REŠENJA

4. a) Vz/R8=10mA→Vz=5V.

b) $\text{Vout}=-105\Omega\cdot 10\text{mA}\cdot 10=-10.5\text{V}$.

c) Kada je temperatura nula na izlazu treba da bude nula, prema tome Vref treba da bude jednako 10V.

d) Minimalni mogući napon na izlazu je –12V.

$-12\text{V}=-100\text{mV}\cdot T_{\max}/\,^{\circ}\text{C}\rightarrow T_{\max}=12\text{V}\cdot\,^{\circ}\text{C}/100\text{mV}=120\,^{\circ}\text{C}$

e) $I=10\text{mA}-\dfrac{10\text{mA}}{(1+\beta)^2}=10\text{mA}\left(1-\dfrac{1}{(1+\beta)^2}\right)$

5. a)

$B_1=B_2=B_3=B_4=2mA/V^2$

$I_{D1}=I_{D2}=I_{D3}=I_{D4}=I_R=1mA$

$V_{SG4}=|V_{T4}|+\sqrt{\dfrac{2I_{D4}}{B_4}}=2V$

$V_{GS1}=V_{T1}+\sqrt{\dfrac{2I_{D1}}{B_1}}=2V$

$V_{DD}-V_{SG4}-I_RR_R-V_{GS1}-V_{SS}=0$

$R_R=\dfrac{V_{DD}-V_{SG4}-V_{GS1}-VSS}{I_R}=20k\Omega$

b)

$g_{m3}=\sqrt{2I_{D3}B_3}=2mS$

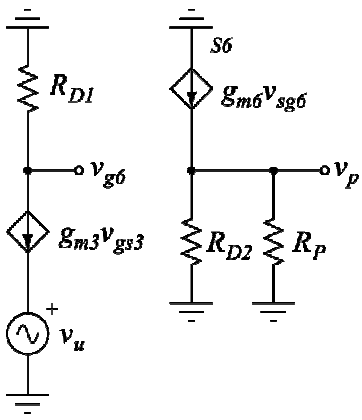
$g_{m6}=\sqrt{2I_{D6}B_6}=4mS$

$v_{gs3}=-v_u$

$v_{g6}=-g_{m3}v_{gs3}R_{D1}$

$v_p=g_{m6}g_{sg6}R_{D2}||R_p$

$A_v=-g_{m3}g_{m6}R_{D1}\cdot R_{D2}||R_p=-2mS\cdot 4mS\cdot 5k\Omega\cdot\dfrac{5k\Omega\cdot 15k\Omega}{20k\Omega}=-150$



c)

$i_u=-g_{m3}v_{gs3}=g_{m3}v_u$

$R_u=\dfrac{v_u}{i_u}=\dfrac{1}{g_{m3}}=500\Omega$

$A_v'=\dfrac{R_u}{R_u+R_{gen}}A_v=-150\dfrac{500\Omega}{500\Omega+500\Omega}=-75$

d)

$R_i=R_{D2}=5k\Omega$

6. a)

$I_C=\dfrac{V_{CC}-V_C}{R_C}=1.5mA$

$I_B=\dfrac{I_C}{\beta}=30\mu A$

$I_E=\dfrac{\beta+1}{\beta}I_C=1.53mA$

$V_{CC}-R_{B1}(I_B+I_{RB2})-V_{BE}-R_E(I_E+I_{RB2})=0$

$I_{RB2}=\dfrac{V_{CC}-R_{B1}I_B-V_{BE}-R_EI_E}{R_{B1}+R_E}\approx 0.68mA$

$R_{B2}=\dfrac{V_{BE}}{I_{RB2}}\approx 1.03k\Omega$

b)

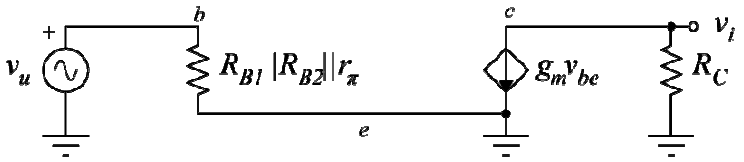
$$v_i = -g_m R_C v_{be} = -g_m R_C v_u$$

$$A_v = -g_m R_C = -\frac{I_C}{V_t} R_C = -120$$

$$i_i = \frac{v_i}{R_C} = -g_m v_u$$

$$i_u = \frac{v_u}{R_{B1} || R_{B2} || r_\pi}$$

$$A_i = \frac{i_i}{i_u} = -g_m R_{B1} || R_{B2} || r_\pi \approx -60mS \cdot 440\Omega \approx -26.4$$



c)

$$i_u = \frac{v_u}{R_{B1} || R_{B2} || r_\pi}$$

$$R_u = \frac{v_u}{i_u} = R_{B1} || R_{B2} || r_\pi \approx 440\Omega$$

$$A_v' = \frac{R_u}{R_u + R_{gen}} A_v \approx -62.85$$

$$v_u = 1mV \cdot \sin \omega t$$

$$v_i = A_v v_u = -120mV \cdot \sin \omega t$$

$$v_i' = A_v' v_u = -62.85mV \cdot \sin \omega t$$

7. a) Svi tranzistori imaju približno istu jednosmernu struju:

$g_m = 4mS$

$r_\pi = \beta / g_m = 25k\Omega$

b) Tačno rešenje se dobija ako se računaju bazne struje

$I_P = 100\mu A \cdot 0.99 \cdot 0.98 - 100\mu A \cdot 0.99 \cdot 0.98 \cdot 0.98 = 100\mu A \cdot 0.99 \cdot 0.98 \cdot 0.02 = 1.9\mu A$

$V_P = 19\text{uV}$

c) $a = -g_m \cdot R_P = -0.04$

d)

$\underline{V_{g1}} = 1\text{mV} / \sqrt{2}$

$\underline{V_{g2}} = \left(-2\text{mV} / \sqrt{2}\right)\left(\cos\frac{\pi}{6} + j \sin\frac{\pi}{6}\right)$

$\underline{V_d} = \underline{V_{g1}} - \underline{V_{g2}} == \frac{1\text{mV}}{\sqrt{2}}\left(\sqrt{3} + 2j\right) = V_d e^{j\varphi}$

$V_d = 1\text{mV} \cdot \sqrt{\frac{7}{2}} \approx 1.9\text{mV}$

$V_p = -0.04 V_d \approx -0.08\text{mV}$