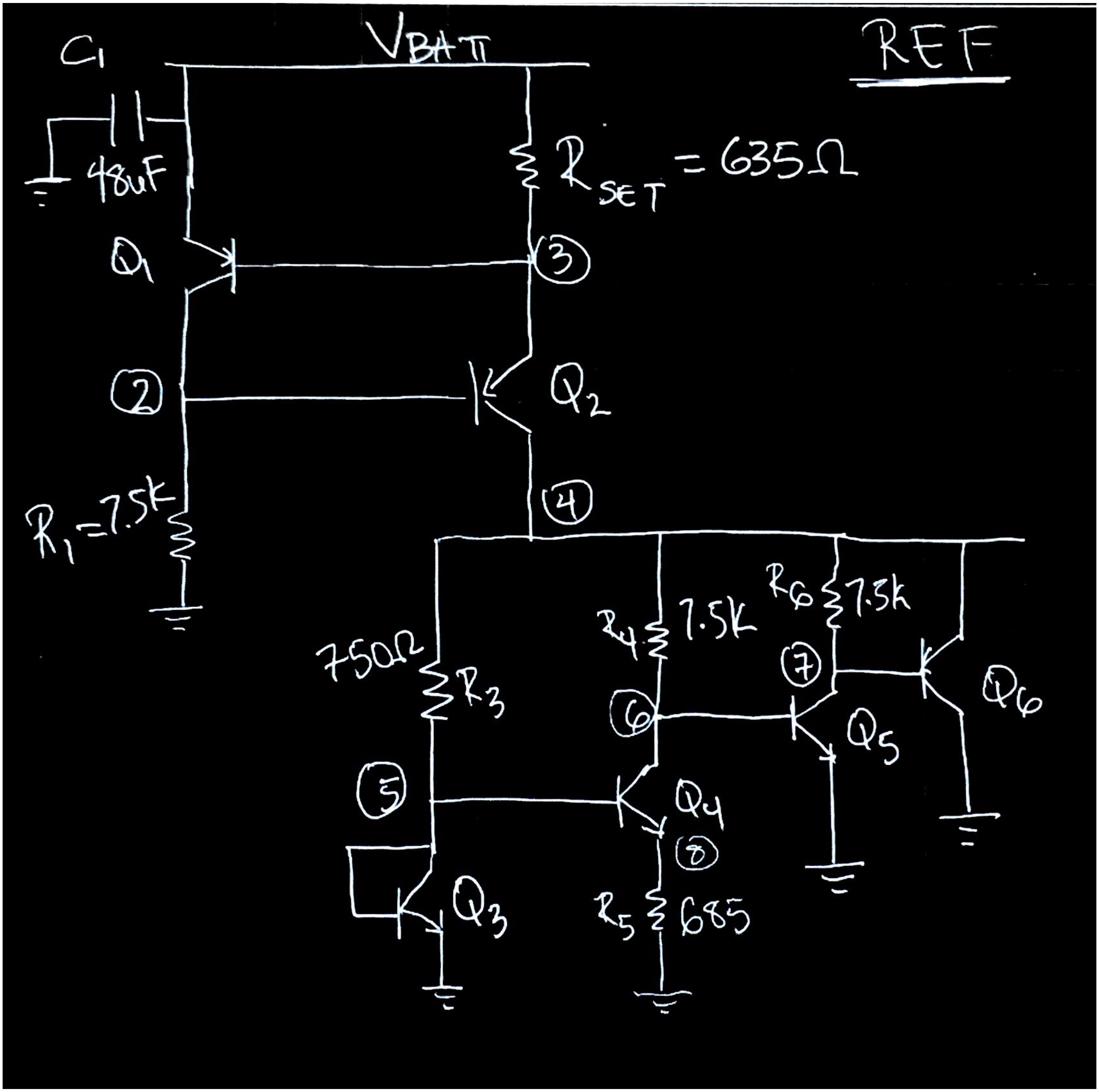
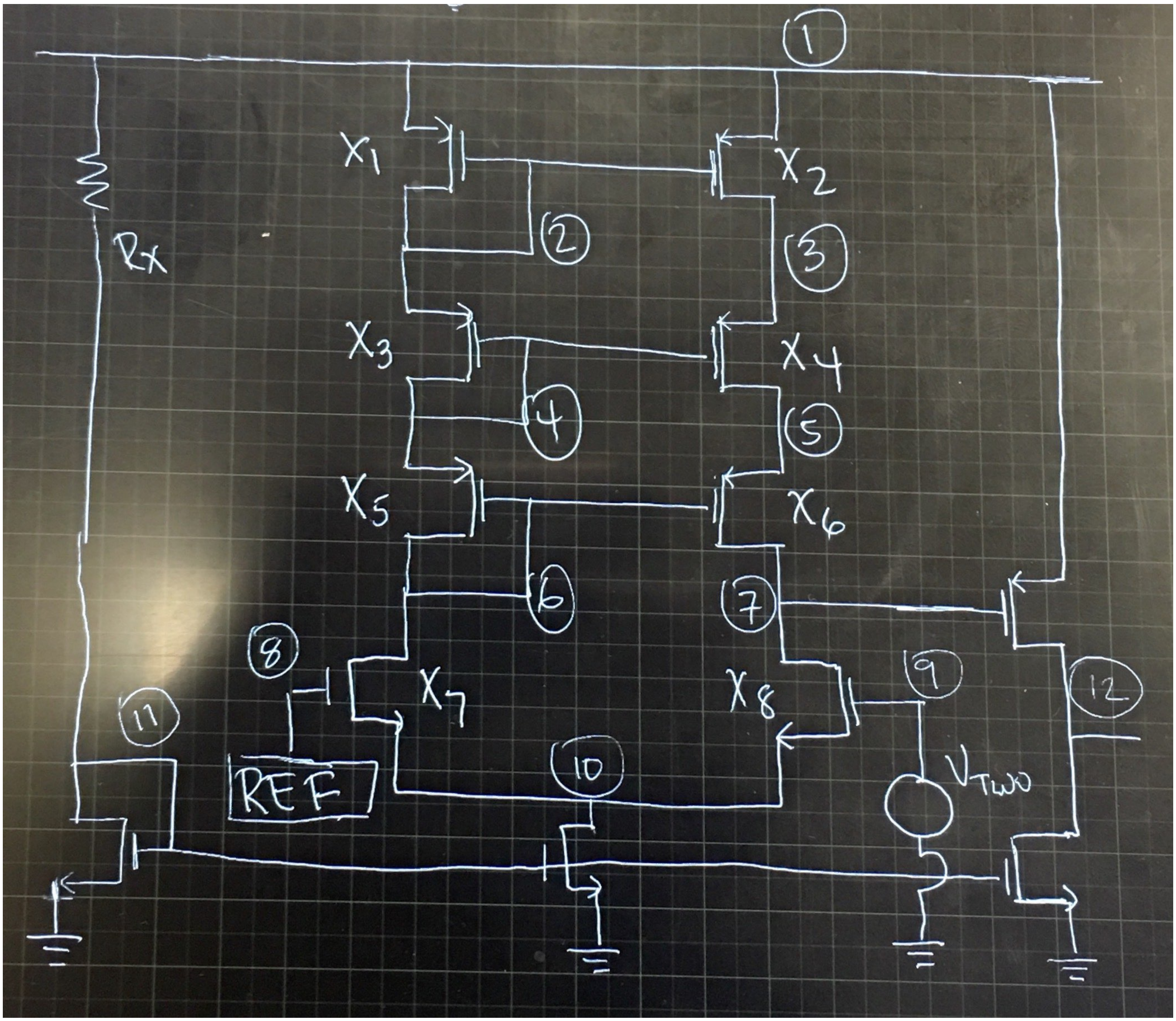
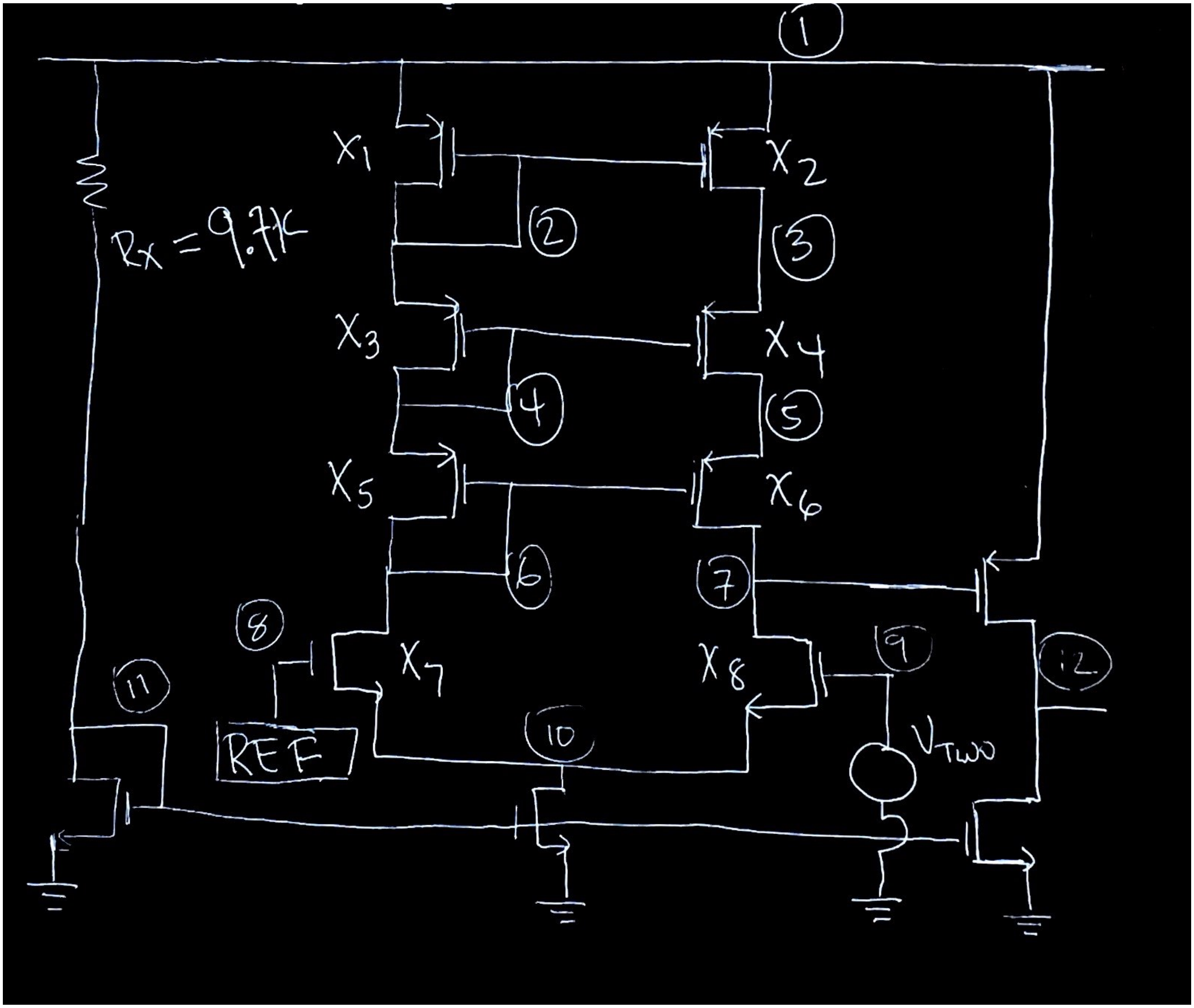


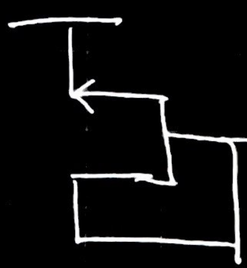
REF
VBATT
C1
48uF
RSET = 635Ω
Q1
3
2
Q2
4
R1=7.5K
750Ω
R3
R4 7.5K
R6 7.5k
7
Q6
6
Q5
5
Q4
8
Q3
R5 685


1
X1
X2
2
3
Rx
X3
X4
4
5
X5
X6
6
7
8
X7
X8
9
12
11
10
REF
VTWO

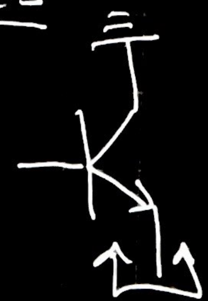

1
X1
X2
Rx = 9.7K
2
3
X3
X4
4
5
X5
X6
6
7
8
X7
X8
9
12
11
10
REF
VTWO

Opm Amp

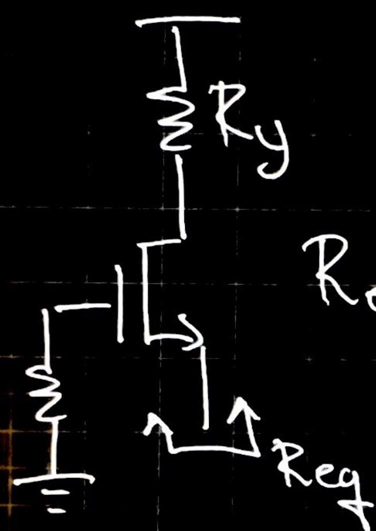
Resistor Rules



$\frac{1}{g_m}$



$R_{eq} = \frac{1}{g_m}$



$$R_{eq} = \frac{r_o + R_y}{1 + (g_m)(r_o)} \approx \frac{\cancel{r_o}}{(g_m)(\cancel{r_o})} \approx \frac{1}{g_m}$$

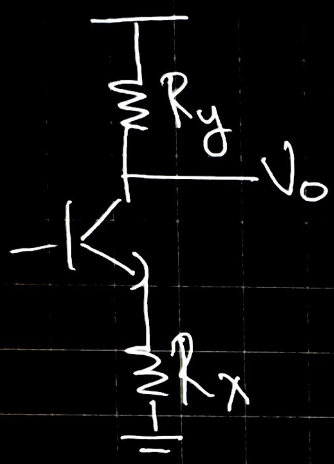
$$g_m = 2\sqrt{K I_D}$$

↳ same K value for two or more NPN

↳ same is true for PNP

↳ Same F
two or m
↳ Same is true for
PNP

Using the Gain Rule Learned in 315 and Review in 316.



$$\frac{V_o}{V_{in}} = \frac{-g_m R_y}{1 + g_m R_x}$$

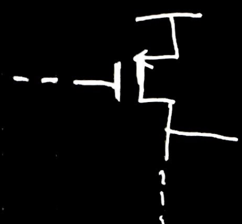
To find the small signal gain of our opm amp

↳ We can replace the current source which is produce by the circuit below with an ideal current source.

5:56 PM

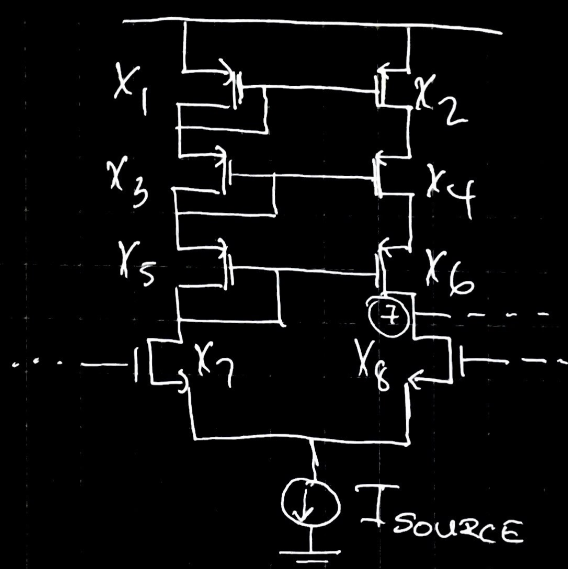
We will investigate the current source later.

↳ To simplify our computation by removing the piece at node 7 shown below.



We will add this piece later

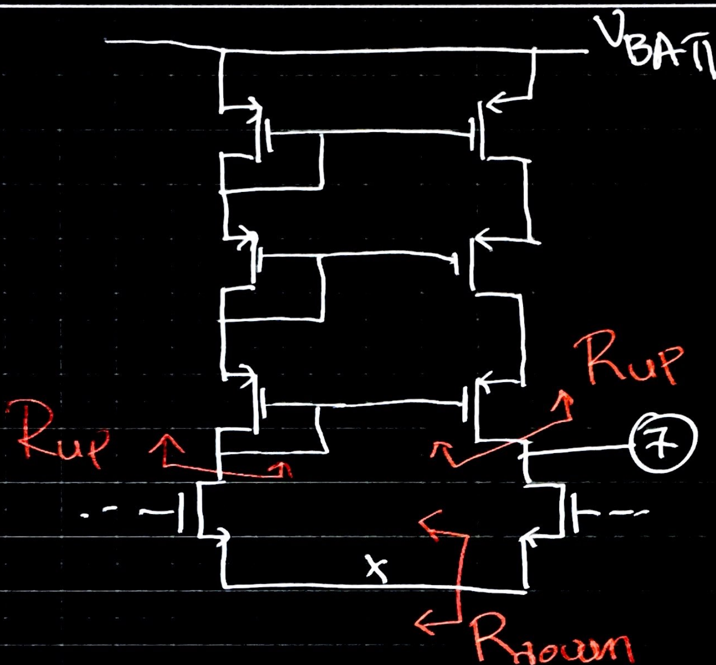
Therefore our Open Amp is reduce to



We can open I_{source} to find the gain at Node 7.

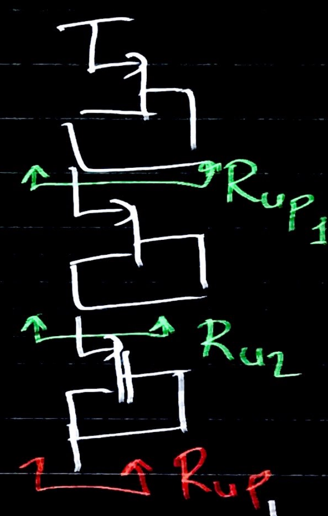
39% 6:00 PM

↳ Redrawing the opm



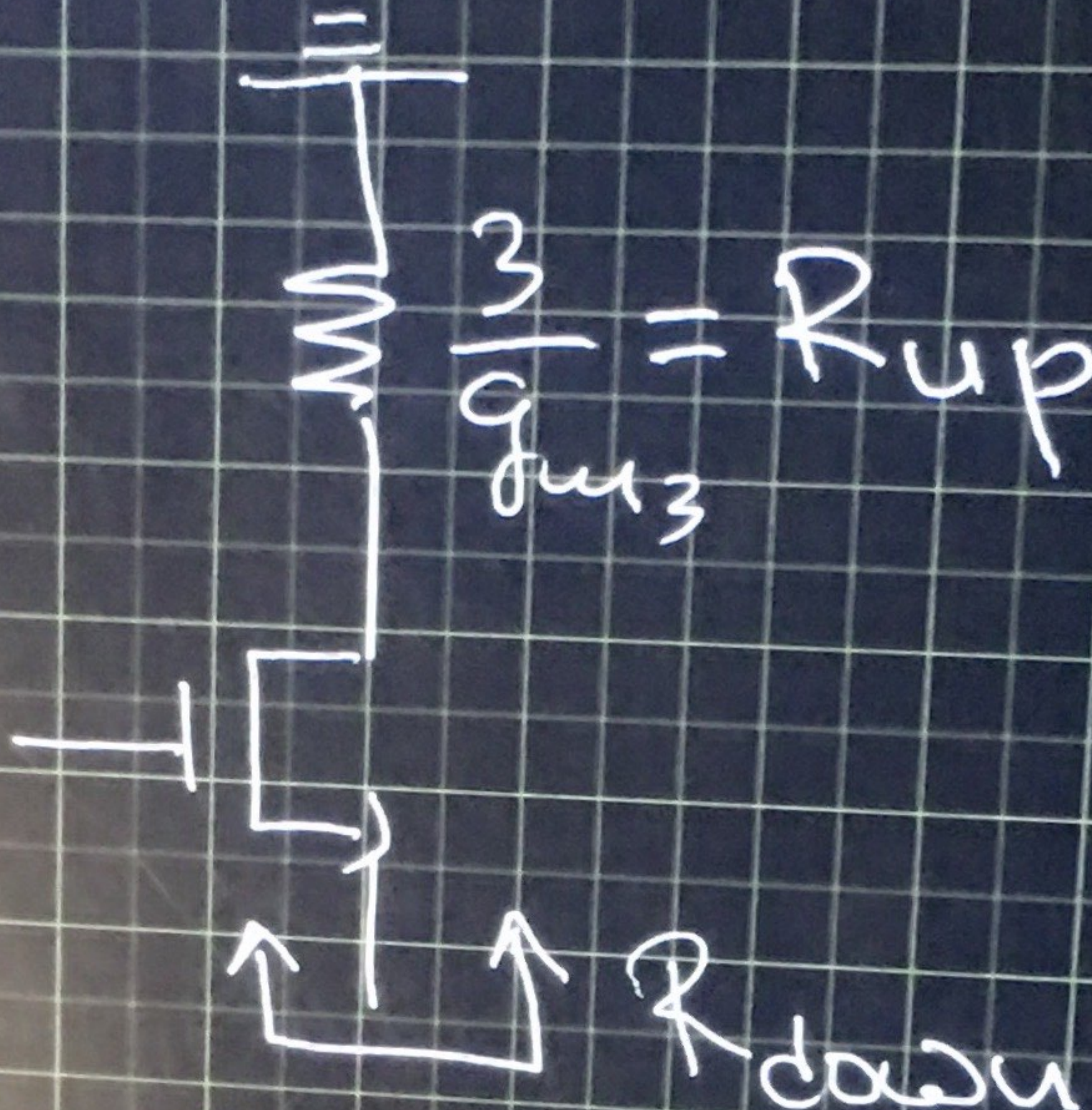
We can solve for R_{up}, R_{down}, and R_{up}

R_{up} is equal to

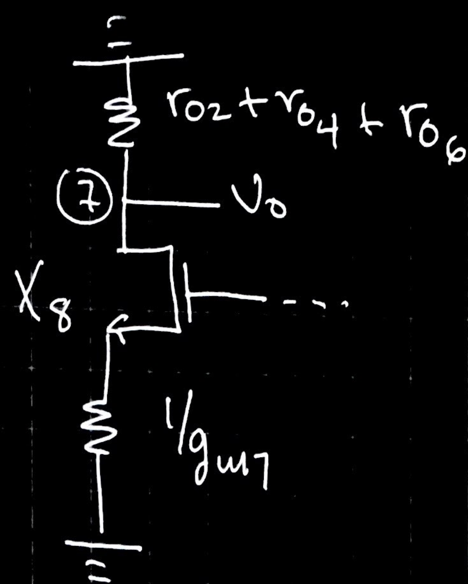


$$R_{u_p} = R_{up_1} + R_{up_1} + R_{u_2}$$

$$R_{up} = \frac{1}{g_{m_1}} + \frac{1}{g_{m_2}} + \frac{1}{g_{m_3}}$$



$\frac{3}{g_{m_3}} = R_{up}$
R_{down}



Using the gain equation 4.

$$\frac{V_o}{V_{in}} = \frac{-g_{m8}\,(r_{o2}+r_{o4}+r_{o6})}{1+g_{m8}\left(\frac{1}{g_{m7}}\right)}$$

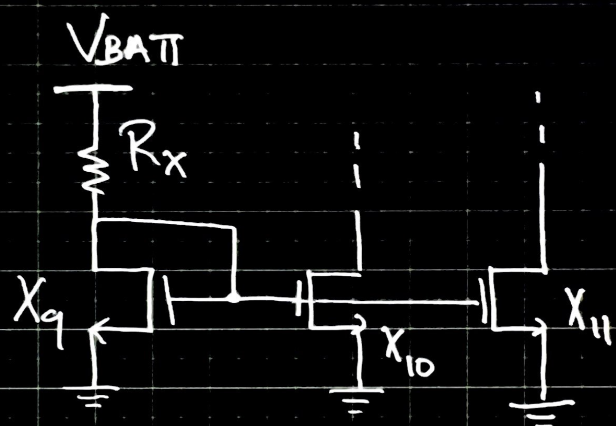
Equation VI

↳ And using figure 3 we know that X_7 & X_8 have the same g_m

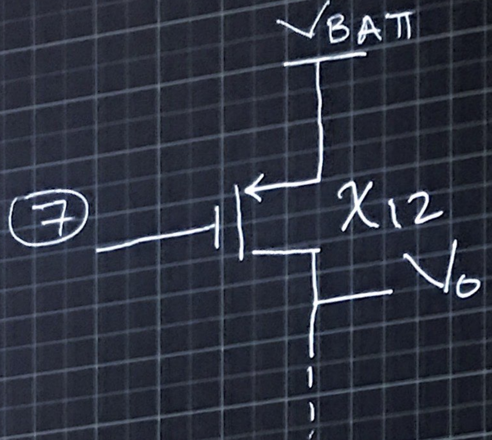
↳ So we can rewrite Equation VI as:

$$A_v = \frac{-(g_{m8})(r_{o2}+r_{o4}+r_{o6})}{2}$$

X_8



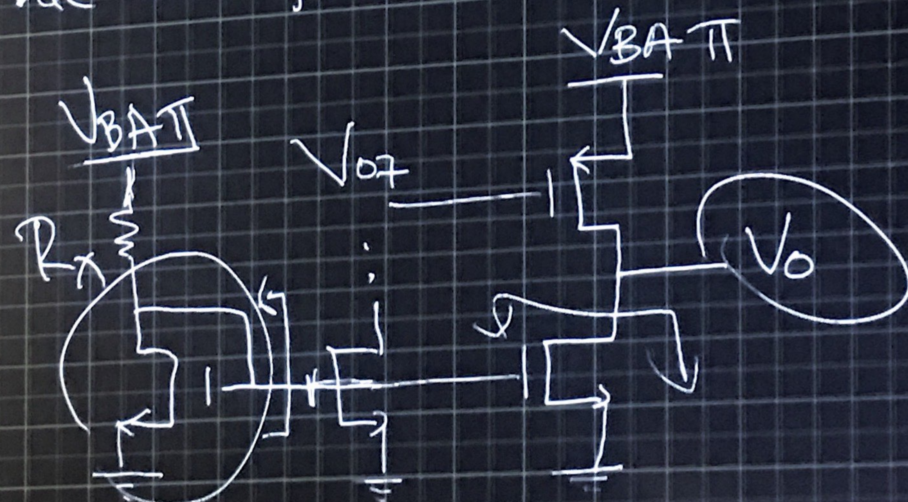
Now we add figure 6



This will give us the complete Opm Amp shown in figure 1

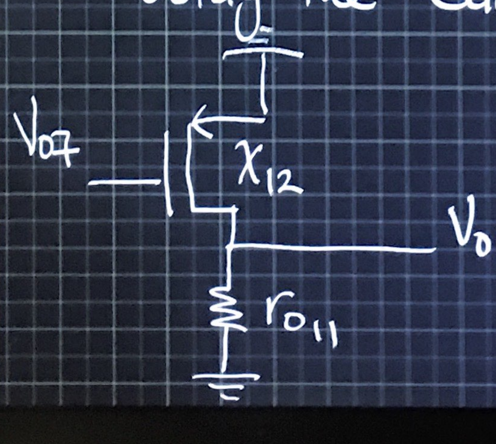
$$V_{o7} = \frac{(-g_{m8})(r_{o2}+r_{o4}+r_{o6})}{2} V_{in}$$

We can final add figure 6



$R_{down} = r_{o11}$

Redrawing The Opm Amp and using the Gain Equation we get



$$\frac{V_o}{V_{o7}} = -g_{m_{12}} r_{o11}$$