Lösningar elektronik aug 2016

1a Kondensatorn har även induktans och resistans.

1b filter : stabil kapacitans, små förluster

Koppling : Låg impedans över stort frekvensområde.

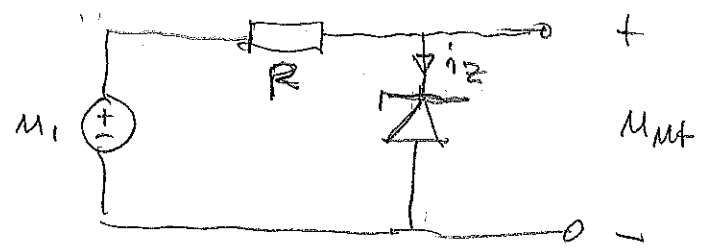
1c Diod : likriktning

Z-diod : spänningsstabilisering

1d. $T_j - T_a = P_f \cdot \Theta_{ja} \Rightarrow 150°C - T_a = 1W \cdot 62{,}5\,°C/W \Rightarrow$

$T_a = 87{,}5°C$

1e.

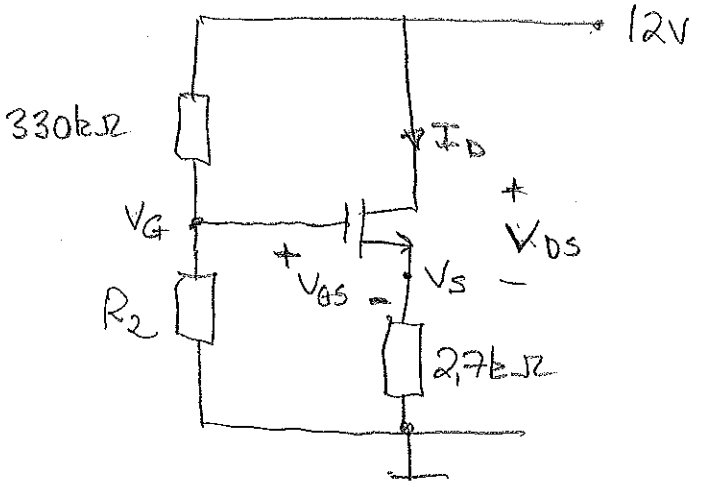


Stabil $U_{ut} \Leftrightarrow i_Z \geq 0 \Rightarrow U_1 \geq E_Z = 10V$

U_{1max} ges av $i_Z \leq \frac{P_Z}{E_Z} = \frac{0{,}5W}{10V} = 50mA \Rightarrow$

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

1F.



$V_t = 2V$

$k = 4mA/V^2$

$g_m = 4mA/V$

$$g_m = \sqrt{2kI_D} \Rightarrow I_D = \frac{g_m^2}{2k} = \frac{(4mA/V)^2}{2 \cdot 4mA/V^2} = \underline{2mA}$$

$$\Rightarrow V_S = 2{,}7k\Omega \cdot 2mA = \underline{5{,}4V}$$

$$2mA = \frac{4mA/V^2}{2}(V_{GS} - 2V)^2 \Rightarrow$$

$$V_{GS} = \pm 1V + 2V = \begin{cases} (1V) \text{ (stryp!; ty } V_{GS} < V_t \\ 3V \end{cases}$$

$V_{DS} = 12V - V_S = 6{,}6V > V_{GS} - V_t = 1V \Rightarrow$

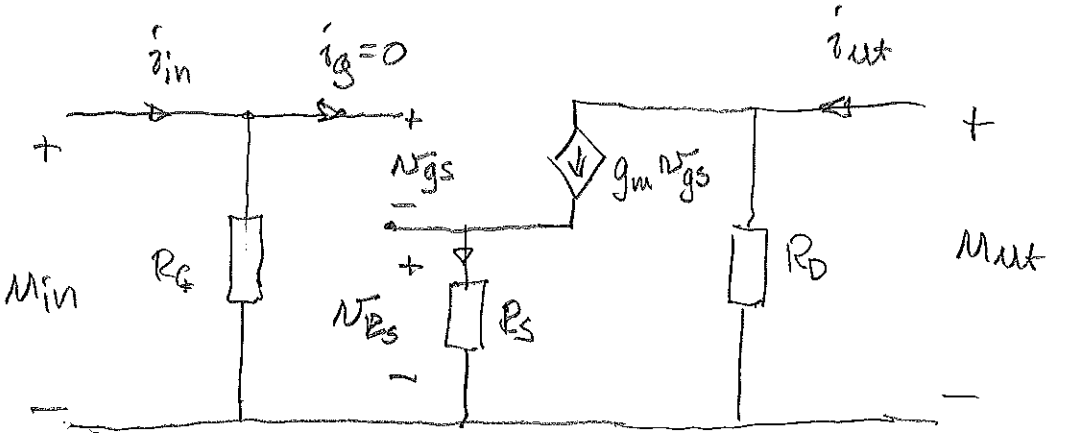
strömmättnad!

$V_G = V_{GS} + V_S = 3V + 5{,}4V = 8{,}4V$

$$V_G = \frac{R_2}{R_2 + 330k} \cdot 12V = 8{,}4V \Rightarrow$$

$$1 + \frac{330k}{R_2} = \frac{12V}{8{,}4V} \Rightarrow \underline{\underline{R_2 = 770k\Omega}}$$

2 (aug 2016) Små signal schema



$R_D = 1{,}2\,k\Omega$ $R_S = 200\,\Omega$ $R_G = 560\,k\Omega$ $g_m = 7\,mA/V$

R_{in}: $R_{in} = \left.\frac{u_{in}}{i_{in}}\right|_{i_{ut}=0} = R_G = 560\,k\Omega$, ty $i_g = 0$.

$$\left.\frac{u_{ut}}{u_{in}}\right|_{i_{ut}=0} \quad \left.\begin{aligned} u_{in} &= v_{gs} + R_S \cdot g_m v_{gs} = (1 + g_m R_S)\cdot v_{gs} \\ u_{ut} &= -g_m R_D v_{gs} \end{aligned}\right\} \Rightarrow$$

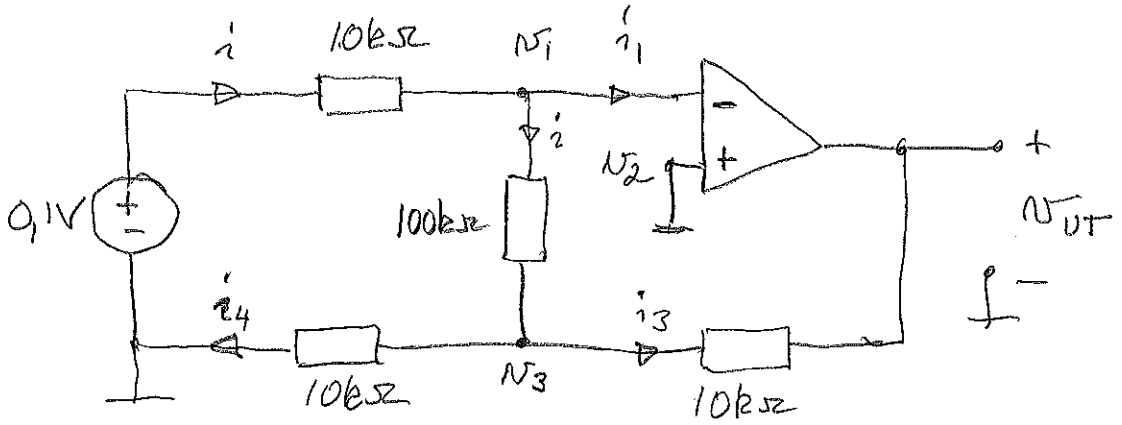
$$\frac{u_{ut}}{u_{in}} = -\frac{g_m R_D}{1 + g_m R_S} = -3{,}5 \text{ ggr}$$

$$R_{ut} = \left.\frac{u_{ut}}{i_{ut}}\right|_{u_{in}=0} \qquad u_{in} = 0 \Rightarrow v_{R_S} = -v_{gs}$$

Men $v_{R_S} = g_m R_S \cdot v_{gs}$, så $-v_{gs} = g_m R_S v_{gs} \Rightarrow$

$v_{gs} = 0 \Rightarrow i_{ut} = \frac{u_{ut}}{R_D} \Rightarrow R_{ut} = R_D$

3



Ideal mattoppled OP $\Rightarrow$ $i_1 = 0$, $v_1 = v_2 = 0$

Rin

$$i = \frac{0{,}1V - v_1}{10k} = \frac{0{,}1V - 0V}{10k} = 10\mu A$$

$$R_{in} = \frac{0{,}1V}{i} = \underline{10k\Omega}$$

V_{UT} : $V_{UT} = V_3 - 10k\Omega \cdot i_3$

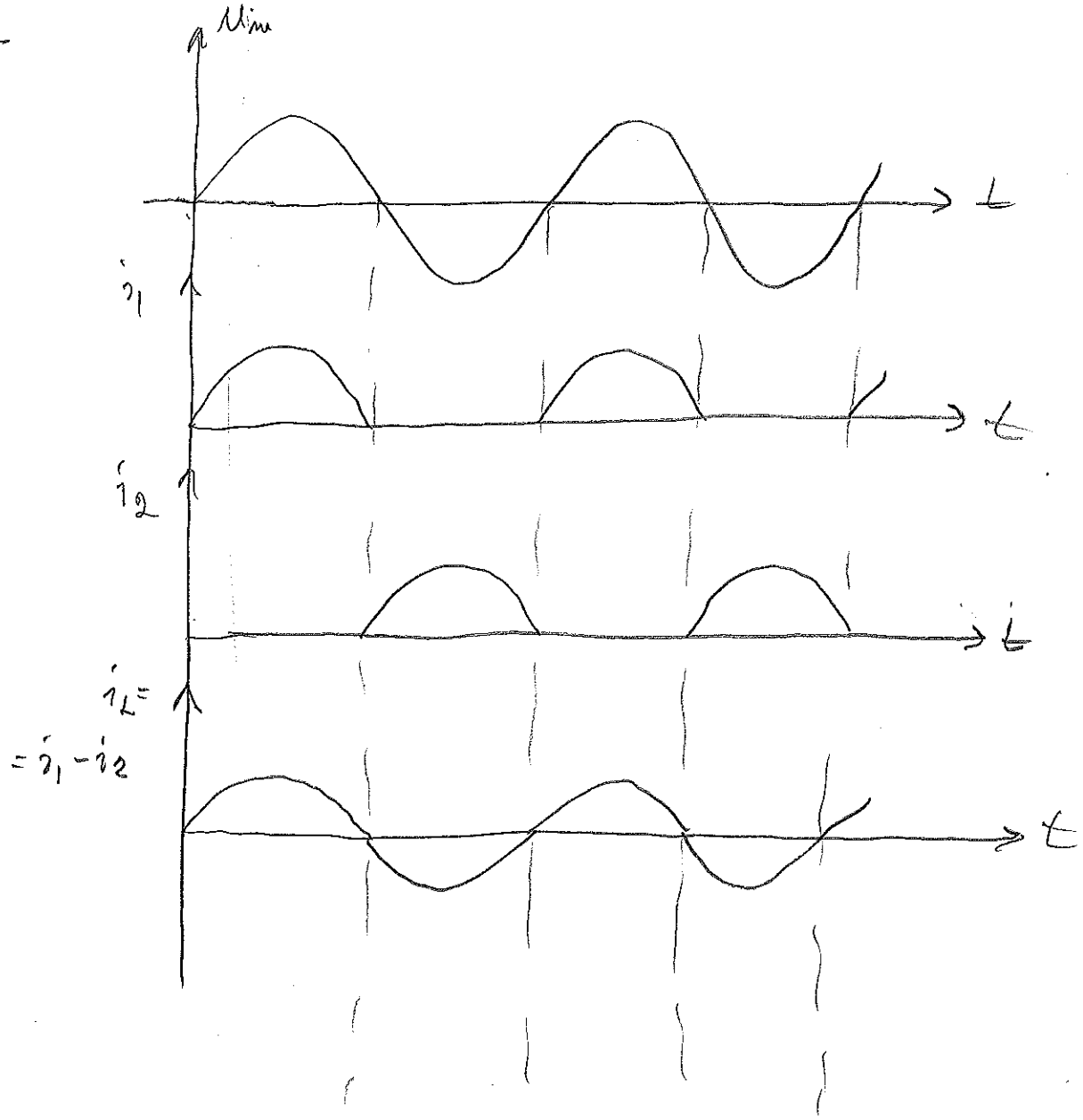
$$v_3 = v_1 - 100k\Omega \cdot i = 0 - 100k\Omega \cdot 10\mu A = -1V$$

$$i_4 = \frac{v_3}{10k\Omega} = \frac{-1V}{10k\Omega} = -100\mu A$$

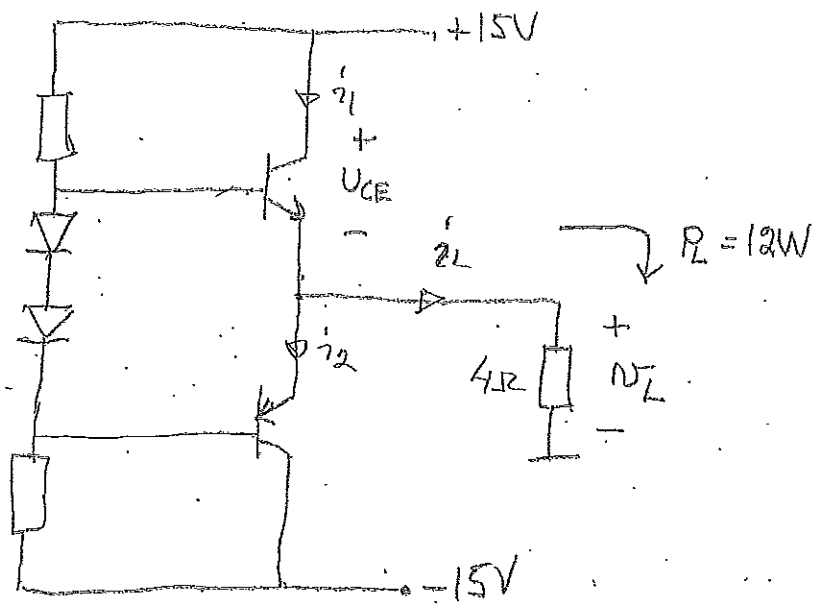
$$i_3 = i - i_4 = 10\mu A - (-100\mu A) = 110\mu A$$

$\Rightarrow$ $V_{UT} = -1V - 10k\Omega \cdot 110\mu A = \underline{-2{,}1V}$

4a



4.b



$$\cdot\ P_L = 4\Omega \cdot \frac{\hat{i}_L^2}{2} \Rightarrow \hat{i}_L = \sqrt{\frac{2 \cdot 12W}{4\Omega}} = \underline{2,45A}$$

$$\Rightarrow \hat{i}_1 = \underline{2,45A}$$

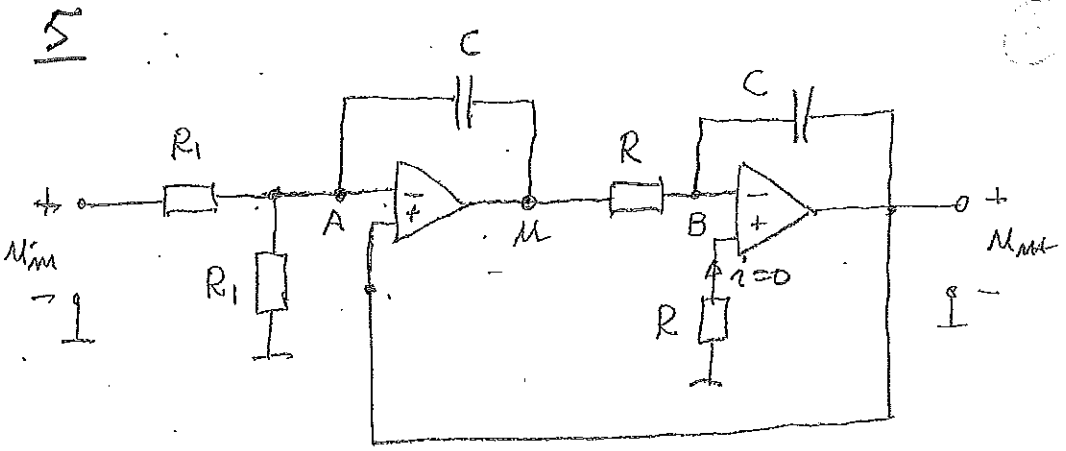
$$\cdot\ P_{in} = 2 \cdot 15V \cdot \frac{\hat{i}_1}{\pi} = 30V \cdot \frac{2,45A}{\pi} = \underline{23,39W} \Rightarrow$$

$$\eta = \frac{P_L}{P_{in}} = \frac{12W}{23,39W} = \underline{\underline{51,3\%}}$$

$$\cdot\ P_{E\text{-}Transistor} = \frac{P_{in} - P_L}{2} = \underline{\underline{5,70W}}$$

$$\cdot\ P_{L\,max} = \frac{(\hat{U}_{L\,max})^2}{2 \cdot 4\Omega} = \frac{(15V)^2}{2 \cdot 4\Omega} = \underline{\underline{28,1W}}$$

5



Ideala motkopplade OP ⇒ • ingångarna = 0
• lika potential på ingångarna.

$\Rightarrow V_A = U_{ut}$, $V_B = 0$

Nodanalys:

A $\quad \frac{V_A - U_{in}}{R_1} + \frac{V_A}{R_1} + \frac{V_A - M}{1/sC} = 0$; $V_A = U_{ut} \Rightarrow$

$(2 + sR_1C) \cdot U_{ut} = sR_1C \cdot M + U_{in}$ (1)

B $\quad \frac{V_B - M}{R} + \frac{V_B - U_{ut}}{1/sC} = 0$; $V_B = 0 \Rightarrow$

$M = -sRC \cdot U_{ut}$ (2) ; Sätt in i (1)

$(2 + sR_1C) \cdot U_{ut} = -s^2RR_1C^2 + U_{in} \Rightarrow$

$$\frac{U_{ut}}{U_{in}} = \frac{1}{s^2RR_1C^2 + sR_1C + 2} = \frac{1}{RR_1C^2} \cdot \frac{1}{s^2 + \frac{1}{RC} \cdot s + \frac{2}{RR_1C^2}}$$

Poler: $s^2 + \frac{1}{RC} \cdot s + \frac{2}{RR_1C^2} = 0 \Rightarrow$

$$s = -\frac{1}{2RC} \pm \sqrt{\frac{1}{4R^2C^2} - \frac{2}{RR_1C^2}}$$

$\sqrt{\quad} = 0$

(6)

Maximalt snabbt utan överslång $\Rightarrow$

$$\frac{1}{4R^2C^2} = \frac{2}{RR_1C^2} \Rightarrow \quad R_1 = 8R = \underline{\underline{80k\Omega}}$$

Då gäller att

$$\frac{M_{ut}}{M_{in}} = \frac{1}{RR_1C^2} \cdot \frac{1}{\left(s+\frac{1}{2RC}\right)^2} = 56{,}6\cdot 10^6 \cdot \frac{1}{(s+10638)^2} =$$

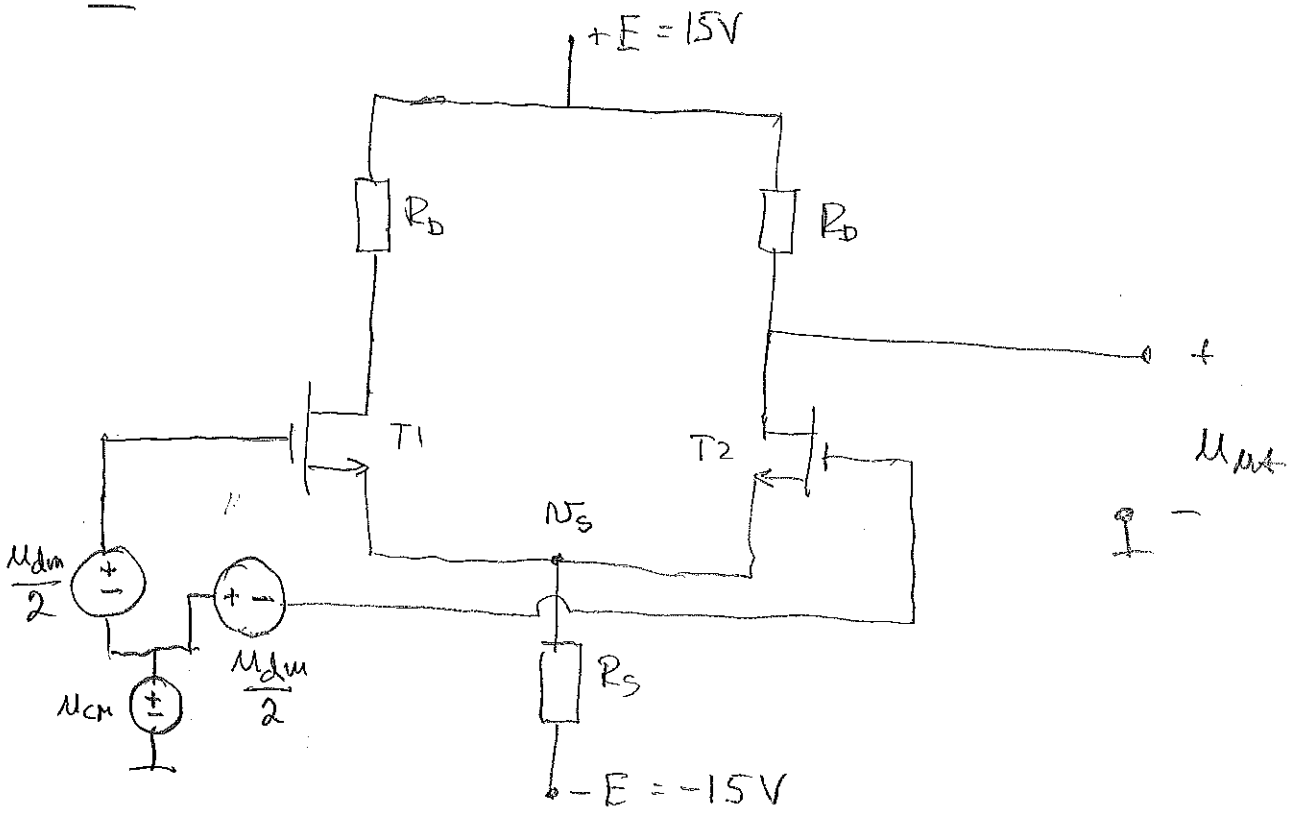
$$= \frac{0{,}5}{\left(1+\frac{s}{10638}\right)^2} \cdot \text{Dubbelpol } s = -10638 \Rightarrow$$

$$\omega''_{\ddot{o}TOT} = 10638\,\text{rad/s} \cdot \sqrt{2^{1/2}-1} = 6847\,\text{rad/s} \Rightarrow$$

Övre gränsfrekvens $f_{\ddot{o}} = \frac{6847}{2\pi}\,\text{Hz} = 1089{,}7\,\text{Hz}$

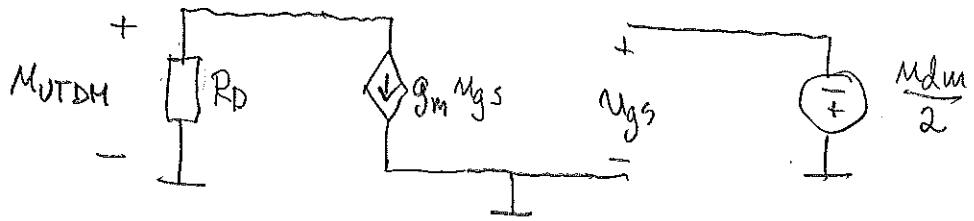
$\Rightarrow$ Stigtiden $t_r = \frac{0{,}35}{f_{\ddot{o}}} = \underline{\underline{0{,}32\,\text{ms}}}$

6



$R_D = 10\,k\Omega$ $\quad R_S = 3{,}3\,k\Omega$ $\quad g_m = 10\,mA/V$

DM : $U_{CM} = 0$ $\quad U_S = 0$ Betrakta T2

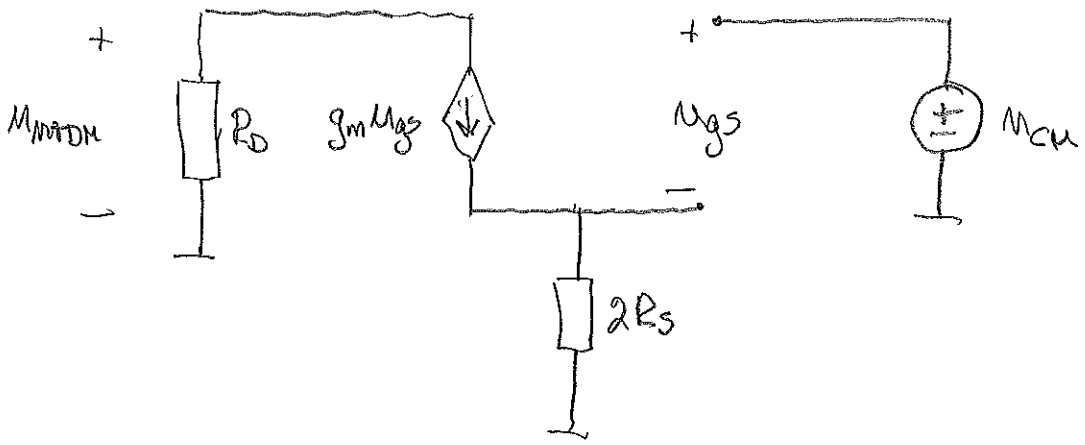


$$U_{utDM} = -g_m R_D U_{gs} \quad ; \quad U_{gs} = -\frac{U_{dm}}{2} \Rightarrow$$

$$U_{ut} = g_m R_D \cdot \frac{U_{dm}}{2} \Rightarrow$$

$$A_{dm} = \frac{U_{utdm}}{U_{dm}} = \frac{g_m R_D}{2} = \underline{50ggr}$$

CM : $u_{dm} = 0$, Betrakta T2



$$u_{ut1CM} = -g_m R_D u_{gs}$$

$$u_{CM} = u_{gs} + 2g_m R_S \cdot u_{gs} = (1 + 2g_m R_S) \cdot u_{gs} \Longrightarrow$$

$$A_{CM} = \frac{u_{ut1CM}}{u_{CM}} = -\frac{g_m R_D}{1 + 2g_m R_S} = -1{,}49 \text{ ggr}$$

$$CMRR = 20 \cdot \log \left| \frac{A_{dm}}{A_{CM}} \right| = 20 \cdot \log \frac{50}{1{,}49} = \underline{30{,}5 \text{ dB}}$$