.3$ MHz

$I_{d\,max} = ?$ zanemarivi gubici $P_{DD} = ?$

$$P_{iz} = \frac{2}{\pi^2} \cdot \frac{R_p U_{DD}^2}{(R_p + r_{DSon})^2} \qquad P_{DD} = \frac{2}{\pi^2} \cdot \frac{U_{DD}^2}{R_p + r_{DSon}}$$

* zanemareni gubici:

$$P_{iz} = \frac{2}{\pi^2} \cdot \frac{R_p U_{DD}^2}{R_p^2} = \frac{2}{\pi^2} \cdot \frac{U_{DD}^2}{R_p} \Rightarrow R_p = \frac{2}{\pi^2} \cdot \frac{U_{DD}^2}{P_{iz}} = \frac{2}{\pi^2} \cdot \frac{75^2}{300}$$

$$R_p = 3.8\ \Omega$$

$$I_{d\,max} = \frac{2}{\pi} \cdot \frac{U_{DD}}{R_p} = \frac{2}{\pi} \cdot \frac{75}{3.8}$$

$$I_{d\,max} = 12.56\ A$$

* uz gubitke:

- gubici zbog C_D:

$$P_d = 4 C_D U_{DD}^2 f = 4 \cdot 500 \cdot 10^{-12} \cdot 75^2 \cdot 13.56 \cdot 10^6$$

$$P_d = 152.55\ W$$

- gubici zbog r_{DSon}:

$$P_{DD} - P_{iz} = \frac{2}{\pi^2} U_{DD}^2 \frac{r_{DSon}}{(R_p + r_{DSon})^2} = \frac{2}{\pi^2} \cdot 75^2 \cdot \frac{0.085}{(3.8 + 0.085)^2}$$

$$P_{DD} - P_{iz} = 6.42\ W$$

$$P_{duk} = P_d + P_{DD} - P_{iz} = 152.55 + 6.42$$

$$P_{duk} = 158.97\ W$$

$$\eta = \frac{P_{iz}}{P_{duk} + P_{iz}} = \frac{300}{300 + 158.97} = 0.6536$$

$$\eta = 65.36\%$$

$f' = 1.3$ MHz $\Rightarrow$ $P_d' = 4 \cdot 500 \cdot 10^{-12} \cdot 75^2 \cdot 1.3 \cdot 10^6$

$$P_d' = 14.625\ W$$

$$P_{duk}' = P_d' + P_{DD} - P_{iz} = 14.625 + 6.42$$

$$P_{duk}' = 21.045\ W$$

$$\eta' = \frac{P_t}{P_{disip} + P_t} = \frac{300}{21.045 + 300} = 0.9344$$

$$\eta = 93.44\ \%$$

28. $P_t = 100\ W$

$R_p = 50\ \Omega$

$U_{DSS} = 100\ V$

$I_{Dmax} = 25\ A$

klasa D s pravokutnim oblikom napona

mogu li se koristiti tranzistori = ?

$$P_t = \frac{8}{\pi^2} \cdot \frac{R_p \cdot U_{DD}^2}{(R_p + \underbrace{r_{DSon}}_{=0})^2} = \frac{8}{\pi^2} \cdot \frac{U_{DD}^2}{R_p} \Rightarrow U_{DD} = \sqrt{\frac{\pi^2}{8} R_p P_t} = \sqrt{\frac{\pi^2}{8} \cdot 50 \cdot 10}$$

$$U_{DD} = 78.54\ V$$

$U_{Dmax} = 2 U_{DD} = 157.08\ V$ $\boxed{>}$ $U_{DSS} = 100\ V \Rightarrow$ ne mogu se koristiti tran

$I_{Dtom} = I_{Dmax} = \frac{4 U_{DD}}{\pi R_p} = \frac{4 \cdot 78.54}{\pi \cdot 50} = 2\ A$ $\boxed{<}$ $I_{Dmax} = 25\ A$ ✓