LÖSNINGSFÖRSLAG TENTAMEN ELEKTRONIK 100816

1. a)

$$\begin{cases} E - U_{CEQ} - I_{CQ} \cdot R_8 = 0 \\ U_B = E \cdot \dfrac{R_7}{R_6 + R_7} \simeq 12 \cdot \dfrac{40k}{25k + 40k} = 7{,}38\,V \end{cases}$$

$$U_B - U_{BEQ} - I_{CQ} \cdot R_8 = 0$$

$$7{,}38 - 0{,}7 - I_{CQ} \cdot 1k = 0 \quad \hookrightarrow \quad I_{CQ} \simeq 6{,}7\,mA \quad \longrightarrow \quad U_{CEQ} = 5{,}3\,V$$

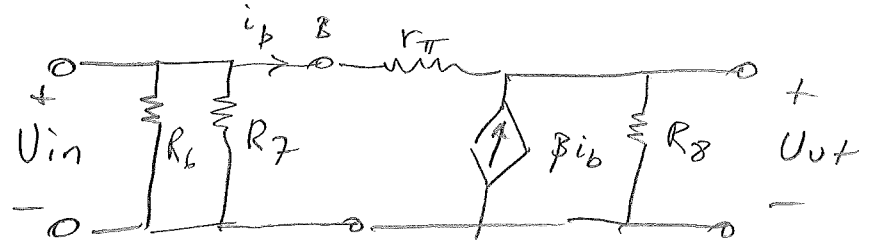
b)

$$Z_{in} = R_6 \,/\!/\, R_7 \,/\!/ \left(r_\pi + (1+\beta) R_8\right) \simeq 14{,}6\,k\Omega$$

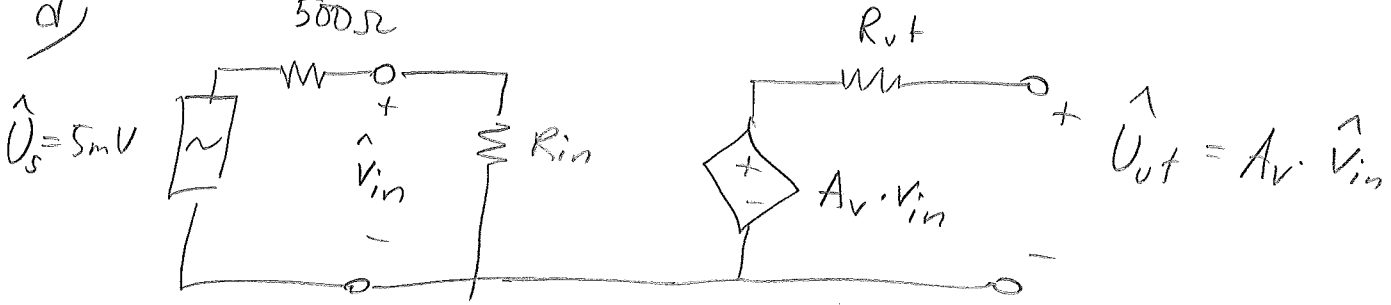
$$Z_{ut} = \frac{1}{(1+\beta)(R_5 /\!/ R_6 /\!/ R_7 + r_\pi) + \frac{1}{R_8}} \simeq \frac{1}{281 /\!/ (1600) + \frac{1}{1000}} \simeq 5{,}7\,\Omega$$

$$A_V = \frac{(1+\beta) R_8}{r_\pi + (1+\beta) R_8} \simeq \frac{281 \cdot 1000}{1600 + 281 \cdot 1000} \simeq 0{,}99$$

c)



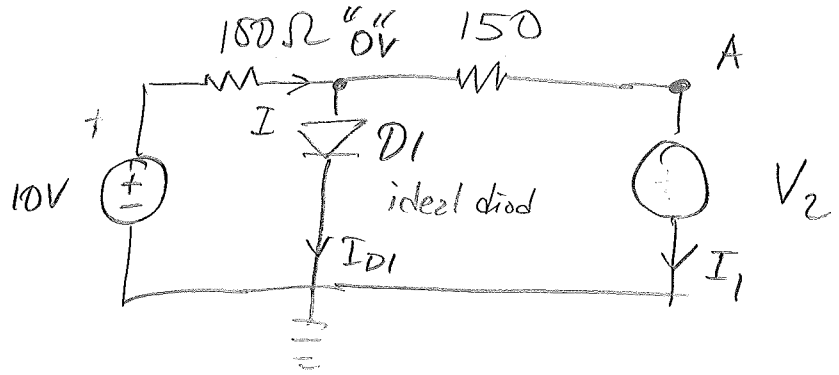
d)



$$\hat{U}_{ut} = A_V \cdot 5mV \cdot \frac{R_{in}}{R_{in} + R_{ut_{signal}}} \simeq 0{,}99 \cdot 5mV \cdot \frac{14600}{14600 + 500} \simeq 4{,}8\,mV$$

Om dioden leder inget spänn. fall över denna vid ideal diod.

2.



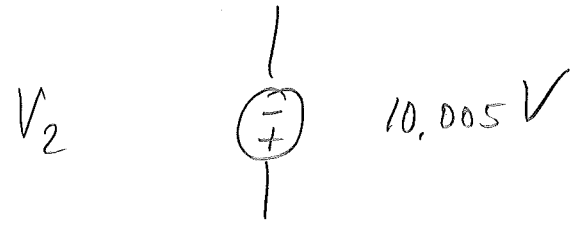
$$I = \frac{10 - 0}{100\,\Omega} = 100\,mA$$

$$I_1 = 2I_{D1}$$

d v s

$$I_1 = 66{,}7\,mA$$

$$\frac{0 - U_A}{150} = 66{,}7\,mA \quad \Rightarrow U_A \simeq -10{,}005\,V$$



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3. "Inverterande Schmittrigger"

a) $V_{ut} = \pm V_{cc}$ $\qquad V_{cc} = 12V$

$$V_{omsl.} = \pm V_{cc} \cdot \frac{R_2}{R_1 + R_2} = \dots$$

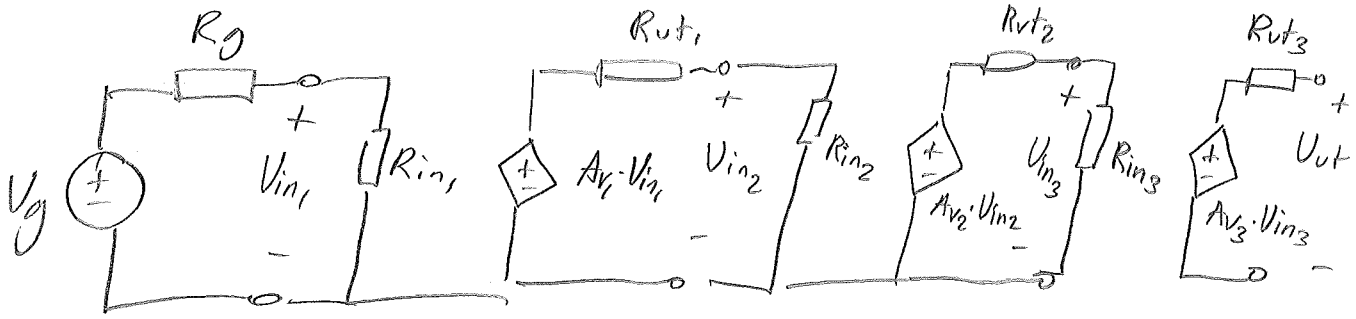
$$4 = 12 \cdot \frac{R_2}{R_1 + R_2} \quad \Rightarrow \quad \frac{1}{3}(R_1 + R_2) = R_2$$

b) Utsignalen slår alltid om efterson U_{in} är mindre än omslagsspänn. dv s V_{ut} = konst +/- 12V.

$$\frac{1}{3}R_1 = \frac{2}{3}R_2$$

$$\frac{R_2}{R_1} = \frac{1}{2}$$

4.



a) $U_{ut_0} = V_g \cdot \frac{R_{in_1}}{R_{in_1} + R_g} \cdot A_{v_1} \cdot \frac{R_{in_2}}{R_{in_2} + R_{ut_1}} \cdot A_{v_2} \cdot \frac{R_{in_3}}{R_{in_3} + R_{ut_2}} \cdot A_{v_3} =$

$= 20 \cdot 10^{-3} \cdot \frac{1k}{1k + 1k} \cdot 40 \cdot \frac{2k}{2k + 0{,}1} \cdot 30 \cdot \frac{4k}{4k + 0{,}4k} \cdot 10 \simeq 103{,}9$

b) $R_L = 100\,\Omega$

$U_{ut} = U_{ut_0} \cdot \frac{R_L}{R_L + R_{ut_3}} = 103{,}9 \cdot \frac{100}{100 + 500}$

$\simeq 17{,}32\ V$

$P_L = \frac{U_{ut}^2}{R_L} = \frac{17{,}32^2}{100} \simeq 3{,}0?\ W$

c) Effektanpassning $R_L = R_{ut_3} = 500\,\Omega$

$U_{ut} = U_{ut_0} \cdot \frac{R_L}{R_L + R_{ut_3}} = 103{,}9 \cdot \frac{1}{2} \simeq 51{,}95\ V$

$P_L = \frac{U_{ut}^2}{R_L} = \frac{51{,}95^2}{500} \simeq 5{,}40\ W$

5.

a) $\frac{V_o}{V_s} = 1 + \frac{Z_2}{R_1} =$

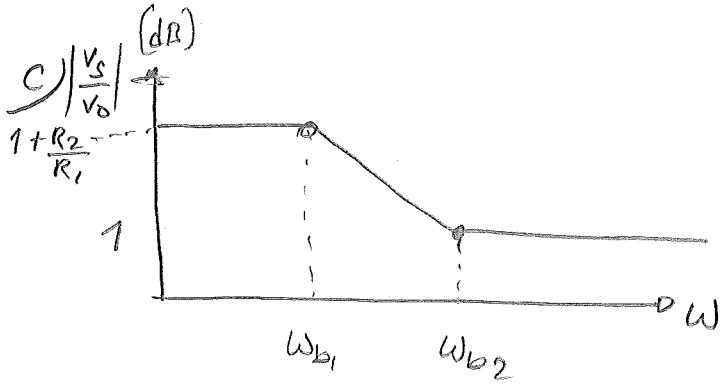
$\left(Z_2 = (R_2 // \frac{1}{j\omega C}) = \frac{R_2 \cdot \frac{1}{j\omega C}}{R_2 + \frac{1}{j\omega C}} = \frac{R_2}{j\omega C R_2 + 1} \right)$

$= 1 + \frac{R_2}{R_1} \frac{1}{j\omega C R_2 + 1} = \frac{j\omega C R_1 R_2 + R_1 + R_2}{j\omega C R_1 R_2 + R_1}$

b) $\omega \to 0$: $1 + \frac{R_2}{R_1}$

$\omega \to \infty$: 1

c) $\left|\frac{V_s}{V_o}\right|$ (dB)



brytfrekvenser där $\omega_{b1} = \frac{1}{CR_2}$ & $\omega_{b2} = \frac{R_1 + R_2}{CR_1R_2}$

6.

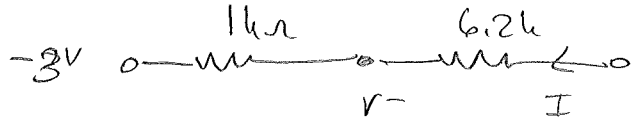
a) $V_o = -\frac{6{,}2k}{1k} \cdot V_s = -6{,}2\,V$ linjärt område

$V^- = 0$

b) $V_o = -\frac{6{,}2k}{1k} V_s = -6{,}2 \cdot (-3) = 18{,}6\,V > 10\,V$

utanför sitt linjära område

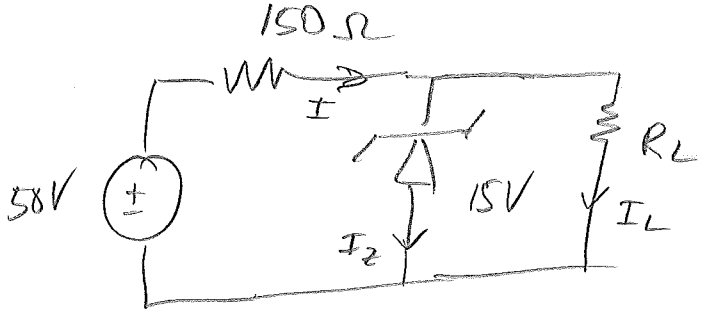
$V_o = 10\,V$ (kan inte bli större..)



$I = \frac{13\,V}{7{,}2k\Omega}$

$V^- = -3V + I \cdot 1k \approx -1{,}2V$

7.



a) $R_L = 75\Omega$

$I = \frac{50-15}{150} = 233{,}3\ mA$

$I_L = \frac{15}{75} = 200\ mA$

$I_Z = I - I_L = 33{,}3\ mA$

$P_Z = U_Z \cdot I_Z = 0{,}5\ W$

b) $R_L = \infty$

$I_Z = I - I_L = I = 233{,}3\ mA$

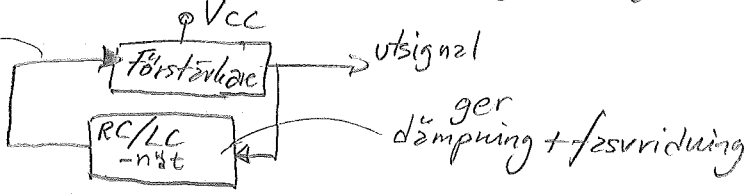
$P_Z = U_Z \cdot I_Z = 3{,}5\ W$

8.

$$Y = \overline{(A+B)\cdot(C+D)\cdot E}$$

9. a) En oscillator är en krets som ger en periodisk vågform enbart m h a matningsspänningen. Ingen egentlig insignal behövs.

b) positiv återkoppling



c) Fasvridningen runt i loopen = 0°
Amplitudförstärkningen i loopen = 1

d)
- Gör kopplingen mindre känslig för brus/störningar
- Stabiliserar kopplingen
- mindre känslig för åldring

e) Hur mycket ström som kretsen kan driva/sänka.

10.

$$V_{GS} = \frac{R_2}{R_1 + R_2} \cdot V_{DD} = 9V$$

Vid $V_{GS} = 9{,}2V \Rightarrow K = \frac{I_D}{(V_{GS} - V_{to})^2} = \frac{g_m}{(12-4)^2} = 0{,}125 mA/V^2$

Vår vilopunkt blir således:

$$I_D = K(V_{GS} - V_{to})^2 = 0{,}125m(9-4)^2 = 3{,}125\ mA$$

$$V_{DS} = V_{DD} - I_D \cdot R_D = 18 - 3{,}125m \cdot 1{,}5k = 13{,}3V$$

$$V_{ut} = A_V \cdot V_{in} = g_m \cdot R_D V_{in} = 4500 \cdot 10^{-6} \cdot 1500 \cdot 0{,}1 = 0{,}675V$$