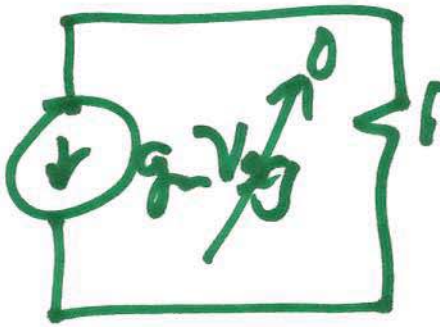
#20.15

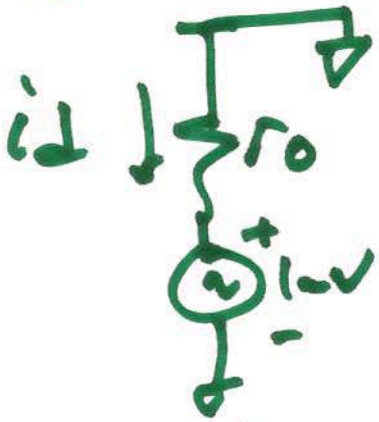
EE 420/ECE 620

Lecture 13

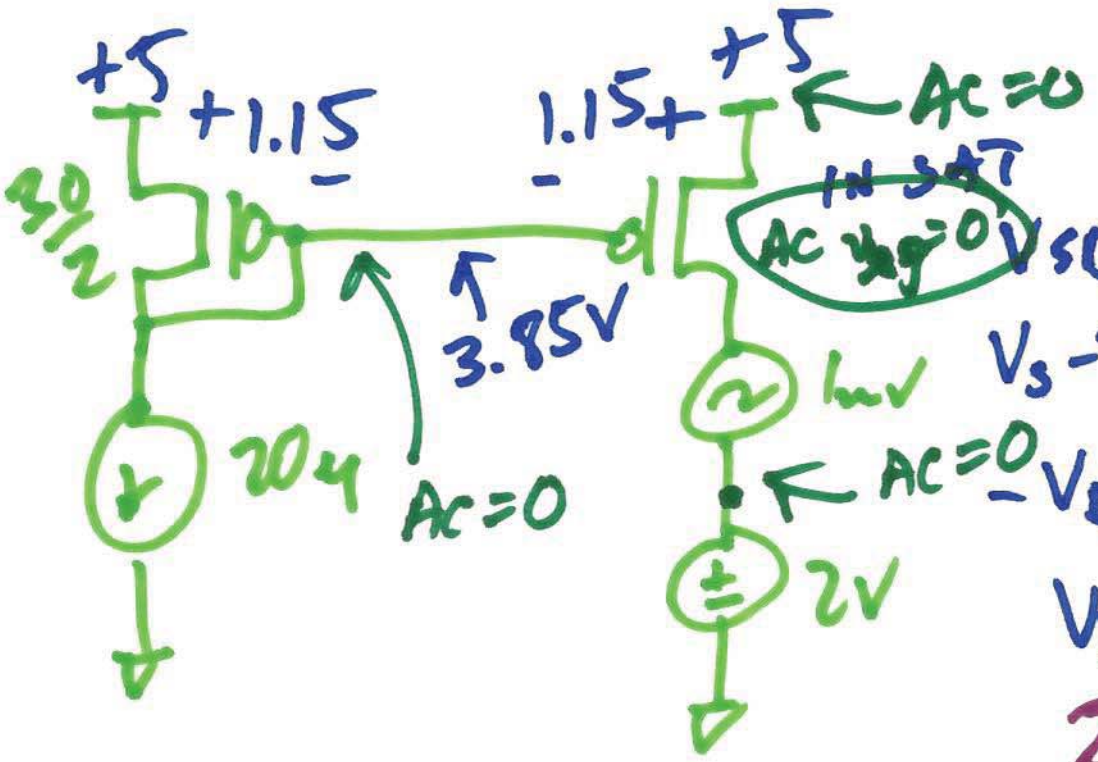
March 1, 2016



$i_C = \frac{10^{-3}}{4M\Omega} = 250nA$



$$i_d = -\frac{v_{in}}{r_o}$$



$V_{SD} \geq V_{SG} - V_{t,HP}$

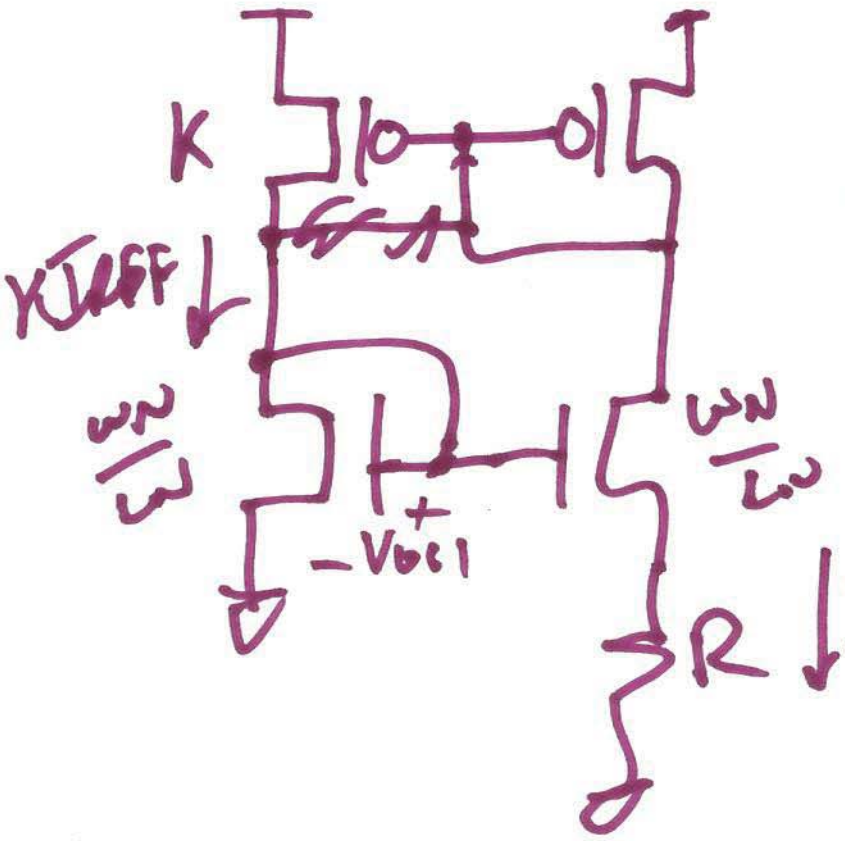
$V_S - V_D \geq V_S - V_G - V_{t,HP}$

$-V_D \geq -V_G - V_{t,HP}$

$V_D \leq V_G + V_{t,HP}$

$2 \overset{?}{\leq} 3.85 + .9$

yes! in SAT



$$V_{GS1} = \sqrt{\frac{K I_{REF} \cdot 2}{\beta_N}} + V_{THN}$$

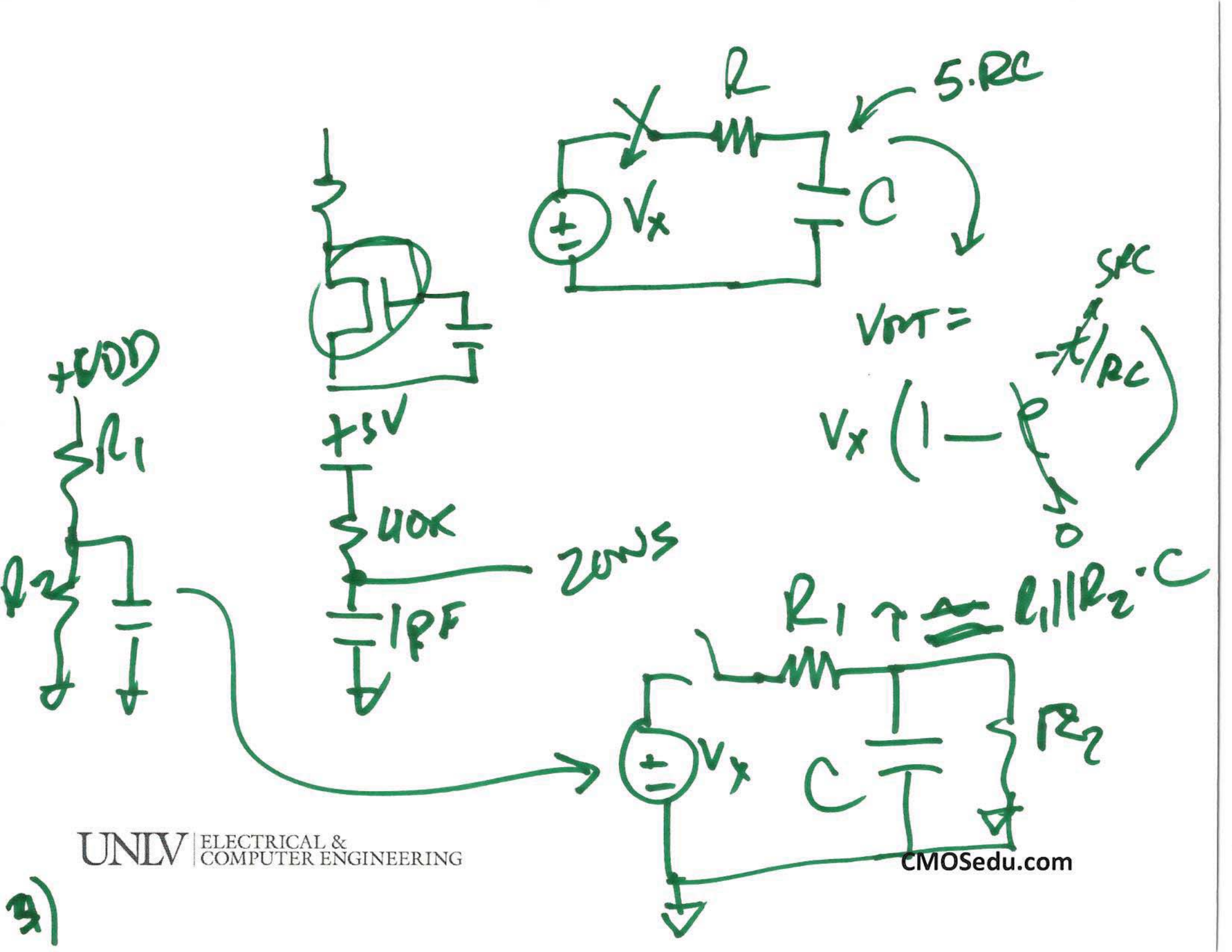
$$V_{GS2} = \sqrt{\frac{I_{REF} \cdot 2}{\beta_N}} + V_{THN}$$

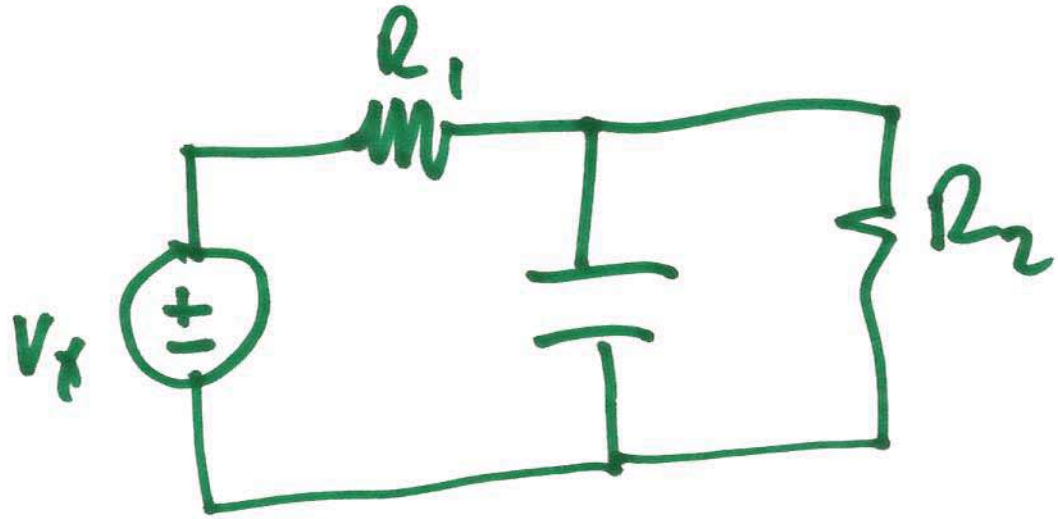
$$I_{REF} = \frac{V_{GS1} - V_{GS2}}{R} = \sqrt{\frac{K I_{REF} \cdot 2}{\beta_N \cdot R^2}} - \sqrt{\frac{I_{REF} \cdot 2}{R^2 \cdot \beta_N}}$$

$$\sqrt{I_{REF}} = \sqrt{\frac{2}{\beta_N R^2}} \left(\sqrt{K} - 1\right)$$

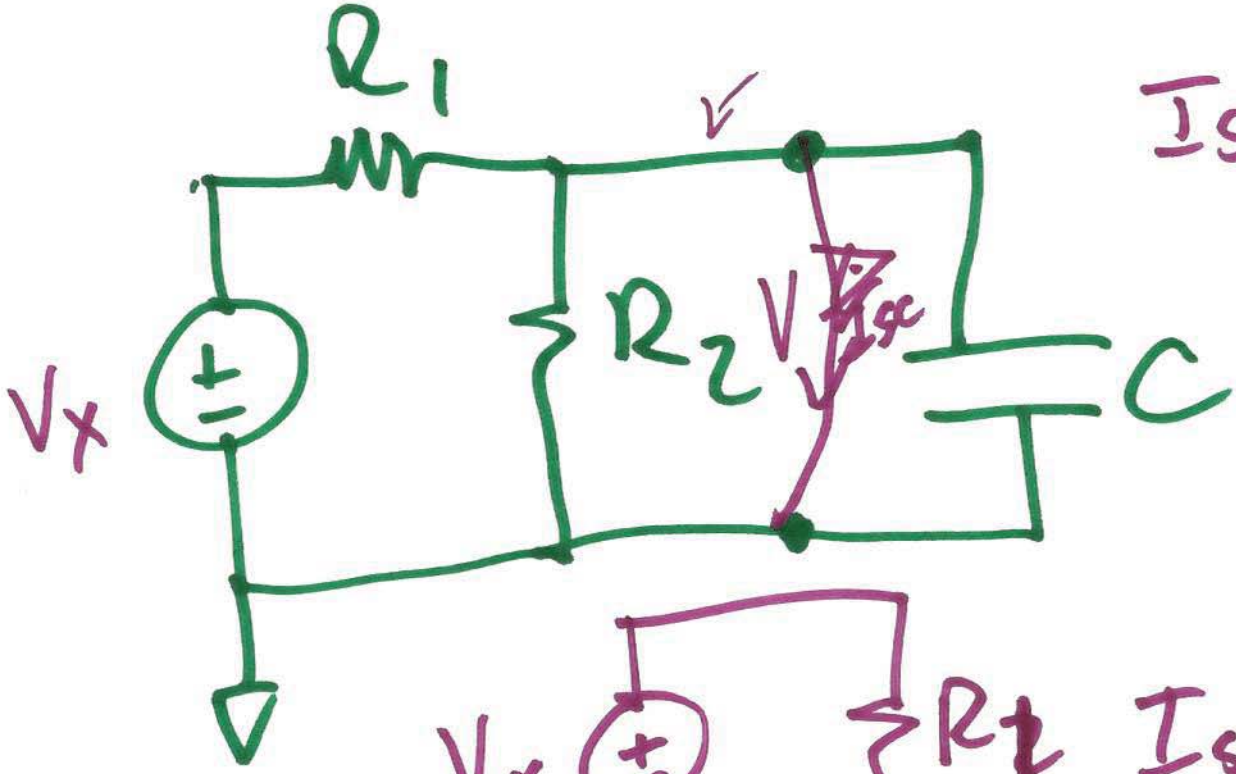
$$I_{REF} = \frac{2}{\beta_N R^2} \left(\sqrt{K} - 1\right)^2, K > 1$$

2)


R
5·RC
Vx
C
VOUT =
Vx (1 − e^(−t/RC))
5RC
+VDD
R1
R2
+5V
40K
20NS
1PF
R1 ∥ R2 · C
Vx
C
R2

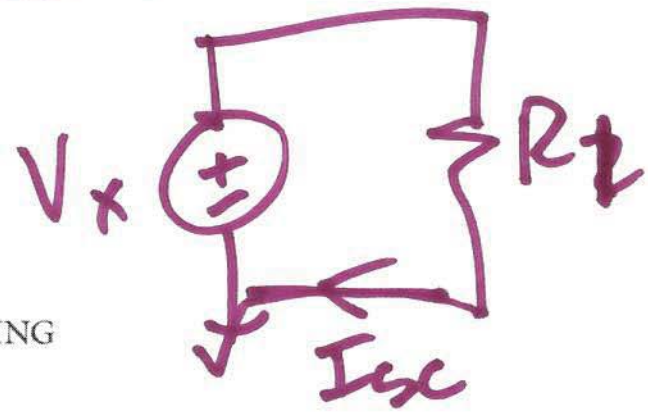


$$V_{THN} = V_{OC} = V_x \cdot \frac{R_2}{R_1 + R_2}$$

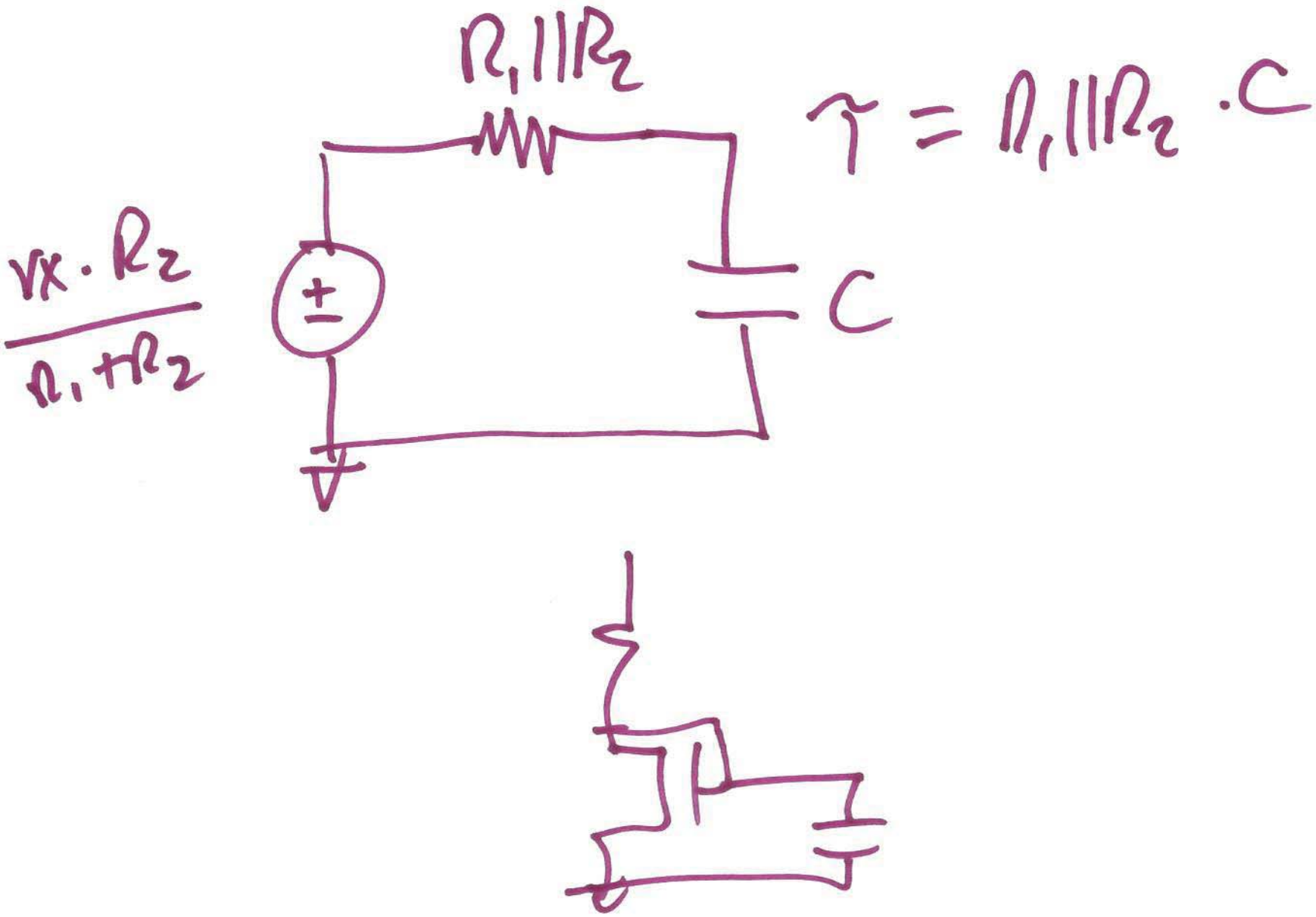


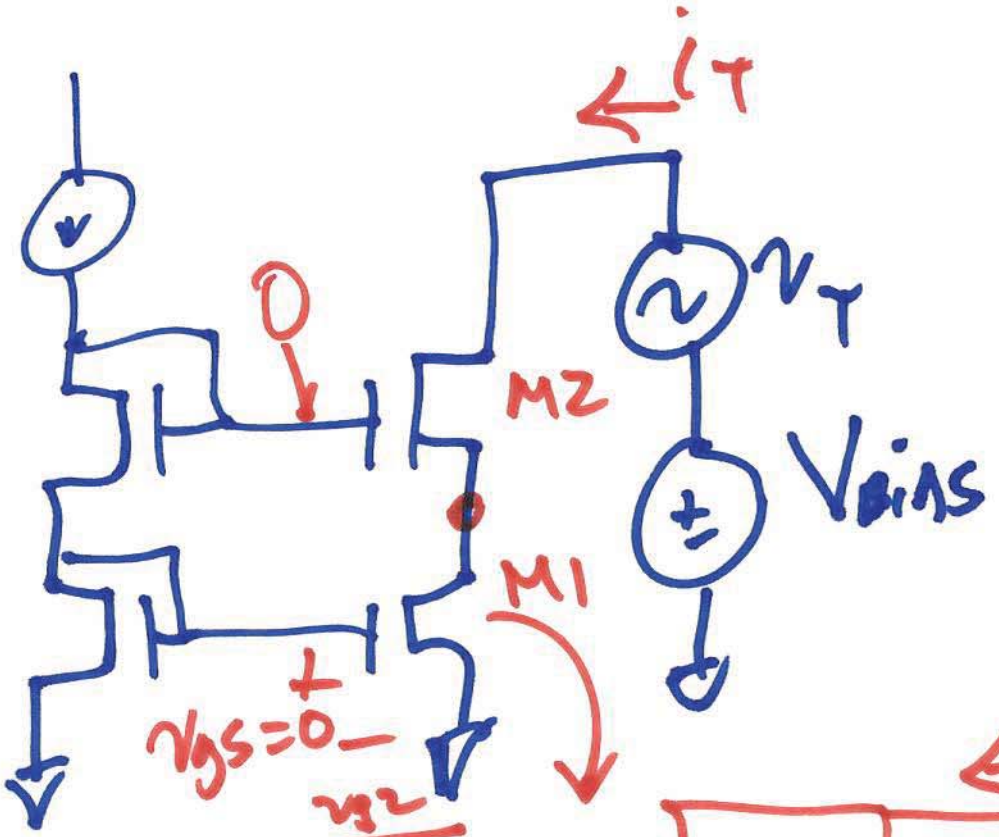
$$I_{SC} = \frac{V_x}{R_1}$$

$$R_{THN} = \frac{V_{OC}}{I_{SC}} = \frac{R_1 \cdot R_2}{R_1 + R_2} = R_1 \| R_2$$



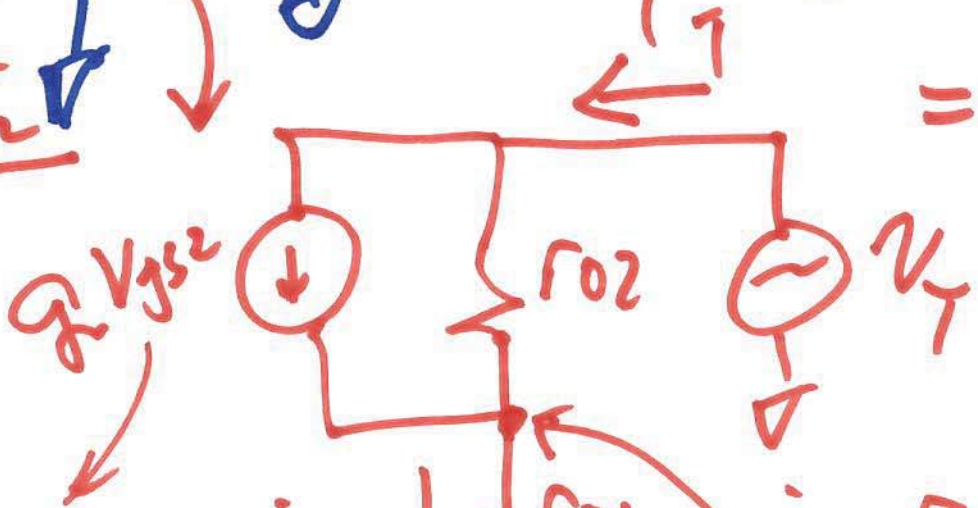
$$I_{SC} = \frac{V_x}{R_1}$$


$R_1 \| R_2$
$\tau = R_1 \| R_2 \cdot C$
$\frac{V_X \cdot R_2}{R_1 + R_2}$
C

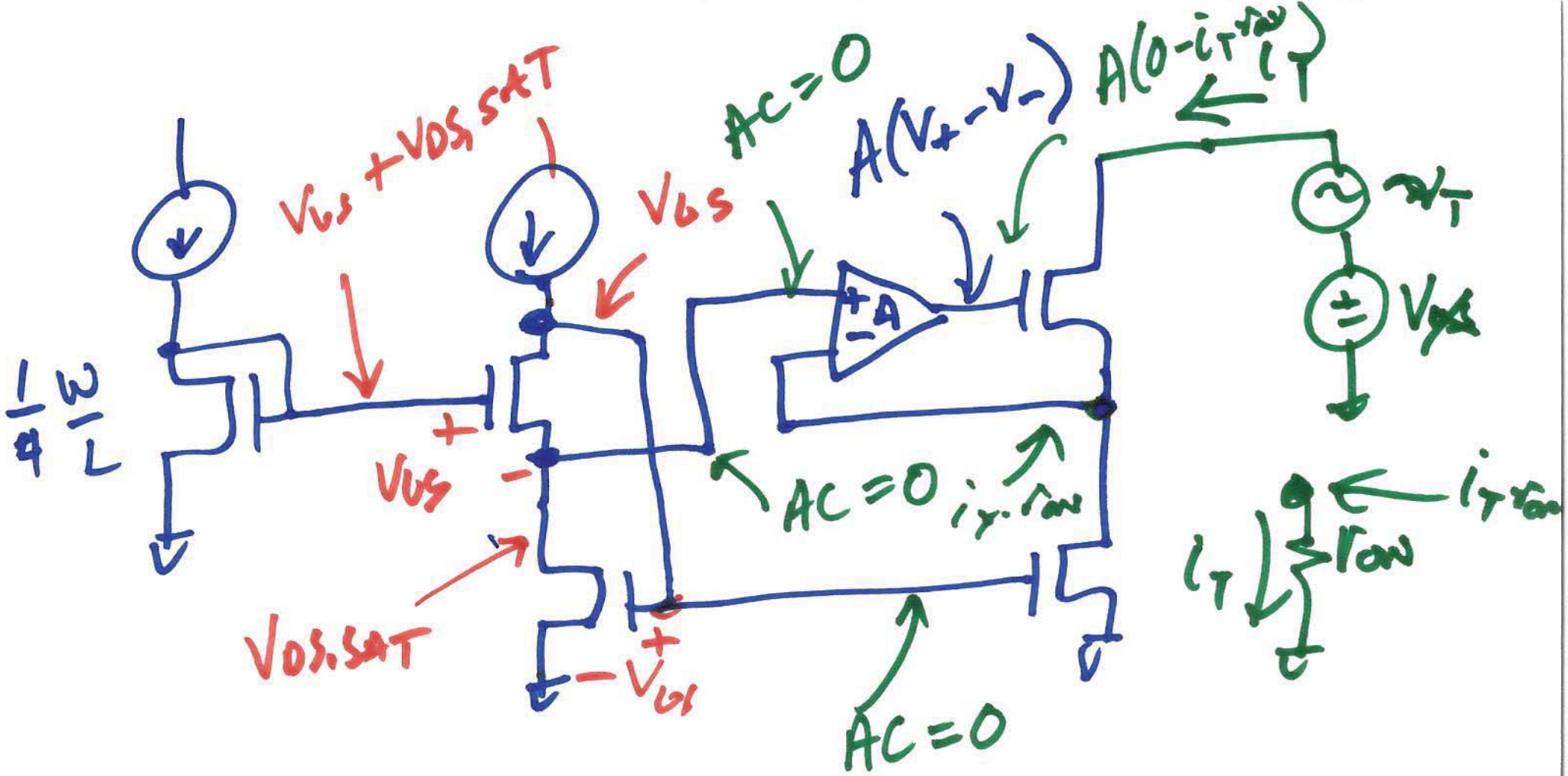


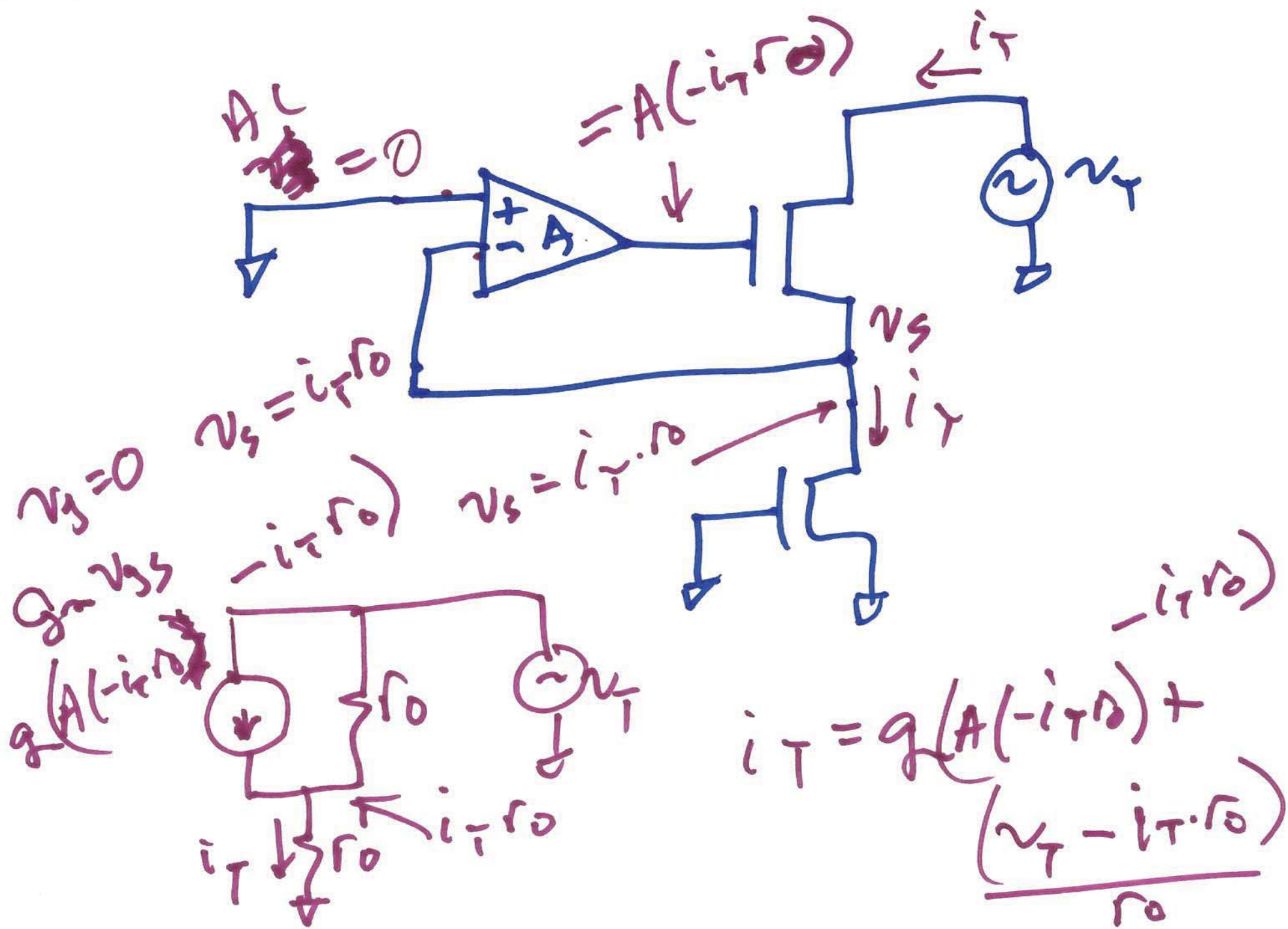
$$i_T = g_m(-i_T r_{O1}) + \frac{v_T - (+i_T r_{O1})}{r_{O2}}$$

$$i_T\left(1 + g_m r_{O1} + \frac{r_{O1}}{r_{O2}}\right) = \frac{v_T}{r_{O2}}$$



$$\frac{v_T}{i_T} = r_{O2} + g_m r_{O1} \cdot r_{O2} + r_{O1}$$


$V_{GS}+V_{DS,SAT}$
V_{GS}
$AC=0$
$A(V_+-V_-)$
$A(0-i_T r_{ON})$
i_T
$\frac{1}{2}\frac{W}{L}$
$+A-$
V_{GS}
$AC=0$
$i_T r_{ON}$
$V_{DS,SAT}$
$-V_{GS}$
$AC=0$
i_T
r_{ON}
$i_T r_{ON}$


$A_L = 0$
$= A(-i_T r_o)$
i_T
v_T
$+$
$-$
A
v_S
$v_S = i_T r_o$
i_T
$v_S = i_T \cdot r_o$
$v_g = 0$
$-i_T r_o)$
$g_m v_{gs}$
$g(A(-i_T r_o)$
r_o
v_T
i_T
r_o
$i_T r_o$
$i_T = g(A(-i_T r_o) +$
$-i_T r_o)$
$\frac{(v_T - i_T \cdot r_o)}{r_o}$

$$i_T = g_m\left(-i_T r_o(1+A)\right) + \frac{v_T}{r_o} - i_T$$

$$i_T\left(1+1+g_m r_o(1+A)\right) = \frac{v_T}{r_o}$$

$$\frac{v_T}{i_T} \simeq g_m r_o^2(1+A) + 2r_o$$