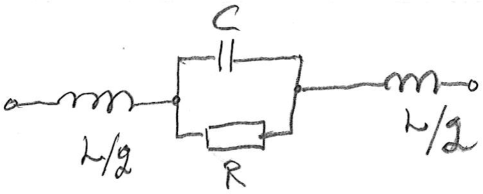
181012-1

1 a)

- stabil kapacitans
- Polykarbonat, Polystyren, Poly propen

b)

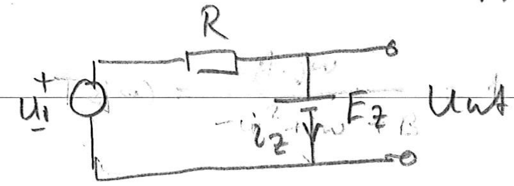


L: induktans i tilledningar
R: Läckresistans
C: Nominell kapacitans

c)

- spärra oönskade högfrekventa störningar
- filter
- switchade nät aggregat

d)

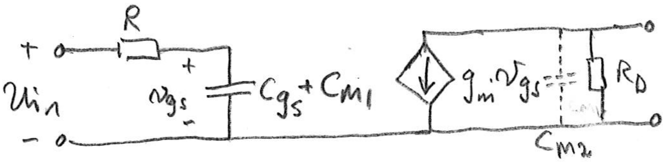


$U_{1min} = E_Z = \underline{10V}$

$P_{Zmax} = E_Z \cdot i_{Zmax} \Rightarrow i_{Zmax} = \frac{0,5}{10} = 50mA$

$U_{1max} = R \cdot i_{Zmax} + E_Z = 100 \cdot 50m + 10 = \underline{15V}$

e)



$g_m = 10m\ A/V$

$R_D = 10k\Omega$

$C_{M1} = C_{gd}(1-k)$; $C_{M1} = 1p \cdot 101 \simeq 100p$

$k = -g_m R_D = -100$ ggr

Inverkan av C_{M2} försummas vid beräkning av w_0^u

$$w_0^u = \frac{1}{R(C_{gs}+C_{M1})} \simeq 19,9 \text{ M rad/s}$$

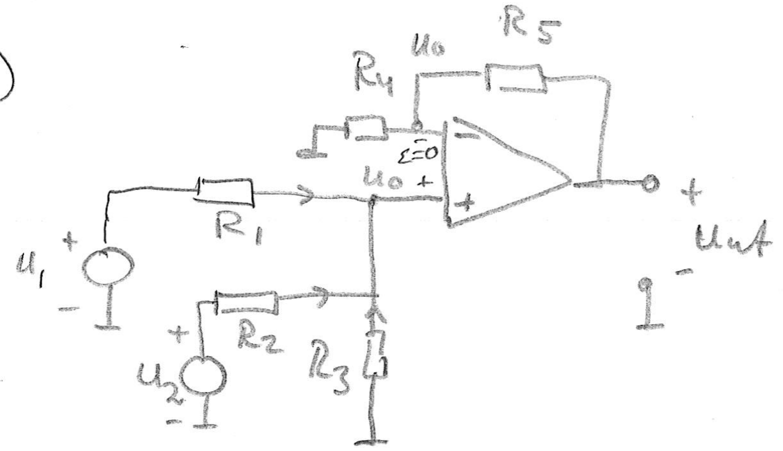
f)

$$T(s=jw) = \frac{A \cdot jw_0}{-w_0^2 + jw_0 + B} = 1 \quad \text{för sinusformad självsväng.}$$

$\therefore$ $B = w_0^2 = (2\pi \cdot f_0)^2 = (2\pi \cdot 1k)^2 \simeq 39,5 \cdot 10^6 \left[\frac{rad}{s}\right]^2$

$A \simeq 1$

(2)



$R_1 = 1k = R$
$R_2 = 2k = 2R$
$R_3 = 2k = 2R$
$R_4 = 1k = R$
$R_5 = 3k = 3R$

Ideal op-amp
neg återkoppling } $\varepsilon = 0$

$$\frac{u_2 - u_0}{R_2} + \frac{0 - u_0}{R_3} + \frac{u_1 - u_0}{R_1} = 0 \Rightarrow \frac{u_2}{2R} + \frac{u_1}{R} = u_0\left(\frac{1}{2R} + \frac{1}{2R} + \frac{1}{R}\right)$$

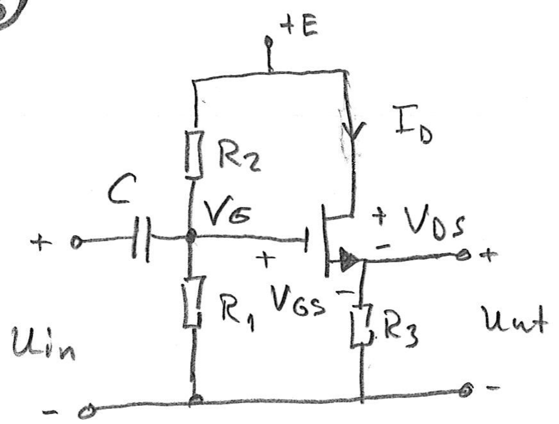
$$\frac{-u_0}{R_4} + \frac{u_{ut} - u_0}{R_5} = 0 \Rightarrow \frac{u_{ut}}{3R} = u_0 \cdot \left(\frac{1}{R} + \frac{1}{3R}\right) \Rightarrow u_{ut} = u_0 \cdot 4$$

$$\therefore \quad \frac{u_2}{2} + u_1 = \frac{u_{ut}}{4}(2)$$

2

$$\therefore \quad \boxed{u_{ut} = u_2 + 2u_1}$$

(3)



$I_D = 4mA$, $k = 2mA/V^2$, $V_t = 1V$

$E = 16$ Volt

Maximalt utstyrningsområde ⇒

$V_{DS} = \frac{E}{2} = 8$ Volt

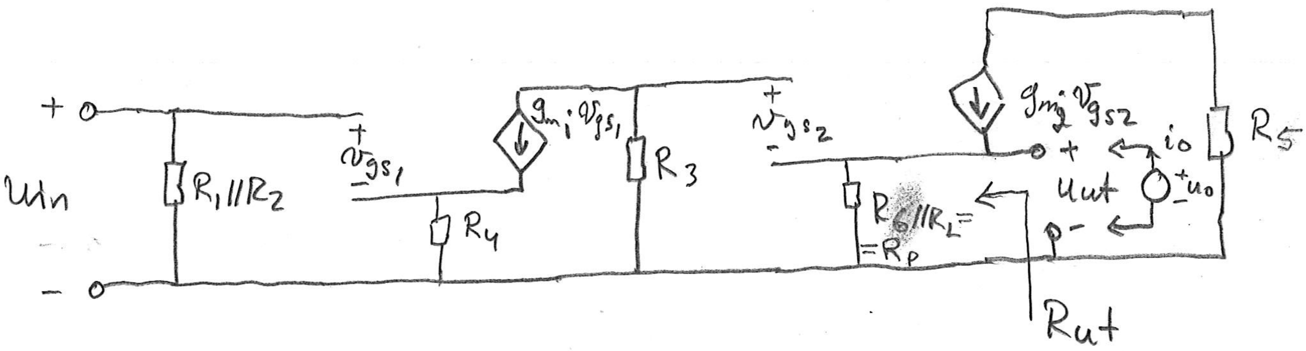
$V_{R_3} = E - V_{DS} = 8$ volt ⇒ $\underline{\underline{R_3}} = \frac{V_{R3}}{I_D} = \frac{8}{4m} = \underline{\underline{2k\Omega}}$

$I_D = \frac{k}{2} \cdot (V_{GS} - V_t)^2 \Rightarrow V_{GS} = \overset{+}{(-)}\sqrt{\frac{2 I_D}{k}} + V_t = \overset{+}{(-)} 2 + 1 = 3$ Volt

$V_G = V_{R_3} + V_{GS} = \frac{E \cdot R_1}{R_1 + R_2}$; $11 = 16 \cdot \frac{R_1}{R_1 + R_2}$

Välj $\underline{\underline{R_1 = 100k\Omega}}$ (10k - 10M Ω ok)

$11 (R_1 + R_2) = 16 \cdot R_1 \Rightarrow R_2 = \frac{5 \cdot R_1}{11} \simeq 50k\Omega$

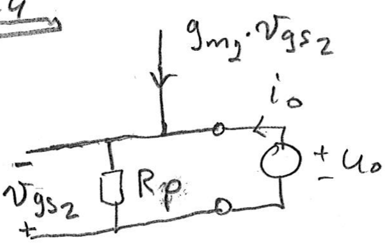


$$u_{in} = v_{gs_1} + g_{m_1} \cdot v_{gs_1} \cdot R_4 = (1 + g_{m_1} \cdot R_4) v_{gs_1}$$

$$-g_{m_1} \cdot v_{gs_1} \cdot R_3 = (1 + g_{m_2} \cdot R_p) v_{gs_2}$$

$$u_{ut} = g_{m_2} \cdot v_{gs_2} \cdot R_p$$

$$\frac{u_{ut}}{u_{in}} = \frac{-g_{m_2} \cdot R_p}{1 + g_{m_2} \cdot R_p} \cdot \frac{g_{m_1} \cdot R_3}{1 + g_{m_1} \cdot R_4} \quad \left(\simeq \frac{R_3}{R_4} \text{ då } \begin{matrix} g_{m_2} \cdot R_5 \gg 1 \\ g_{m_1} \cdot R_4 \gg 1 \end{matrix} \right)$$



$$R_{ut} = \left. \frac{u_0}{i_0} \right|_{u_{in} = 0}$$

$$u_{ut} = -v_{gs_2}$$

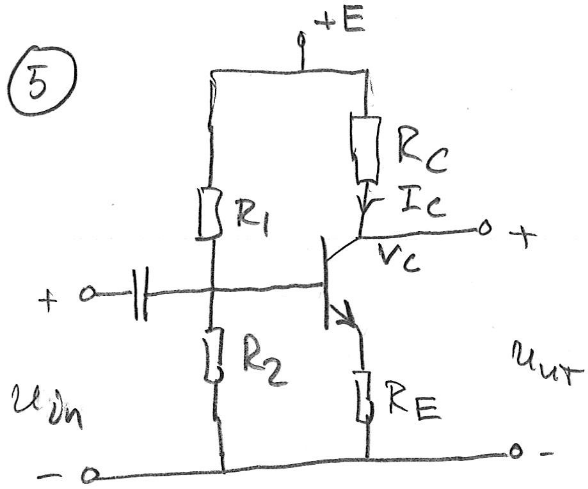
$$u_{ut} = (i_0 + g_{m_2} \cdot v_{gs_2}) \cdot R_p$$

$$u_{ut} (1 + g_{m_2} \cdot R_5) = i_0 \cdot R_p$$

$$\therefore \quad R_{ut} = \frac{R_p}{1 + g_{m_2} \cdot R_p} \quad \left(\simeq \frac{1}{g_{m_2}} \text{ då } g_{m_2} \cdot R_p \gg 1 \right)$$

$$R_{in} = R_1 // R_2$$

(5)



$E = 18\,V$, $V_C = 13\,Volt$

$R_1 = 2{,}4k\Omega$, $R_2 = 200\,\Omega$, $R_C = 100\,\Omega$

$R_E = 10\,\Omega$

a) $I_C = \dfrac{E - V_C}{R_C} = \dfrac{18-13}{100} = 50\,mA$

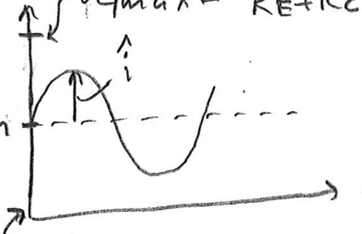
$V_{CE} = E - I_C(R_C + R_E) = 18 - 0{,}05(110) = 12{,}5\ Volt$

$\underline{P_T} = V_{CE} \cdot I_C = \underline{625\ mW}$

b) $\hat{i}_{max} = 50\,mA$ för maximal dynamik

Bottning

$\hat{i}_{q\,max} = \dfrac{E}{R_E + R_C} = \dfrac{18}{110} = 164\,m$



$i_{q\,min} = 0$ (strypning)

$\underline{P_{R_C\,max}} = \dfrac{\hat{i}^2_{max} \cdot R_C}{2} = \underline{125\,mW}$

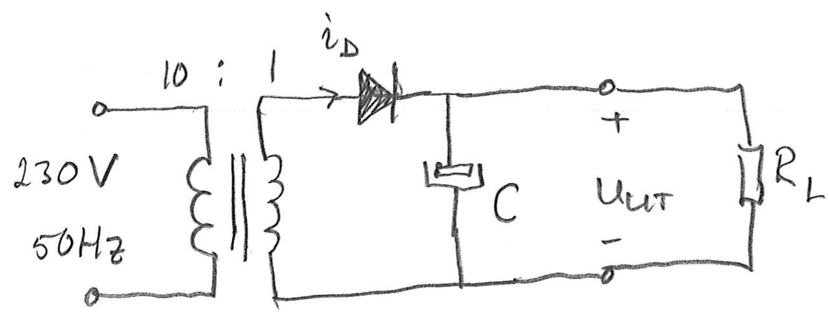
c) $\underline{P_T} = \dfrac{1}{T}\displaystyle\int_0^T \underbrace{[V_{CE} - \hat{i}_{max}(R_C+R_E)\sin\omega t]}_{v_{CE}(t)} \cdot \underbrace{(I_C + \hat{i}_{max}\sin\omega t)}_{i_q(t)}\,dt =$

$= V_{CE} \cdot I_C - \dfrac{\hat{i}^2_{max} \cdot (R_C + R_E)}{2} \simeq \underline{487\,mW}$

18I012-6

(6)

a)



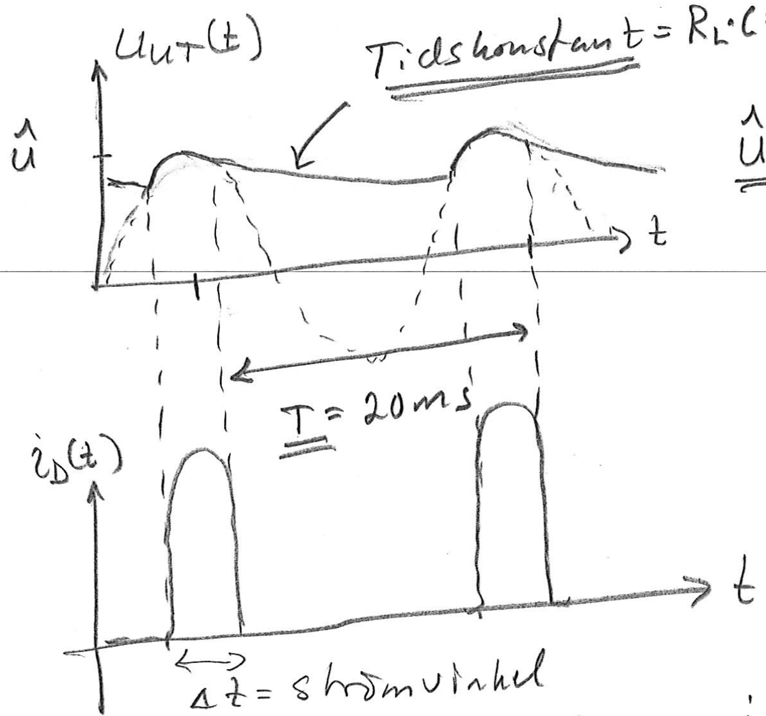
$R_L = 100\,\Omega$

$C = 1500\,\mu F$

$E_Z = 20\,V$

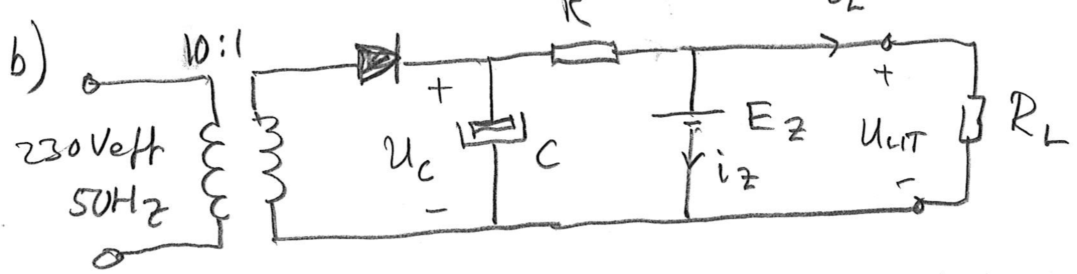
$r_Z = 0$

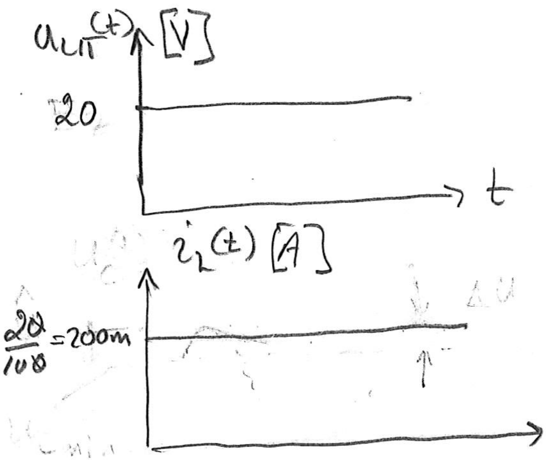
Tidskonstant $= R_L \cdot C = 0{,}15$ sek



$$\hat{u} = \frac{230 \cdot \sqrt{2}}{10} = 32{,}5 \text{ Volt}$$

b)





$U_{ut} = E_Z = 20\,V$

$i_L = E_Z / R_L = 200\,mA$