Αναλογικά Οργ. [illegible]

7954	3.	7826	φ	8300	5
7389	5	7976	φ	7126	3
7811	3	7966	3	7841	5.5
6254	5	7861	2	7005	3•
7572	5	7157	3•	7742	3
7255	3	7943	5	7419	5
6888	3•	7107	3	7933	5.5
7056	3•	7250	5	7449	3•
7964	5	7306	3	7829	3
7216	2	7494	5	6966	5
6723	2	6998	3	7875	5
7043	3•	7534	2	7348	5
7405	3•	7071	3•	7937	6
7780	3	7130	2	7651	5.5
7606	3•	7365	2	7786	3
7777	3	7387	2	7637	5
7799	3	7131	2	7145	5
6754	3	7029	φ	6915	5
5608	3	7687	2	7614 (Π.Γ)	5
7739	5	7200	2	7744	3
7428	3•	6978	φ	6708	5.5
7283	3	7872	6.5	7429	5
6953	3•	7361	3	6497	5
7459	3	7410	3•	7149	φ
7809	5	6932	5		
7210	5	7101	3		
7821	2	7358	5		
7287	2	7305	5		
3600	φ	7913	5		
7295	2	7922	3		
7634	3	7818	5		

ΛΥΣΕΙΣ

4. $I_C = \frac{5V - V_{BE}}{R_C + \frac{R_C + R_F}{\beta}} = 0.801\,mA \quad V_{CE} = 0.966\,V$

$g_m = 4 \times 0.801 = 32\,mS, \quad r_\pi = \frac{150}{g_m} = 4.69\,k \quad r_o = 62.4\,k$

παράλληλη - παράλληλη $\Rightarrow \beta = -\frac{1}{R_F}$

$A' = \frac{v_o}{i_i} = \frac{v_o}{v_\pi} \cdot \frac{v_\pi}{i_i} = -g_m (R_C // R_F // r_o) \cdot \frac{i_i (R_F // r_\pi)}{i_i} = -585\,k\Omega$

$\Rightarrow \beta A' = +\frac{1}{R_F}\left[-g_m (R_C // R_F // r_o) \cdot (R_F // r_\pi)\right] = 11.7$

$A_f = \frac{A'}{1+\beta A'} = \frac{-585\,k\Omega}{1 + 11.7} = -46.06\,k\Omega$ | $R_i = \frac{R_F // r_\pi}{1+\beta A'} = 337\,\Omega$, $R_o = \frac{r_o // R_C // R_F}{1+\beta A'} = 376\,\Omega$

3 α) $R_{out} = r_o\left[1 + \frac{\beta R_E}{R_E + r_\pi + R_1 // R_2}\right] \quad r_o = \frac{V_A}{I_o}$

$I_B = \frac{V_{EE}\frac{R_1}{R_1+R_2} - V_{BE}}{(R_1 // R_2) + (\beta+1) R_E} \Rightarrow I_o = \beta I_B = 100 \frac{5.3\,V}{1 + 27000\,k} = 0.196\,mA = 196\,\mu A$

β) $V_{BE_1} = V_T \ln \frac{I_{REF}}{I_S} \quad V_{BE_2} = V_T \ln \frac{I_o}{I_S}$ αλλά $I_o = \frac{V_{BE_1} - V_{BE_2}}{R_E} \Rightarrow I_o$

Το I_{REF} προκύπτει: $R_1 I_{REF} + V_T \ln \frac{I_{REF}}{I_S} = V_{EE} \Rightarrow I_o \simeq \frac{V_T}{R_E} \ln \frac{I_{REF}}{I_o} \Rightarrow$ όπου I_{REF} προκύπτει

2 $A_{v_{M_b}} = g_m \cdot R_C // R_3 \cdot \frac{R_E // r_e}{R_1 + R_E // \frac{1}{r_e}} \simeq 64\,mS \cdot 17\,k \cdot \frac{79}{179} = 482.45$

$g_m = 64\,mS \quad \omega_{p_1} = \frac{1}{\frac{1}{g_m} // R_E // R_1 \; C_\pi} \Rightarrow f_{p_1} = 8.23 \times 10^8 = 823\,MHz$

$C_\pi = 0.77\,pF$

$\omega_{p_2} = \frac{1}{(R_{out} // R_2)(C_\mu + C_c)} \simeq \frac{1}{R_2 (C_\mu + C_c)} \Rightarrow f_{p_2} \simeq 2.67\,MHz$

$GBW = 482.45 \times 2.67 = 1288\,MHz$

1 $CMRR = 20\log\left|\frac{-g_m \frac{R_D}{2}}{\frac{R_D}{2R_{SS}}}\right| = 80\,dB \Rightarrow g_m R_{SS} = 10^4$

$A_d = 10^2 = g_m \frac{R_D}{2} \quad g_m = \frac{I_s}{V_T} = 40\,mS$

$R_{SS} = \frac{10^4}{40\,mS} = 250\,k\Omega, \quad R_D = \frac{10^2}{40\,mS} = 2.5\,k\Omega$

β) Τα M_1, M_2 παραμένουν ... για $V_{TP} < V_{GS} < V_{TN}$, για $V_{TP} \le V_{GS} \le V_{TN}$. Διορθωτικά ...

$J = \frac{V_{DD}^2 / 2R_L}{2\,V_{DD}^2 / \pi R_L} \simeq \frac{\pi}{4}$

ΜΙΚΡΟΗΛΕΚΤΡΟΝΙΚΗ

8192	5	8149	3	8184	7
7987	7.5	8088	5.5	8193	5
7744	3	8080	6.5	7389	4
7725	5.5	8066	5.5	7115	2
7511	7	7302	8	7811	2
7927	3	8177	3	7739	2
7201	5	8193	3	8115	2
8084	5	7306	3	8006	2
7851	6	8245	3	7494	2
8090	5.5	7712	3	7438	2
7822	5.5	8236	3	7917	2
8091	3	7904	3	8051	2
4246	5	8200	3	7703	Ø
6644	5.5	8219	5	7629	Ø
6966	5.5	7081	3	8118	1
8208	5	7581	3	7131	Ø
8030	6	8073	3	8100	Ø
7414	5.5	8003	3	8163	2
8169	6	8135	3	7590	2
8004	5	7072	3	7317	Ø
7830	3	7025	3	7218	Ø
7999	3	8150	3	7876	2
7913	6.5	8125	5.5	7945	2
7734	6.5	8138	6	8230	2
8167	5.5	8010	5		
7825	7	7784	5		
7826	3	7968	5.5		
7808	3	8099	6		
7738	3	7879	5		
8168	3	6832	5		
7714	3	7986	5		
7634	3	8249	5		

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① A. n-type $N_D = 3\times10^{17}$ $N_A \cong 0$ $N_D > N_A \Rightarrow n = N_D = 3\times10^{17}$

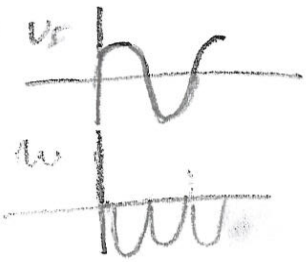
$p = \frac{n_i^2}{n} = \frac{10^{20}}{3\times10^{17}} = 3.33\times10^2$ οπές/cm³ , $n_i^2 = k_{Si}\cdot T^3 \exp\left(-\frac{E_G}{E_T}\right) \Rightarrow n_i(325°K)$

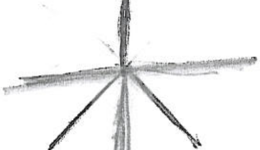
$\cong 4\times10^{10} \Rightarrow p = \frac{n_i^2}{n} = \frac{1.6\times10^{21}}{3\times10^{17}} = 0.53\times10^4 = 5.3\times10^4$

B) $=0$, $qn\mu_n E = J_{n\,drift}\ \frac{A}{cm^2}$, $qD_p\frac{dp}{dx} = -J_p\ \frac{A}{cm^2}$

$J_{n\,ολική} = q\mu_n nE + qD_n\frac{dn}{dx}$, $\sigma_{ολ} = q(n\mu_n + p\mu_p)\ (\Omega cm)^{-1}$

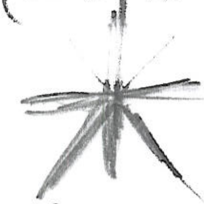
② α) A





ανορθωτής πλήρους κύματος με $v_0 < 0$

B



ανορθωτής πλήρους κύματος με $v_0 > 0$

β) $i = I_S\left(\exp\left(\frac{V_D}{V_T}\right)-1\right) \Rightarrow I_S = \frac{100mA}{e^{\frac{0.9V}{26.25mV}}-1} = 1.28\times10^{-16}A = 12.8fA$

$\frac{2}{1} = \frac{\exp\frac{V_D}{V_{T2}}}{\exp\frac{V_D}{V_{T1}}} = e^{V_D\left(\frac{1}{V_{T2}}-\frac{1}{V_{T1}}\right)} \Rightarrow 2 = e^{0.9\left(\frac{1}{V_{T2}}-\frac{1}{V_{T1}}\right)} \Rightarrow$

$\Rightarrow \ln 2 = 0.9\left(\frac{1}{V_{T2}}-\frac{1}{V_{T1}}\right) \Rightarrow 7.7\times10^{-4} = \left(\frac{1}{V_{T2}}-\frac{1}{V_{T1}}\right) \Rightarrow \frac{1}{V_{T2}} = \frac{1}{V_{T1}} + 7.7\times10^{-4}$

$\Rightarrow T_2 \cong 308°K$ 50mA $\Rightarrow T_2 = 321°K$

③ α) $R_i = r_\pi(1+g_m R_E) = \frac{V_T\cdot B}{I_C}\left(1+\frac{I_C}{V_T}\cdot R_E\right)$, $r_\pi = \frac{V_T}{I_C}$, $R_o = R_E /\!/ \left(r_e + \frac{R_S/\!/R_1}{B+1}\right) = R_E /\!/ \left(\frac{V_T}{I_C} + \frac{R_S/\!/R_1}{B+1}\right)$

2) $R_i = \infty$ $R_o = \frac{1}{g_m}$, $\frac{v_o}{v_I} = \frac{R_G}{R_S+R_G}\ \frac{g_m R_L}{1+g_m R_2}$

4 $A_v = \frac{R_2}{R_1+R_2}\cdot\frac{g_m\cdot(R_3/\!/R_4)}{1+g_m(R_1/\!/R_2)} = 8.48$ $A_i = \alpha \approx 1$ buffer ρεύματος

$R_i = R_2 /\!/ \frac{1}{g_m} /\!/ \frac{1}{r_o} \simeq R_2 /\!/ \frac{1}{g_m} = 13K /\!/ \frac{10^3}{10}\ \Omega$

$13K /\!/ 100\Omega \cong 100\Omega$

$g_m = 9.8mS$