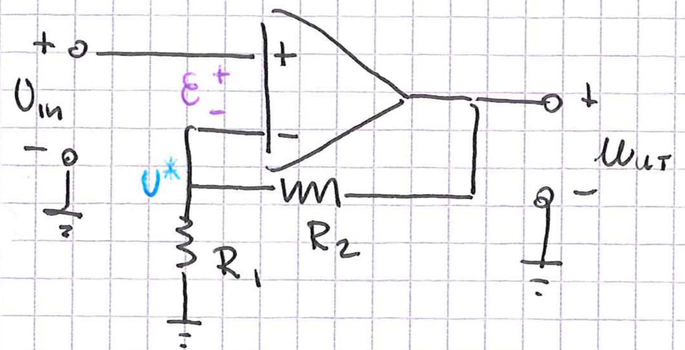
(1c)

$$\boxed{H(s) = \frac{10^5}{1+\frac{s}{25}}} = \frac{H_0}{1+\frac{s}{\omega_1}}$$

$$\begin{cases} H_0 = 10^5 \\ \omega_1 = 25 \end{cases}$$

$R_1 = 1k\Omega$

$R_2 = 99k\Omega$



1) $U^* = U_{UT} \frac{R_1}{R_1+R_2}$ (I)

$U_{in} = U^* + \varepsilon$ (II)

$H(s)\,\varepsilon = U_{UT}$ (III)

(I & II & III)

2) $U_{in} = U_{UT}\frac{R_1}{R_1+R_2} + \frac{U_{UT}}{H(s)} = U_{UT}\left(\frac{1}{H(s)} + \frac{R_1}{R_1+R_2}\right)$

3) $$\frac{U_{UT}}{U_{in}} = \frac{H(s)(R_1+R_2)}{R_1+R_2 + R_1 H(s)} \Big/ \frac{R_1+R_2}{R_1+R_2} = \frac{H(s)}{1+\frac{R_1}{R_1+R_2}H(s)} = \frac{H(s)}{1+\beta H(s)}$$

$\beta = \frac{1}{1+99} = \frac{1}{100}$

now substitute $H(s) = \frac{H_0}{1+s/\omega_1}$

$$= \frac{H_0}{1+s/\omega_1}\cdot\frac{1}{1+\beta\frac{H_0}{1+\frac{s}{\omega_1}}} = \frac{H_0}{1+\frac{s}{\omega_1}+\beta H_0} =$$

$$= \frac{\frac{H_0}{1+\beta H_0}}{\frac{1+\beta H_0+\frac{s}{\omega_1}}{1+\beta H_0}} = \frac{H_0}{1+\beta H_0}\cdot\frac{1}{1+\frac{s}{\omega_1(1+\beta H_0)}}$$

$H_{MAX} \approx \frac{1}{\beta} = 100$ ggr

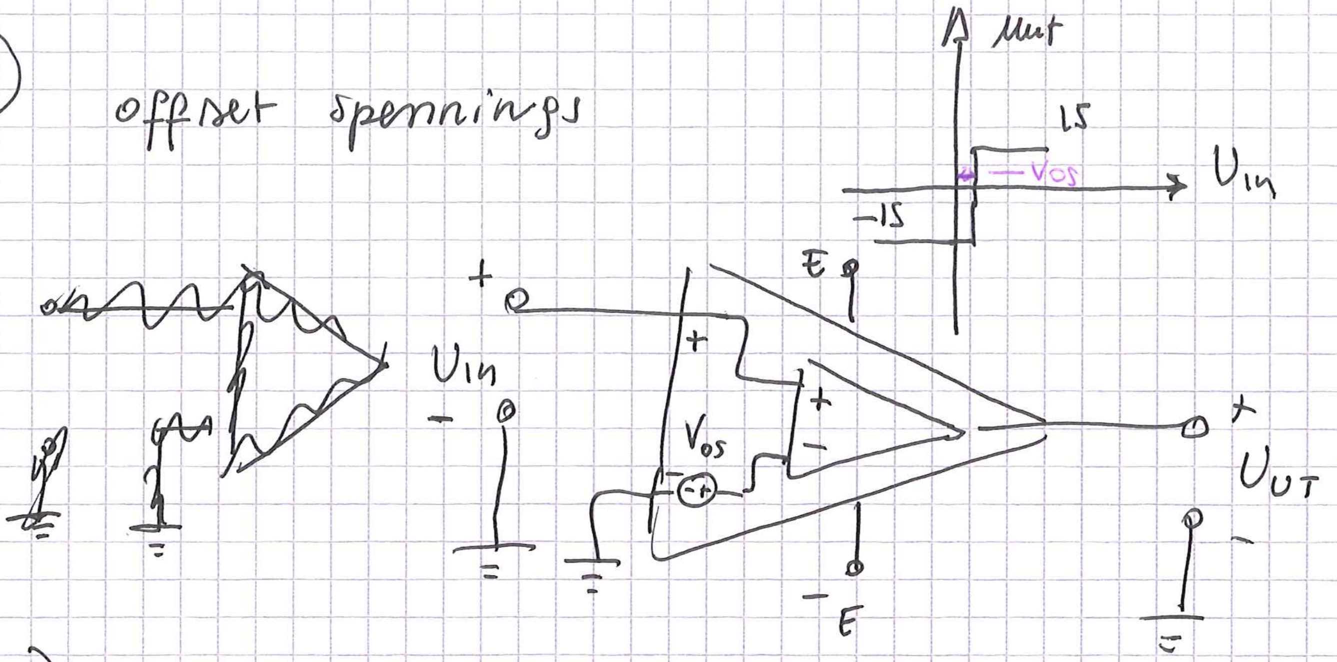
(because H_0 is big)

$\omega_{0\,TOT} = \omega_1(1+\beta H_0)$

25 rad/sec

(1e)

offset spennings



(1f)

$$H(s) = \frac{a}{2s^2 + 16bs + 10}$$

Real poles $\quad 2s^2 + 16bs + 10$

$s^2 + 8bs + \cancel{10}\ 5$

we need to find solutions of this and make sure they are real

$$s_{1,2} = \frac{-8b \pm \sqrt{8^2b^2 - 4.5}}{2} =$$

$$= \frac{-8b \pm \sqrt{16b^2 - 5}}{2} =$$

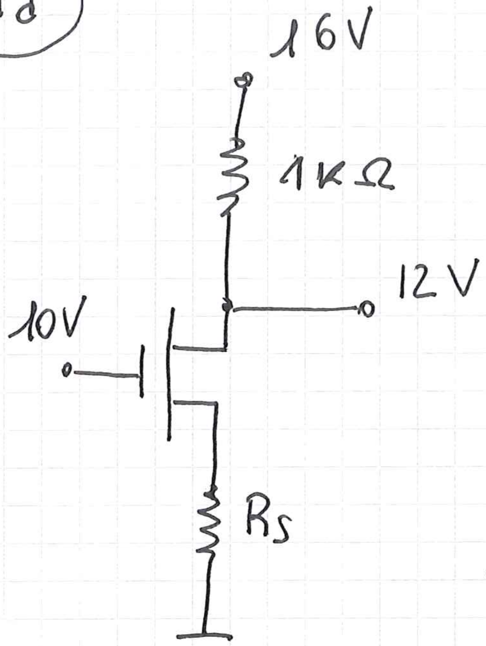
≥ 0

$16b^2 - 5 \geq 0$

$b^2 \geq \frac{5}{16}$ $\quad b > \frac{\sqrt{5}}{4}$

$b < -\frac{\sqrt{5}}{4}$

1d



$R_S = ?$

$V_D = 12V$

$V_G = 10V$

$V_t = 3V$

$k = 4mA/V^2$

$$I_D = \frac{16 - 12V}{1k\Omega} = 4mA$$

$$V_S = I_D R_S$$

$V_{DS} : V_{GS} - V_T$

$$I_D = (V_{GS} - V_t)^2 \frac{k}{2} \Rightarrow V_{GS} = \pm\sqrt{\frac{2 I_D}{k}} + V_T$$

$V_D - V_S : V_G - V_S - V_T$

$$= \pm\sqrt{2} + 3 = 4{,}4V$$

1,6V ↓

MA NON SAREBB IN SAT.

$$\begin{cases} 12 - V_S : 10 - V_S - 3 \\ V_S > 0 \ \& \ V_S < 12 \end{cases}$$

$12 - V_S : 7 - V_S$

always >

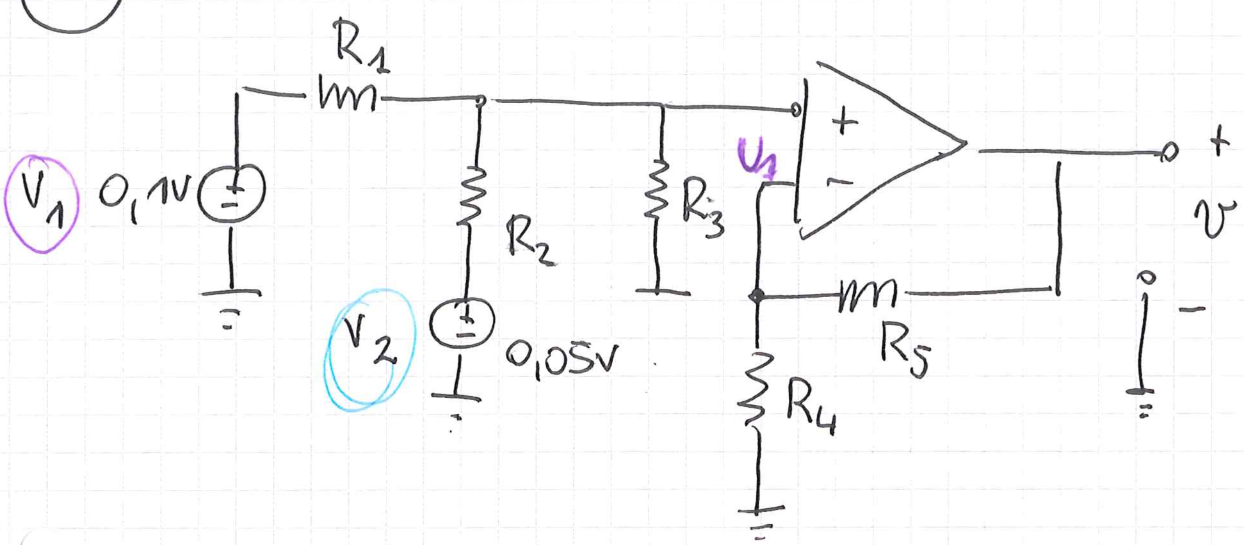
So we are in saturation area

$$V_{GS} = V_G - V_S \Rightarrow V_S = V_G - V_{GS}$$

$$\boxed{R_S = \frac{V_S}{I_D} = \frac{V_G - V_{GS}}{I_D}}$$

$$\Rightarrow R_S = \frac{10 - 4{,}4V}{4mA} = 1{,}4k\Omega$$

2



$R_1 = 1k\Omega$, $R_2 = 2k\Omega$, $R_3 = 2k\Omega$, $R_4 = 1k\Omega$, $R_5 = 3k\Omega$

$R_2 // R_3 =$

$$\frac{1}{R_{eq}} = \frac{1}{R_2} + \frac{1}{R_3} = \frac{R_3 + R_2}{R_2 R_3}$$

$$R_{eq} = \frac{R_2 R_3}{R_3 + R_2}$$

$$v = U_1\left(1 + \frac{R_5}{R_4}\right) = U_1 \frac{R_4 + R_5}{R_4} = 0{,}0625 \cdot \frac{4}{1} = 0{,}25V$$

Principle sumperimosition of effects

$$U_1 = U_2 + U_3$$

$$U_2 = V_1 \left.\frac{R_2 // R_3}{R_1 + R_2 // R_3}\right|_{V_2 = 0} = V_1 \frac{R_2 R_3}{R_3 + R_2} \cdot \frac{1}{R_1 + \frac{R_2 R_3}{R_3 + R_2}}$$

$$U_3 = V_2 \left.\frac{R_1 // R_3}{R_2 + R_1 // R_3}\right|_{V_1 = 0} = V_2 \frac{R_1 R_3}{R_3 + R_1} \cdot \frac{1}{R_2 + \frac{R_1 R_3}{R_3 + R_1}}$$

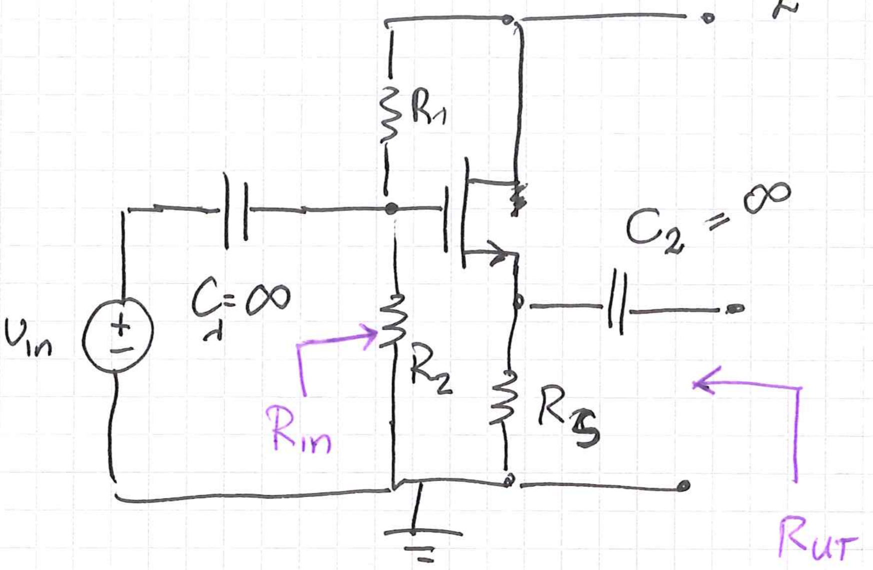
$$U_2 = V_1 \frac{R_2 R_3}{R_1 (R_3 + R_2) + R_2 R_3} = 0{,}1 \cdot \frac{4}{4 + 4} = 0{,}05 V$$

$$U_3 = V_2 \frac{R_1 R_3}{R_2 (R_3 + R_1) + R_1 R_3} = 0{,}05 \cdot \frac{2}{6 + 2} = 0{,}0125 V$$

~~$U_1 = 0{,}0625$~~

$U_1 = 0{,}0625$

(3)



$V_t = 1V$

$k = 2mA/V^2$

$R_1 = 100k\Omega$

$R_2 = 220k\Omega$

$R_S = 2k\Omega$

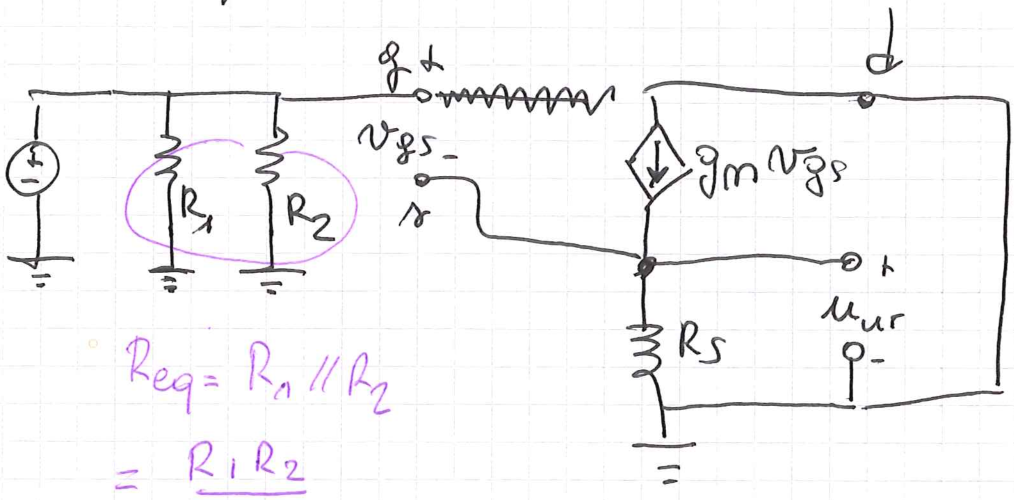
$E = 16V$

$I_D = 4mA$

$$\boxed{R_{in}, \quad R_{ut}, \quad \frac{v_{ut}}{v_{in}} \ ?}$$

$$g_m = \sqrt{2k I_D} = \sqrt{2 \cdot 2 \cdot 4 \, \frac{mA \cdot mA}{V^2}} = 4 \frac{mA}{V}$$

small signals model



$R_{eq} = R_1 // R_2$

$= \frac{R_1 R_2}{R_1 + R_2}$

$v_s = v_{ur}$

$v_s = g_m v_{gs} R_s$

$v_g = u_{in}$

$v_{gs} = v_g - v_s = u_{in} - g_m v_{gs} R_s$

$v_{gs}(1 + g_m R_s) = u_{in}$

$$\frac{u_{ur}}{v_{in}} = \frac{g_m R_s \cancel{v_{gs}}}{1 + g_m R_s \cancel{v_{gs}}} = \frac{g_m R_s}{1 + g_m R_s} = \frac{4\frac{mA}{V} \cdot 2k\Omega}{1 + 4\frac{mA}{V} \cdot 2k\Omega} = \frac{8}{9} \approx 0{,}89$$

continua 3

$$R_{in} = \frac{v_{in}}{i_{in}}\bigg|_{u_{ut}=0} = R_1 // R_2 = 68{,}75\,k\Omega$$

no current in R_S : does not contrib. to R_{in}

$$R_{ut} = \frac{v_{ut}}{i_{ut}}\bigg|_{v_{in}=0}$$

$$= (g_m v_{gs} + i_{ut}) R_S = v_{ut} \quad \text{II}$$

but $v_{ut} = v_S = -v_{gs}$ I

$$v_{gs} = v_g - v_s = 0 - v_s$$

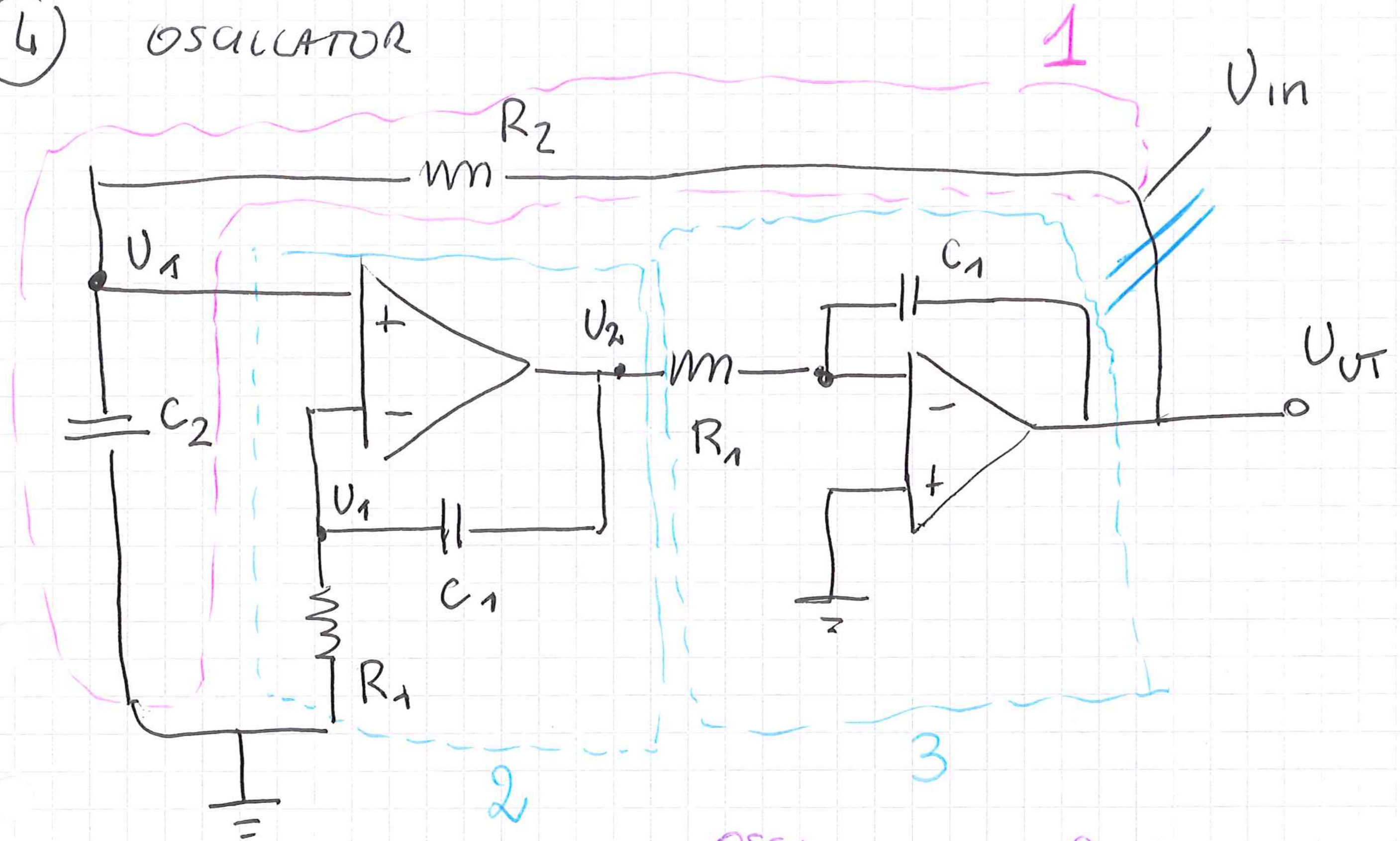
I & II $\Rightarrow$ $v_{ut} = (i_{ut} - g_m v_{ut}) R_S$

$$u_{ut}(1 + g_m R_S) = i_{ut} R_S$$

$$R_{ut} = \frac{u_{ut}}{i_{ut}} = \frac{R_S}{1 + g_m R_S} = \frac{2\,k\Omega}{1 + 4\frac{mA}{V} \cdot 2k\Omega} =$$

$$= 222\,\Omega$$

4 OSCILLATOR



OSCILLATING CONDITION

$T(j\omega) \equiv 1$

1) $U_1 = \dfrac{U_{in}}{\frac{1}{sC_2} + R_2} \dfrac{1}{sC_2} = U_{in} \dfrac{1}{R_2 C_2 s + 1}$

2) $U_2 = 1 + \dfrac{1}{sC_1 R_1} U_1 = \dfrac{R_1 s C_1 + 1}{R_1 s C_1}$

3) $U_{UT} = - \dfrac{U_2}{R_1} \dfrac{1}{sC_1}$

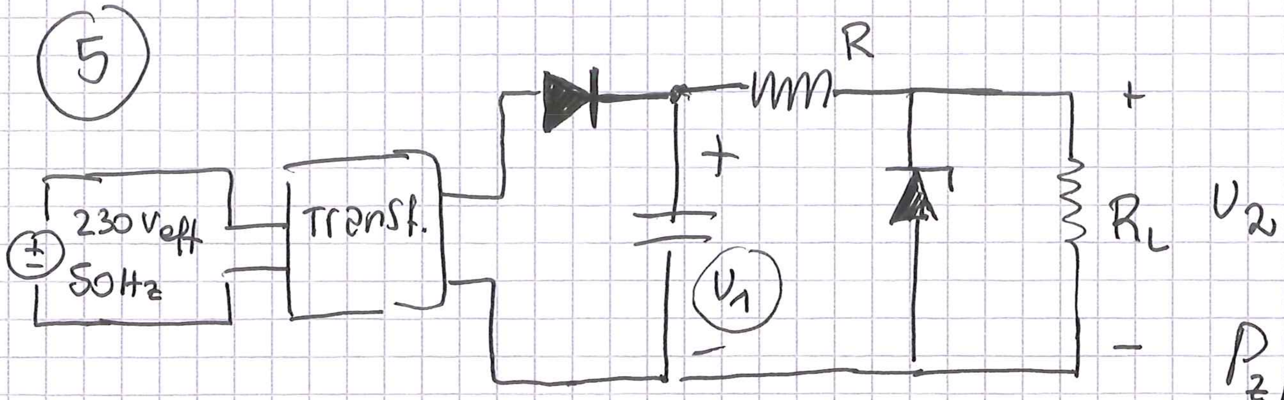
(1), (2) and (3) $\quad T(s) = \dfrac{U_{UT}}{U_{in}} = - \dfrac{1}{R_2 C_2 s + 1} \dfrac{R_1 C_1 s + 1}{R_1 C_1 s} \dfrac{1}{R_1 C_1 s}$

$$T(j\omega) = - \frac{R_1 C_1 j\omega + 1}{R_1^2 C_1^2 (j\omega)^2 (R_2 C_2 j\omega + 1)} \equiv 1$$

- $R_1 C_1 j\omega + 1 = R_2 C_2 j\omega + 1 \Rightarrow R_1 C_1 = R_2 C_2$
- $\omega^2 R_1^2 C_1^2 = 1$ $\quad \omega = \sqrt{\dfrac{1}{R_1^2 C_1^2}} = 0{,}03 \cdot 10^6 \text{ rad/sec}$ $\quad C_1 = \dfrac{R_2 C_2}{R_1} = 4{,}02 \text{ nF}$

$f = 4{,}83 \text{ kHz}$

(5)

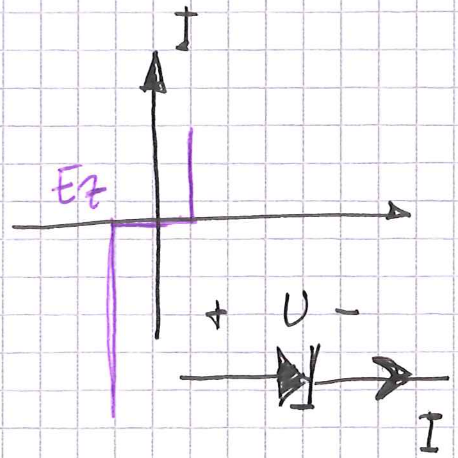


$R = 60\,\Omega$

$R_L = 120\,\Omega$

$E_z = 20\,V$

$P_{zMAX} = 2W$



within which limits of (U_1) ~~do we find~~ is found ~~if~~ the stabilization is mantained without the power lost by Zener exceeds P_{zMAX}?

U_{1MAX}? U_{1MIN}?

U_{1MAX}: $P_{zMAX} = I_{zMAX} \, E_z \Rightarrow I_{zMAX} = \dfrac{P_{zMAX}}{E_z} = \dfrac{2W}{20} = 0{,}1A$

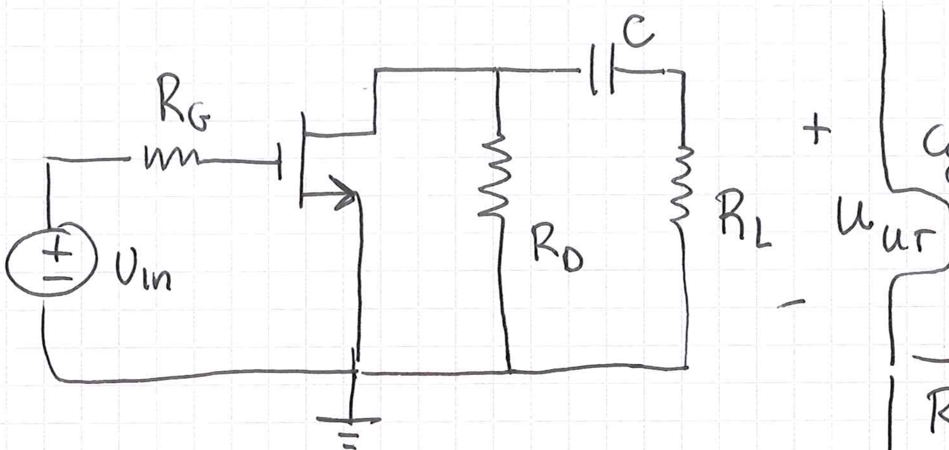
$U_{1MAX} = (I_{zMAX} + I_L) R + E_z = 16 + 20V = 36V$

$I_L = \dfrac{E_z}{R_L} = \dfrac{20V}{120\,\Omega} = 0{,}167A$

U_1 min: $I_z = 0$

$U_{1\,min} = I_L R + E_z = 10 + 20 = 30V$

6



$g_m = 40\,mA/V$

$C_{gs} = 30\,pF$

$C_{gd} = 4\,pF$

$R_G = 800\,\Omega$

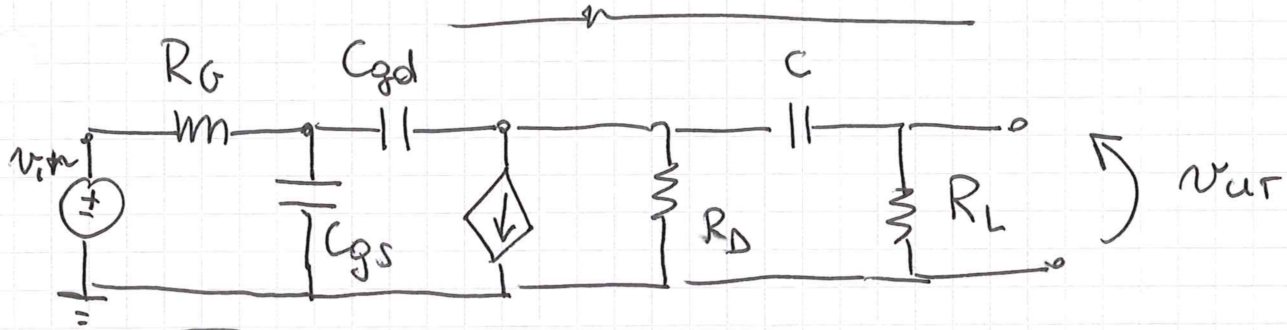
$R_D = 4\,k\Omega$

$R_L = 4\,k\Omega$

$C = 200\,nF$

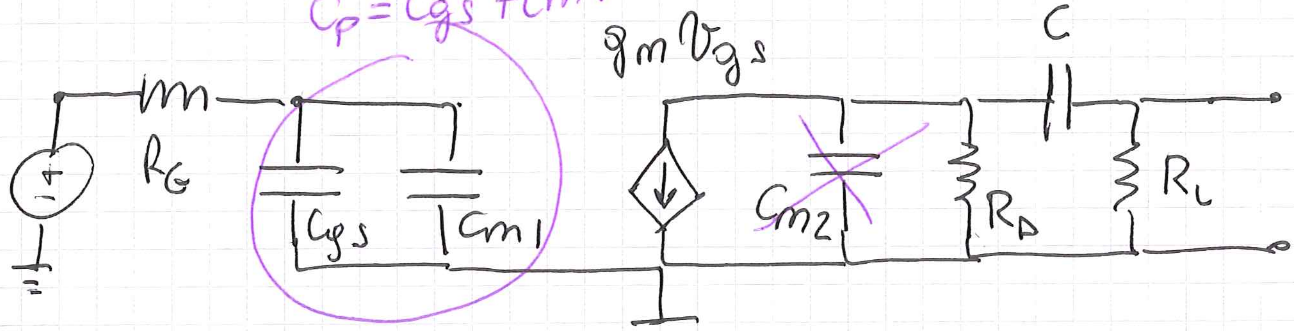
$C = \infty \rightarrow$ short $C = 0$ (open - AVBROTT)

Bode diagram $\dfrac{u_{ur}}{U_{in}}$



• miller

$C_p = C_{gs} + C_{m1}$



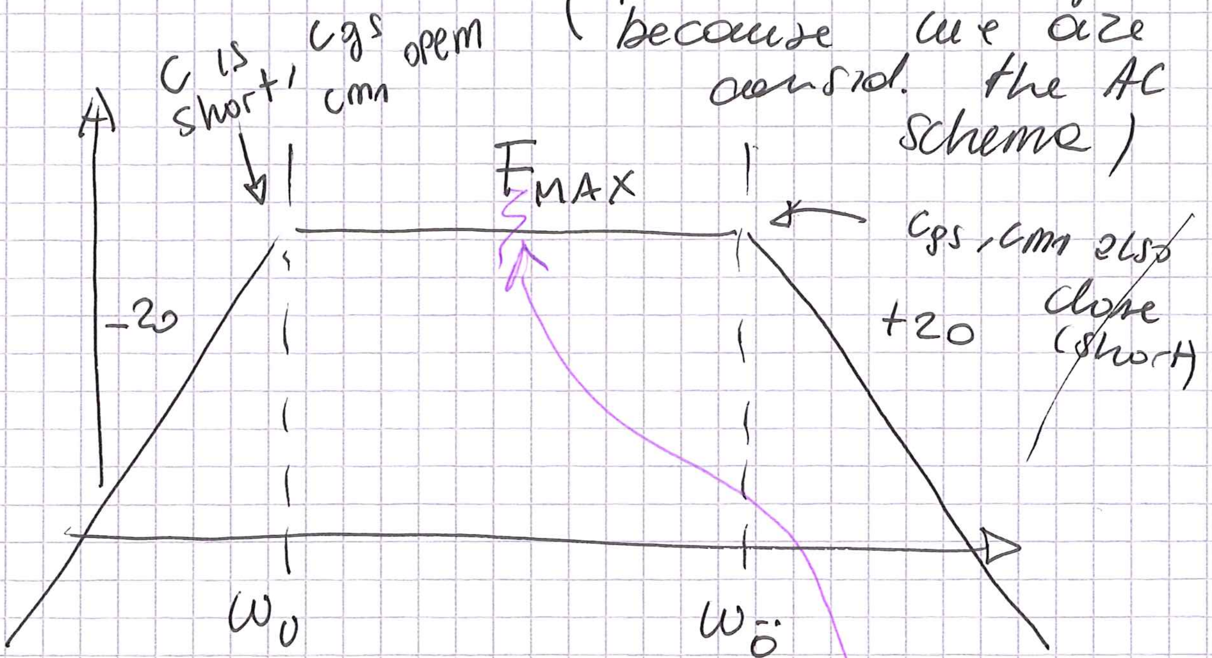
$C_{m1} = C_{gd}(1-K)$

$C_{m2} = \cancel{C_{gd}\dfrac{(K-1)}{K}}$ $K = \dfrac{v_{ds}}{v_{gs}}$

6 continue

the smaller capacitors are the ones that will come into play later (in freq) while the bigger will have a smaller cut off freq

(pole in the origine because we are consid. the AC scheme)

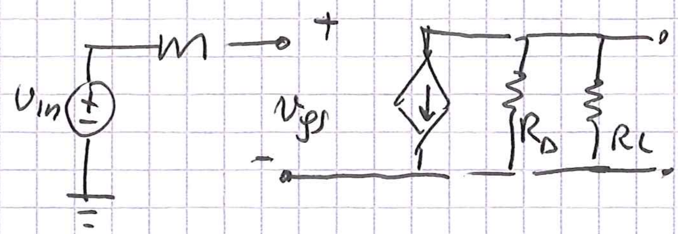


• F_{MAX} we need to be here

it means that C_{IS} short and C_{m}, C_{gs} open

$C = \infty \qquad C_{gs} = C_{m} = 0$

$v_{in} = v_{gs}$



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

$$\boxed{\frac{v_{out}}{v_{in}} = -g_m \; R_D // R_L}$$

current divider

• ω_u now we need to express transfer function but still C_{gs} and $C_m = 0$

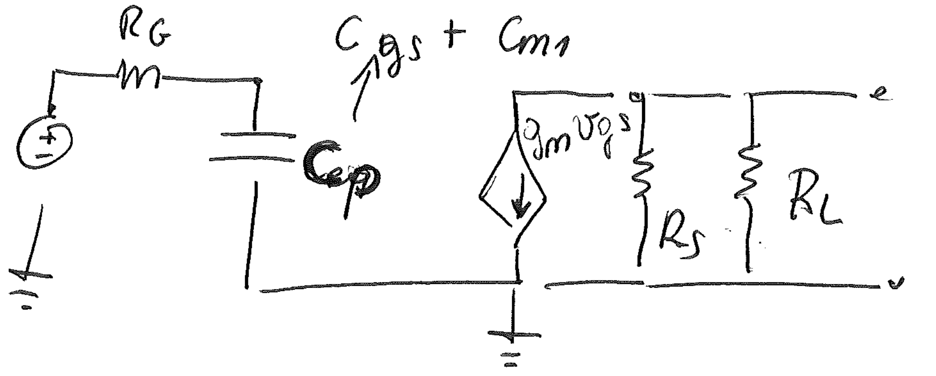
$$v_{out} = -g_m v_{gs} \left(\frac{R_D}{R_D + \frac{1}{sC} + R_L} \right) \cdot R_L = -\frac{g_m v_{gs} R_D R_L sC}{1 + sC(R_D + R_L)}$$

$v_{in} = v_{gs} \qquad \Rightarrow \omega_u = 1/C(R_D + R_L)$

@ continue

now we want to find $\omega_{\ddot{o}}$

C = ∞
short



$$v_{gs} = \frac{1}{sC_p} \frac{1}{R_G + \frac{1}{sC_p}} U_{in} \qquad U_{in} = v_{gs}\, sC_p \left(R_G + \frac{1}{sC_p}\right)$$

$$u_{ut} = -g_m v_{gs} \; R_s /\!/ R_L$$

$$\frac{u_{ut}}{U_{in}} = -\frac{g_m \cancel{v_{gs}} \; R_s /\!/ R_L}{\cancel{v_{gs}}\, sC_p \left(R_G + \frac{1}{sC_p}\right)} = -\frac{g_m \; R_s /\!/ R_L}{sC_p R_G + 1}$$

$$\omega_{\ddot{o}} = \frac{1}{C_p R_G} = \frac{1}{(C_{gs} + C_{m1}) R_G}$$

CURRENT DIVIDER