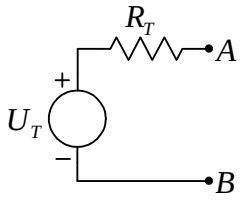
REŠENJA

1. a) $U_{AB} = -2R(I_{G1} + I_{G2})$

b) $U_T = -2R(I_{G1} + I_{G2})$

$R_T = 2R$



c) $P_{G1} = 2R(I_{G1} + I_{G2})I_{G1}$

d) $P_{5\Omega} = 0$

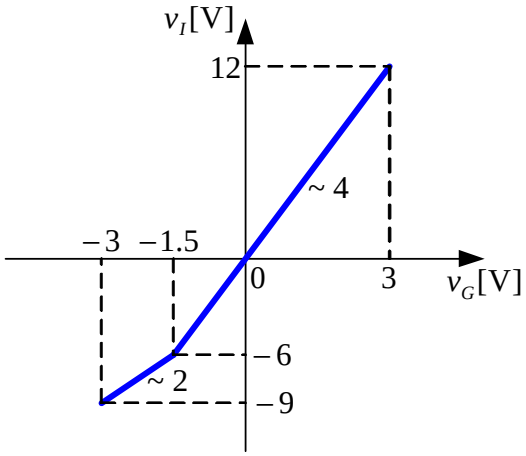
e) $|q| = \frac{4}{3}R(I_{G1} + I_{G2})C$

f) $R_P = R_T = 2R$

2.

$v_I[\mathrm{V}] = 2v_G[\mathrm{V}] - 3$, za $-3\mathrm{V} \le v_G \le -1{,}5\mathrm{V}$ (IOP-lin. režim, D-ON);

$v_I[\mathrm{V}] = 4v_G[\mathrm{V}]$, za $-1{,}5\mathrm{V} \le v_G \le 3\mathrm{V}$ (IOP-lin. režim, D-OFF).



3. Struje I_R je struja drejnova tranzistora M_1 i M_2 ($I_{D1} = I_{D2} = I_R$), pa oni sigurno rade (provode).
Tranzistor M_2 radi u zasićenju jer su mu drejn i gejt kratkospojeni ($V_{G2} = V_{D2} = V_I$).
Za tranzistor M_1važi$V_{GS1} = V_{G1} - V_{S1} = V_I - 0 = V_I$, dok je $V_{DS1} = V_I - V_{GS2}$.
Poznavajući struju drejna $I_{D2} = \frac{B_2}{2}(V_{GS2} - V_{TN})^2 = I_R$ možemo odrediti napon $V_{GS2} = V_{TN} + \sqrt{\frac{2I_D}{B_2}} = 1.3V$

Sada na osnovu napona V_{GS1} i V_{DS1} zaključujemo da važi $V_{DS1} < V_{GS1} - V_{TN}$ pa je tranzistor $\mathbf{M_1}$u triodnoj oblasti.

$I_{D1} = B_1((V_{GS1} - V_{TN})V_{DS1} - V_{DS1}^2/2$, zamenom izraza $V_{GS1} = V_I$ i $V_{DS1} = V_I - V_{GS2}$ u prethodnu jednačinu dobijamo $V_I^2 - 2V_I V_{TN} + 2V_{TN}V_{GS2} - V_{GS2}^2 - \frac{2I_R}{B_1} = 0$, tj. $V_I^2 - 2V_I + 0.64 = 0$. Dobijamo dva rešenja $V_I = 1.6V$ i $V_I = 0.4V$. Pošto je izlazni napon ujedno i napon gejt-sors tranzistora M_1 on mora biti veći od napona praga pa je tačno rešenje $V_I = 1.6V$.

4.

a)

$V_{GS} - V_T = \sqrt{20} = 4.47 \Rightarrow V_{GS} = 6.47\text{V}$

$(24\text{V} - 6.47\text{V}) / R_D = 1\text{mA} \Rightarrow R_D = 17.53\text{k}\Omega$

b)

$I_{B5} \approx 2\% \cdot 0.5\text{mA}=10=\mu\text{A}$

$I_{E5} = 101 \cdot I_{B5} \approx 1\text{mA} \Rightarrow V_I \approx 2\text{V}$

c)

$g_{m1} = g_{m2} = g_m = 20\text{mS}$

$g_{m5} = 40\text{mS}$

$a = \beta \cdot g_m \cdot R_E = 20\,000$

d)

$\frac{g_{m5} R_E}{1 + g_{m5} R_E} \approx 1 \Rightarrow a_1 \approx a$

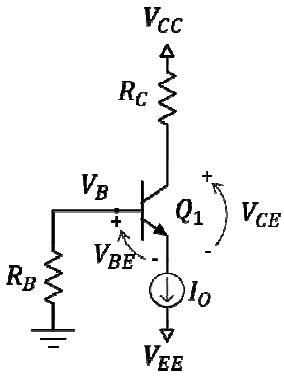
e) Sinusoida srednje vrednosti 2V amplitude 2V, sa negativnim predznakom

f) Dobija se jedinični pojačavač, AC signal je sinusoida amplitude 1V

5. a) $I_E = I_R = 1.01mA$ ->$I_B = \frac{I_E}{(\beta_f+1)} = 0.01mA$, $I_C = 1mA$

$V_E = V_{CC} - I_C R_C - V_{CE} = 0 - I_B R_B - V_{BE}$, ->$R_C = \frac{V_{CC} - V_{CE} + V_{BE} + I_B R_B}{I_C} = 5k\Omega$

$g_m = \frac{I_C}{V_t} = 0.04S$, $r_\pi = \frac{\beta_F}{g_m} = 2.5k\Omega$



b) $v_{be} = v_g \frac{R_B||r_\pi}{R_B||r_\pi + R_g}$, $v_p = -g_m v_{be} R_C||R_P$,

$a_v = \frac{v_p}{v_g} = -\frac{\frac{g_m R_C||R_P}{R_B||r_\pi + R_g}}{\frac{R_B||r_\pi}{R_B||r_\pi + R_g}} \approx -\frac{g_m R_C||R_P}{1+\frac{R_g}{r_\pi}} = -26.7$

c) $a_i = a_v \frac{R_g + R_B||r_\pi}{R_P} = -33.3$

d) $R_u = R_g + R_B||r_\pi \approx R_g + r_\pi = 12.5k\Omega$,

$R_i = R_C = 5k\Omega$