IR2OAE, IR3OAE Osnovi analogne elektronike - rešenja zadataka, kolokvijum 2014:

**1**. Beleške za predavanja, „2_Dioda.pdf“, slajdovi 35, 37 i 39.

a) $v_{peff} = \left(240 \cdot \sqrt{2}/10\right) - V_D = 240 \cdot \sqrt{2}/10$;

b) $v_{peff} = 24\text{V}$.

2. Beleške za predavanja, „3_Bipolarni_tranzistor.pdf“, slajdovi 18 i 25.

3.

a)

$V_{GS2} = V_{GS1} \Rightarrow I_{M2} = I_{M1} \Rightarrow I_{IZL} = I_{REF} = 20\,\mu\text{A}$

$V_{I\min} = 2\sqrt{2I_{IZL}/B} + V_T = 2\text{V}$

b)

$v_{g4} = -g_{m1} r_{ds1} v_{gs1} \qquad v_{s4} = v_{gs1} \qquad v_{gs4} = -\left(1 + g_{m1} r_{ds1}\right) v_{gs1}$

$v_{gs1} = \left(\frac{1}{g_{m2}} \| r_{ds2}\right) i_t$

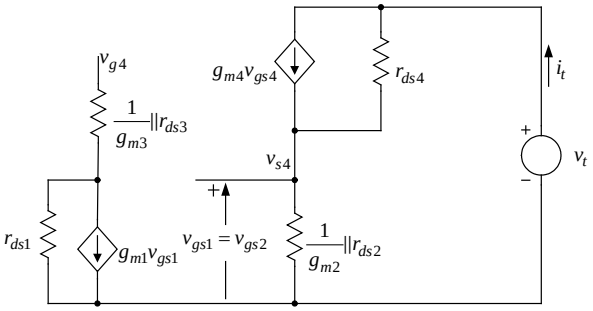
$v_t = v_{gs1} - g_{m4} r_{ds4} v_{gs4} + r_{ds4} i_t$

$v_t = \left(\frac{1}{g_{m2}} \| r_{ds2}\right) i_t + g_{m4} r_{ds4} \left(1 + g_{m1} r_{ds1}\right) \left(\frac{1}{g_{m2}} \| r_{ds2}\right) i_t + r_{ds4} i_t$

$R_{izl} = \frac{v_t}{i_t} = \left[1 + g_{m4} r_{ds4} \left(1 + g_{m1} r_{ds1}\right)\right] \left(\frac{1}{g_{m2}} \| r_{ds2}\right) + r_{ds4}$

$g_m = \sqrt{2 I_{IZL} B} = 80\,\mu\text{S} \qquad g_m r_{ds} = 8$

$R_{izl} = 73 \times 11{,}11\,\text{k}\Omega + 100\,\text{k}\Omega = 911{,}11\,\text{k}\Omega$




4.

I $-10\text{V} \le v_U < -V_D$, DZ direktno polarisana, M1 isključen

$$i_Z = \frac{v_U + V_D}{R_G}$$
$$i_D = 0$$
$$v_I = V_{DD}$$

II $-V_D \le v_U < V_T$, DZ je isključena, M1 isključen

$$i_Z = 0$$
$$i_D = 0$$
$$v_I = V_{DD}$$

III $V_T \le v_U < V_Z$, DZ je isključena, M1 vodi u zasićenju (po uslovu zadatka)

$$i_Z = 0$$
$$i_D = \frac{B}{2}(v_U - V_T)^2,\ i_D(V_Z) = 4\text{mA}$$
$$v_I = V_{DD} - i_D R_D$$

IV $V_Z < v_U \le 10\text{V}$, DZ inverzno polarisana i vodi u proboju, M1 vodi u zasićenju (po uslovu zadatka)

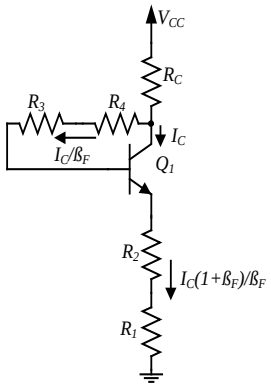
$$i_Z = \frac{v_U - V_Z}{R_G}$$
$$i_D = \frac{B}{2}(V_Z - V_T)^2 = 4\text{mA}$$
$$v_I = V_{DD} - i_D R_D$$

Potrebno je obezbediti da tranzistor ne ulazi u triodnu oblast odnosno da važi:

$$v_{DG1} \geq -V_T \Rightarrow V_{DD} - i_D R_D - V_Z \geq -V_T$$

$$R_D \leq \frac{V_{DD} + V_T - V_Z}{i_D} = 1.425\text{k}\Omega$$

5.




a) $$I_C = \frac{V_{CC} - V_{BE}}{(1+\frac{1}{\beta_F})R_C + (R_3 + R_4)\frac{1}{\beta_F} + \frac{(1+\beta_F)}{\beta_F}(R_2 + R_1)} = 937\mu\text{A}$$

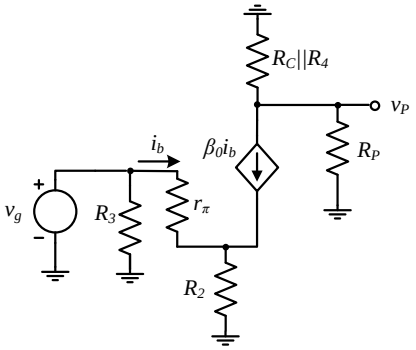
$$V_{CE} = V_{BE} + (R_3 + R_4)\frac{I_C}{\beta_F} = 1.07\text{V} > V_{CES}$$

b) $$r_\pi = \frac{\beta_0 V_T}{I_C} = 5.34\text{k}\Omega$$

$$v_P = -\beta_0 i_b (R_C \parallel R_4 \parallel R_P)$$

$$i_b = \frac{v_g}{r_\pi + (1+\beta_0)R_2}$$

$$a_v = \frac{v_p}{v_g} = -\frac{\beta_0 (R_C \parallel R_4 \parallel R_P)}{r_\pi + (1+\beta_0)R_2} = -16.5$$




$$a_i = \frac{i_p}{i_g} = \frac{v_p}{R_p}\frac{R_3 \parallel (r_\pi + (1+\beta_0)R_2)}{v_g}$$

$$a_i = a_v \frac{R_3 \parallel (r_\pi + (1+\beta_0)R_2)}{R_p} = -15.5$$

c) $R_u = R_3 \parallel (r_\pi + (1+\beta_0)R_2) = 11.76\text{k}\Omega$

d) $R_i = R_C \parallel R_4 = 1.46\text{k}\Omega$