①

MKE 020828

1a) En varistor är en resistor vars resistans sjunker med ökad pålagd spänning

b) Aluminiumelektrolytkondensator
Tantalkondensator

c) Brunstens-, alkaliskt-, kvicksilver- batteri
Silveroxid-, Litium-, Zink/Luft - batteri

d) $F(s) = \frac{10^4}{s^2 + a \cdot s + 10^4}$ kritiskt dämpad => dubbel pol

$\therefore s_{1,2} = -\frac{a}{2} \pm \sqrt{\underbrace{\frac{a^2}{4} - 10^4}_{=0}} \Rightarrow a = \pm\sqrt{4 \cdot 10^4} = (\pm) 2 \cdot 10^2$

(−) ger pol i högra hpl.

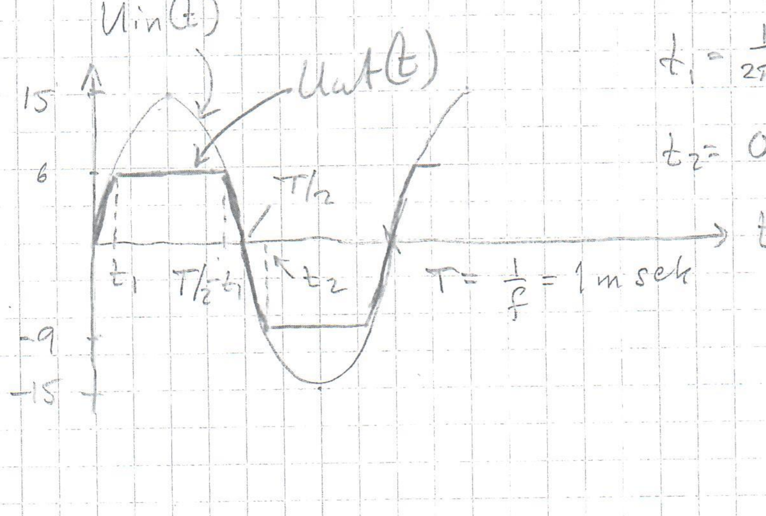
Svar: $a = 2 \cdot 10^2$

e) $I_D = \frac{k}{2}(V_{GS} - V_t)^2$

$g_m = k(V_{GS} - V_t) = \sqrt{2k \cdot I_D}$

$V_{GS} = 0 \Rightarrow 8m = \frac{k}{2} \cdot 4^2 \Rightarrow k = 1m\ A/V^2$

$\therefore g_m = \sqrt{2 \cdot 1m \cdot 2m} = 2m\ A/V$

f)


$T = \frac{1}{f} = 1\,msek$

$t_1 = \frac{1}{2\pi \cdot 1k} \cdot \arcsin\frac{6}{15} \approx 0{,}066\,m\,se$

$t_2 = 0{,}5m + \frac{1}{2\pi \cdot 1k} \cdot \arcsin\frac{9}{15} = 0{,}6\,m$

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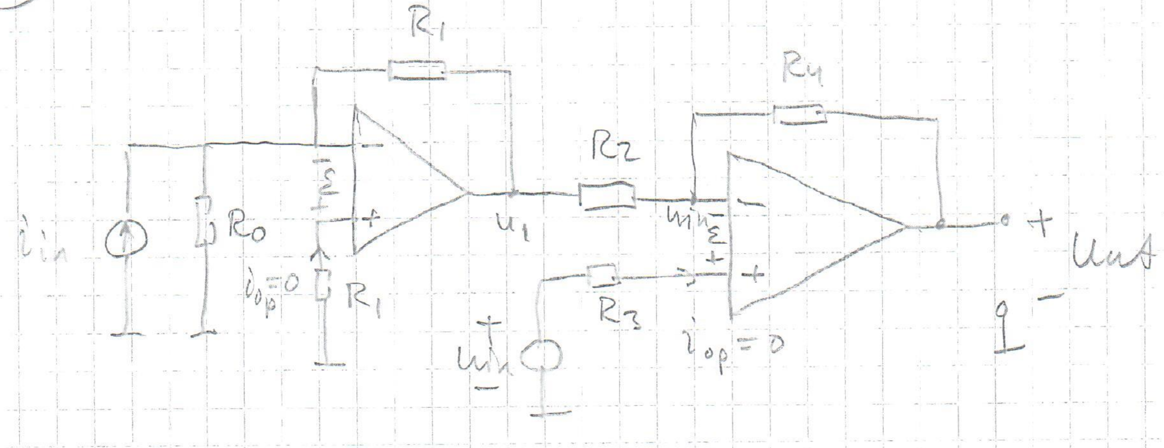

$\Sigma = 0$

$$i_{in} = \frac{-u_1}{R_1}$$

$$\frac{u_1 - u_{in}}{R_2} + \frac{u_{ut} - u_{in}}{R_4} = 0$$

$$-i_{in} \cdot R_1 \cdot R_4 - u_{in} \cdot R_4 + u_{ut} \cdot R_2 - u_{in} \cdot R_2 = 0$$

$$u_{ut} = \frac{i_{in} \cdot R_1 \cdot R_4}{R_2} + u_{in} \cdot \frac{R_2 + R_4}{R_2}$$

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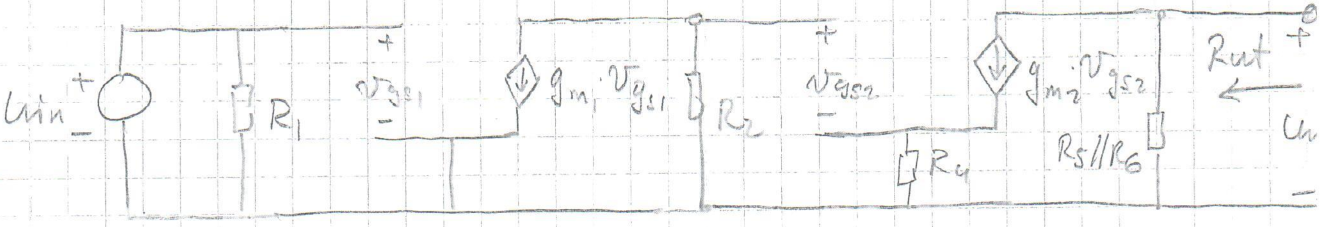
(3)



$$u_{in} = v_{gs_1}$$

$$-g_{m_1} \cdot v_{gs_1} \cdot R_2 = v_{gs_2} + g_{m_2} \cdot v_{gs_2} \cdot R_4$$

$$u_{ut} = -g_{m_2} \cdot v_{gs_2} \cdot R_5 // R_6$$

$$\frac{u_{ut}}{u_{in}} = \frac{-g_{m_2} \cdot R_5//R_6 \cdot v_{gs_2}}{-(1+g_{m_2} \cdot R_4)\, v_{gs_2} / (g_{m_1} \cdot R_2)} = \frac{g_{m_1} \cdot g_{m_2} \cdot R_2 \cdot R_5//R_6}{1 + g_{m_2} \cdot R_4}$$

$$R_{ut} = R_5 // R_6$$

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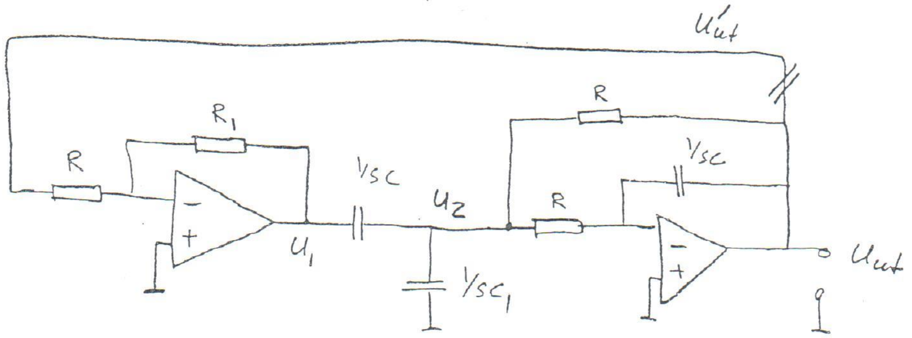
(4.)



$$\begin{cases} \dfrac{U_2}{R} + U_{ut} \cdot sC = 0 & \Rightarrow U_2 = -U_{ut} \cdot sRC \\ \dfrac{U_{ut}'}{R} + \dfrac{U_1}{R_1} = 0 & \Rightarrow U_1 = -U_{ut}' \dfrac{R_1}{R} \\ (U_1 - U_2)sC + \dfrac{U_{ut} - U_2}{R} - U_2 \cdot sC_1 - \dfrac{U_2}{R} = 0 \end{cases}$$

$$U_{ut}' \cdot \frac{sCR_1}{R} = U_{ut} s^2 RC^2 + \frac{U_{ut}}{R} + U_{ut} sC + U_{ut} s^2 RCC_1 + U_{ut} \cdot sC$$

Slingförst. $T = \dfrac{U_{ut}}{U_{ut}'} =$

$$= \frac{sCR_1}{s^2R^2C^2 + s^2R^2CC_1 + 2sRC + 1} = \frac{sCR_1}{s^2R^2C(C+C_1) + 2sRC + 1} =$$

$$= \{s = j\omega\} = \frac{j\omega R_1 C}{-\omega^2 R^2 C(C+C_1) + j\omega 2RC + 1} = 1$$

$\underline{\underline{\text{Im}[T] = 0}}$ $\Rightarrow$ $-\omega^2 R^2 C(C+C_1) + 1 = 0$, $C + C_1 = \dfrac{1}{\omega^2 R^2 \cdot C}$

$$C_1 = \frac{1}{\omega^2 R^2 C} - C = \frac{1}{(2\pi \cdot 100)^2 (20 \cdot 10^3)^2 \cdot 50 \cdot 10^{-9}} - 50 \cdot 10^{-9} = \underline{\underline{77\ nF}}$$

$\underline{\underline{\text{Re}[T] = 1}}$ $\Rightarrow$ $\dfrac{\omega R_1 C}{\omega 2RC} = 1$ $\Rightarrow$ $R_1 = 2R = \underline{\underline{40\ k\Omega}}$

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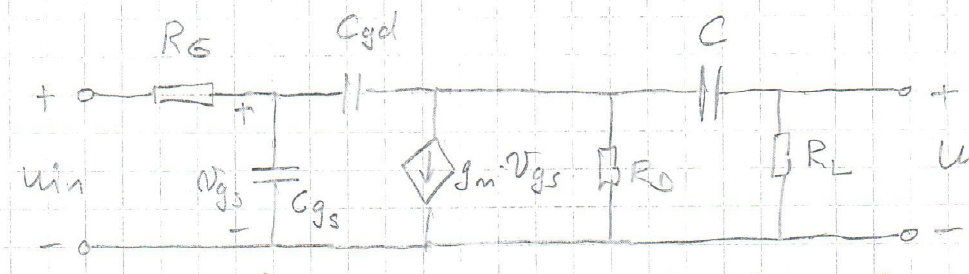
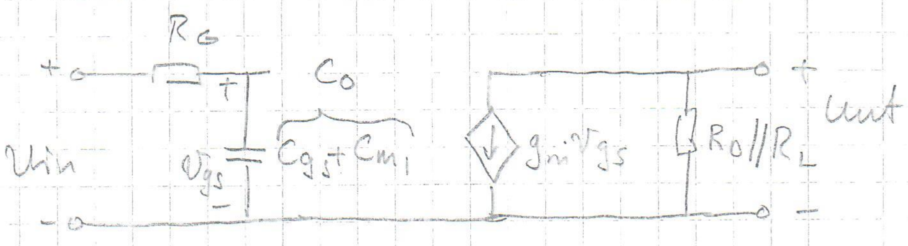


$g_m = 40m\,\frac{A}{V}$
$R_D = 4k\Omega$
$R_L = 4k\Omega$
$R_G = 800\Omega$

$C_{gs} = 29pF, \quad C_{gd} = 3pF, \quad C = 200nF$

<u>Höga frekvenser</u> $\quad \frac{1}{\omega C} = 0$; Miller approx. $\Rightarrow \frac{1}{\omega C_{m_2}} = 0$



$k = \frac{u_{ut}}{v_{gs}} = -g_m \cdot R_D // R_L =$

$= -40m \cdot 2k = -80$ ggr

$C_{m_1} = C_{gd}(1-k) = 243pF$

$C_0 = C_{gs} + C_{m_1} = 272pF$

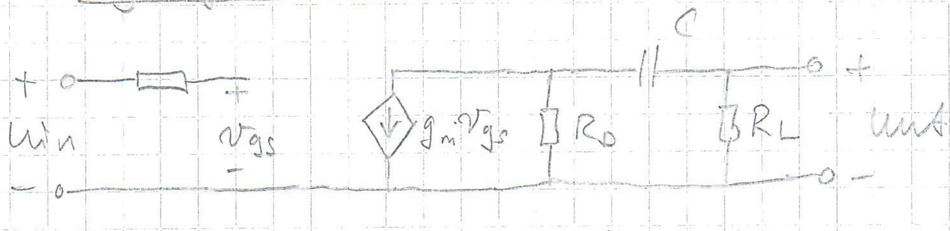
$u_{ut} = -g_m v_{gs} \cdot R_D // R_L$

$v_{gs} = u_{in} \cdot \frac{1}{sC_0} \cdot \frac{1}{\frac{1}{sC_0} + R_G} = \frac{u_{in}}{1 + sC_0 \cdot R_G}$

$\frac{u_{ut}}{u_{in}} = \frac{-g_m \cdot R_D // R_L}{1 + s/\omega_0^h}$ där $\omega_0^h = \frac{1}{C_0 R_G} = \frac{1}{272p \cdot 800} \approx 4{,}6$ mrad/sek

$\underline{t_r} = 2.2/\omega_0^h = \underline{479\ n\,sek}$

<u>Låga frekvenser</u> $\quad \frac{1}{\omega C_0} = \infty$



$u_{in} = v_{gs}$

$u_{ut} = -\frac{g_m v_{gs} \cdot R_D}{R_D + R_L + 1/sC} \cdot R_L$

$\frac{u_{ut}}{u_{in}} = -\frac{g_m \cdot R_D \cdot R_L \cdot sC}{1 + \underbrace{sC(R_D + R_L)}_{1/\omega_u}}$

$P_{rel} = \frac{\Delta t}{T} \cdot 100\% = \Delta t \cdot \omega_u \cdot 100 = \frac{0{,}1m \cdot 100}{200\mu \cdot (4k + 4k)} = \frac{0{,}1}{2} \cdot \frac{1}{8m} = \underline{6{,}25\%}$

$\Delta t = 0{,}1$ msek

$\omega_u = 625$ rad/sek.

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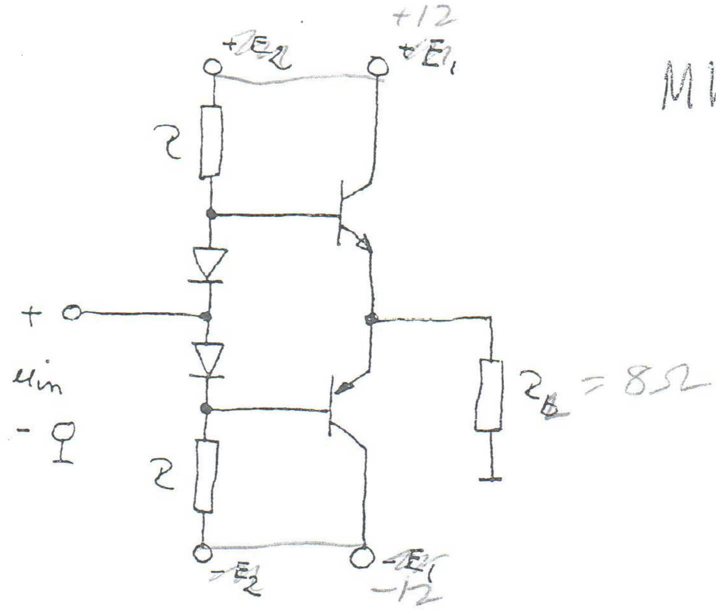

a)
$$\begin{cases} P_{R_L max} = \dfrac{\hat{I}^2 \cdot R_L}{2} \\ \hat{I} = \dfrac{E_1 - u_{CEsat}}{R_L} = \dfrac{12 - 0.2}{8} = 1.48\ A \end{cases}$$

$$P_{R_L max} = \frac{1.48^2 \cdot 8}{2} = 8.7\ W$$

$$P_{R_L max} = \frac{E^2}{2R_L} = 9W$$

b) $P_{R_L 1} = \dfrac{8.7}{2}\ W$

$$\hat{I} = \sqrt{\frac{P_{R_L} \cdot 2}{R_L}} = \sqrt{\frac{8.7}{8}} = 1.04\ A$$

$$\hat{I} = \frac{E}{\sqrt{2} R_L} = 1.06A$$

$$I_{med} = \frac{\hat{I}}{\pi} = \frac{1.04}{\pi}\ A$$

$$I_{DC} = \frac{\hat{I}}{\pi} = 0.338A$$

$$P_{bat} = 2 \cdot I_{med} \cdot E_1 = 2 \cdot \frac{1.04}{\pi} \cdot 12 = 7.95\ W$$

$$P_{BAT} = 2 I_{DC} E = 8.10W$$

$$\eta = 100 \cdot \frac{P_{R_L 1}}{P_{bat}} = 100 \cdot \frac{\frac{8.7}{2}}{7.95} = 54.7\%$$

$$\eta = \frac{P_{R_L}}{P_{BAT}} = 0.555$$

55.5%

Svar $P_{R_L max} = 8.7\ W$, $\eta = 54.7\%$ då $P_{R_L 1} = 4.35 W$