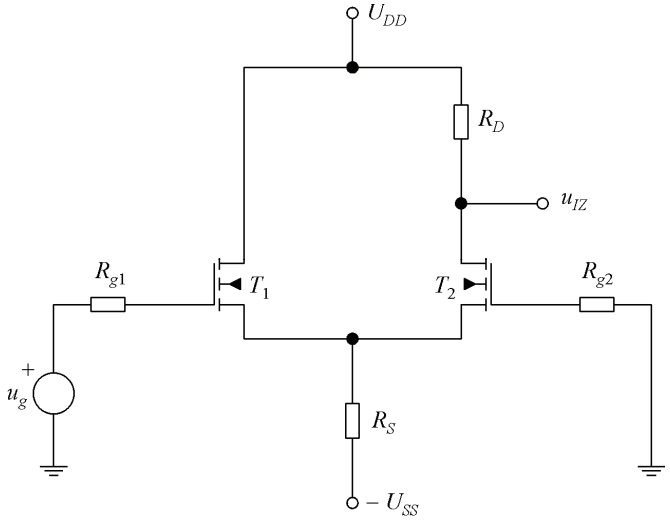
Međuispit iz "Elektronike 2" - rješenja

Zadaci

1. zadatak



$$I_{DQ1} = \frac{U_{SS} - U_{GSQ1}}{2R_S} = \frac{K}{2}\left(U_{GSQ1} - U_{GS0}\right)^2,$$

$$10 \cdot U_{GSQ1}^2 - 19 \cdot U_{GSQ1} - 2 = 0 \quad \rightarrow \quad U_{GSQ1} = 2\ \text{V} = U_{GSQ2},$$

$$I_{DQ1} = I_{DQ2} = \frac{U_{SS} - U_{GSQ1}}{2R_S} = 2\ \text{mA},$$

$$U_{DSQ1} = U_{DD} + U_{SS} - 2R_S I_{DQ1} = 14\ \text{V}, \quad U_{DSQ2} = U_{DD} + U_{SS} - \left(R_D + 2R_S\right) I_{DQ2} = 10\ \text{V},$$

$$g_{m2} = = K\left(U_{GSQ2} - U_{GS0}\right) = 4\ \text{mA/V}, \quad r_{d2} \rightarrow \infty$$

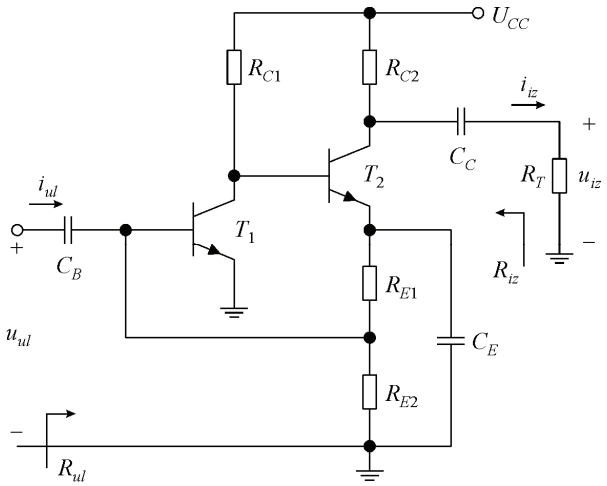
$$A_{Vz} = \frac{u_{iz}}{u_z} = \frac{-g_{m2} R_D}{1 + 2g_{m2} R_S} = -0{,}38, \; A_{Vd} = \frac{u_{iz}}{u_d} = \frac{-g_{m2} R_D}{2} = -4,$$

$$\rho = \frac{\left|A_{Vd}\right|}{\left|A_{Vz}\right|} = 10{,}5,$$

$$U_{zm} = \frac{U_{gm} + 0}{2} = 125\ \text{mV}, \; U_{dm} = 0 - U_{gm} = -250\ \text{mV},$$

$$U_{izm} = A_{Vz} U_{zm} + A_{Vd} U_{dm} = 952\ \text{mV}, \; u_{iz} = 952 \sin \omega t\ \text{mV}.$$

2. zadatak

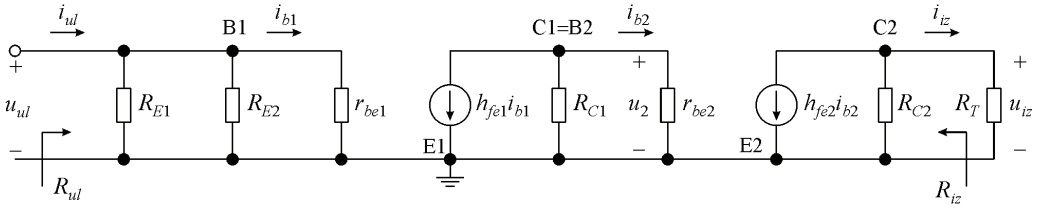


$$I_{CQ2} \approx \frac{U_{BEQ1}}{R_{E2}} = 2{,}5 \text{ mA},$$

$$U_{CC} \approx I_{CQ1} R_{C1} + U_{BEQ2} + I_{CQ2}\left(R_{E1} + R_{E2}\right) \quad \rightarrow \quad I_{CQ1} = 2{,}03 \text{ mA},$$

$$U_{CEQ1} \approx U_{CC} - I_{CQ1} R_{C1} = 3{,}9 \text{ V}, \; U_{CEQ2} \approx U_{CC} - I_{CQ2}\left(R_{C2} + R_{E1} + R_{E2}\right) = 3{,}8 \text{ V},$$

$$r_{be1} = \frac{U_T}{I_{BQ1}} = \frac{\beta U_T}{I_{CQ1}} = 1{,}23 \text{ k}\Omega, \; r_{be2} = \frac{U_T}{I_{BQ2}} = \frac{\beta U_T}{I_{CQ2}} = 1 \text{ k}\Omega,$$



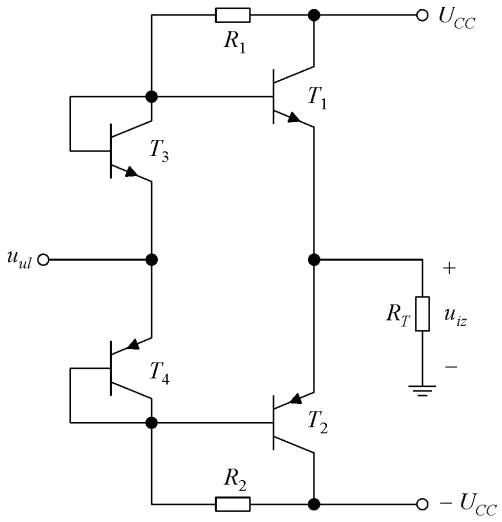
$$A_{V2} = \frac{u_{iz}}{u_2} = -\, h_{fe} \frac{R_{C2} \| R_T}{r_{be2}} = -\, 40, \; A_{V1} = \frac{u_2}{u_{ul}} = -\, h_{fe}\, h_{fe} \frac{R_{C1} \| r_{be2}}{r_{be1}} = -\, 65,$$

$$A_V = \frac{u_{iz}}{u_{ul}} = A_{V2}\, A_{V1} = 2600,$$

$$R_{ul} = \frac{u_{ul}}{i_{ul}} = R_{E1} \| R_{E2} \| r_{be1} = 186 \; \Omega, \; A_I = \frac{i_{iz}}{i_{ul}} = \frac{u_{iz} / R_T}{u_{ul} / R_{ul}} = A_V \frac{R_{ul}}{R_T} = 967,$$

$$R_{iz} = R_{C2} = 2 \text{ k}\Omega.$$

3. zadatak



$$P_{RT} = \frac{U_{izm}^2}{2\,R_T} \quad \rightarrow \quad U_{izm} = 8\ \text{V}\,,$$

$$U_{izm} = \left(U_{CC} - U_{BE}\right)\frac{(1+\beta)\,R_T}{R_1 + (1+\beta)\,R_T} \quad \rightarrow \quad R_1 = 267\ \Omega = R_2\,,$$

$$I_{RQ1} = \frac{U_{CC} - U_{BEQ}}{R_1} = 42\ \text{mA}\,,$$

$$I_{RQ1} = I_{BQ3} + I_{CQ3} + I_{BQ1} = \frac{2+\beta}{\beta} I_{CQ3} \quad \rightarrow \quad I_{CQ3} = 41\ \text{mA} = I_{CQ1}\,,$$

$$P_{T3} = U_{BEQ}\left(I_{BQ3} + I_{CQ3}\right) = 29\ \text{mW}\,,$$

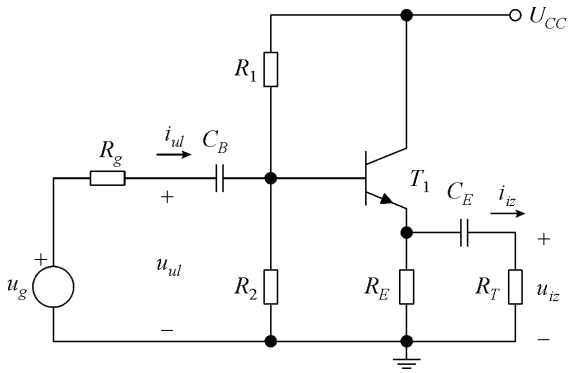
$$P_{T1} = U_{CC}\,I_{CQ1} + \frac{P_{CC} - P_{RT}}{2} = U_{CC}\,I_{CQ1} + U_{CC}\frac{I_{cm}}{\pi} - R_T\frac{I_{cm}^2}{4}\,,$$

$$\text{za } I_{cm} = 0 \quad \rightarrow \quad P_{T1} = P_{T1\min} = U_{CC}\,I_{CQ1} = 0{,}49\ \text{W}\,,$$

$$\frac{\partial P_{T1}}{\partial I_{cm}} = \frac{U_{CC}}{\pi} - R_T\frac{I_{cm}}{2} \equiv 0 \quad \rightarrow \quad I_{cm|P_{T1\max}} = \frac{2}{\pi}\frac{U_{CC}}{R_T}\,,$$

$$\text{za } I_{cm} = \frac{2}{\pi}\frac{U_{CC}}{R_T} \quad \rightarrow \quad P_{T1} = P_{T1\max} = U_{CC}\,I_{CQ1} + \frac{U_{CC}^2}{\pi^2\,R_T} = 2{,}32\ \text{W}\,.$$

4. zadatak

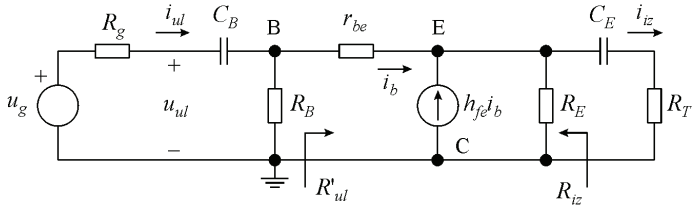


$$U_{BB} = \frac{R_2}{R_1 + R_2} U_{CC} = 8 \text{ V} \,,\; R_B = R_1 \left\| R_2 \right. = 100 \text{ k}\Omega \,,$$

$$I_{BQ} = \frac{U_{BB} - U_{BEQ}}{R_B + (1+\beta) R_E} = 14{,}5 \text{ μA} \,,\; I_{CQ} = \beta I_{BQ} = 1{,}45 \text{ mA} \,,$$

$$U_{CEQ} \approx U_{CC} - R_E I_{CQ} = 6{,}2 \text{ V} \,,$$

$$r_{be} = \frac{U_T}{I_{BQ}} = 1{,}72 \text{ k}\Omega \,,$$



$$\frac{U_{iz}}{U_{ul}} = \frac{(1+h_{fe})(R_E \left\| R_T \right.)}{r_{be} + (1+h_{fe})(R_E \left\| R_T \right.)} = 0{,}979 \,,\; R'_{ul} = r_{be} + (1+h_{fe})(R_E \left\| R_T \right.) = 82{,}5 \text{ k}\Omega \,,$$

$$\frac{U_{ul}}{U_g} = \frac{R_B \left\| R'_{ul} \right.}{R_g + R_B \left\| R'_{ul} \right.} = 0{,}989 \,,\; A_{Vg0} = \frac{U_{iz}}{U_g} = \frac{U_{iz}}{U_{ul}} \frac{U_{ul}}{U_g} = 0{,}968 \,,$$

$$\tau_B = \left(R_g + R_B \left\| R'_{ul} \right. \right) C_B = 22{,}9 \text{ ms} \,,\; \omega_B = \frac{1}{\tau_B} = 43{,}7 \text{ rad/s} \,,$$

$$\tau_E = \left(\frac{r_{be} + R_g \left\| R_B \right.}{1 + h_{fe}} \middle\| R_E + R_T \right) C_E = 5{,}11 \text{ ms} \,,\; \omega_E = \frac{1}{\tau_E} = 196 \text{ rad/s} \,,$$

$$\omega_d = \omega_E = 196 \text{ rad/s} \,,\; f_d = \frac{\omega_d}{2\pi} = 31{,}2 \text{ Hz} \,.$$