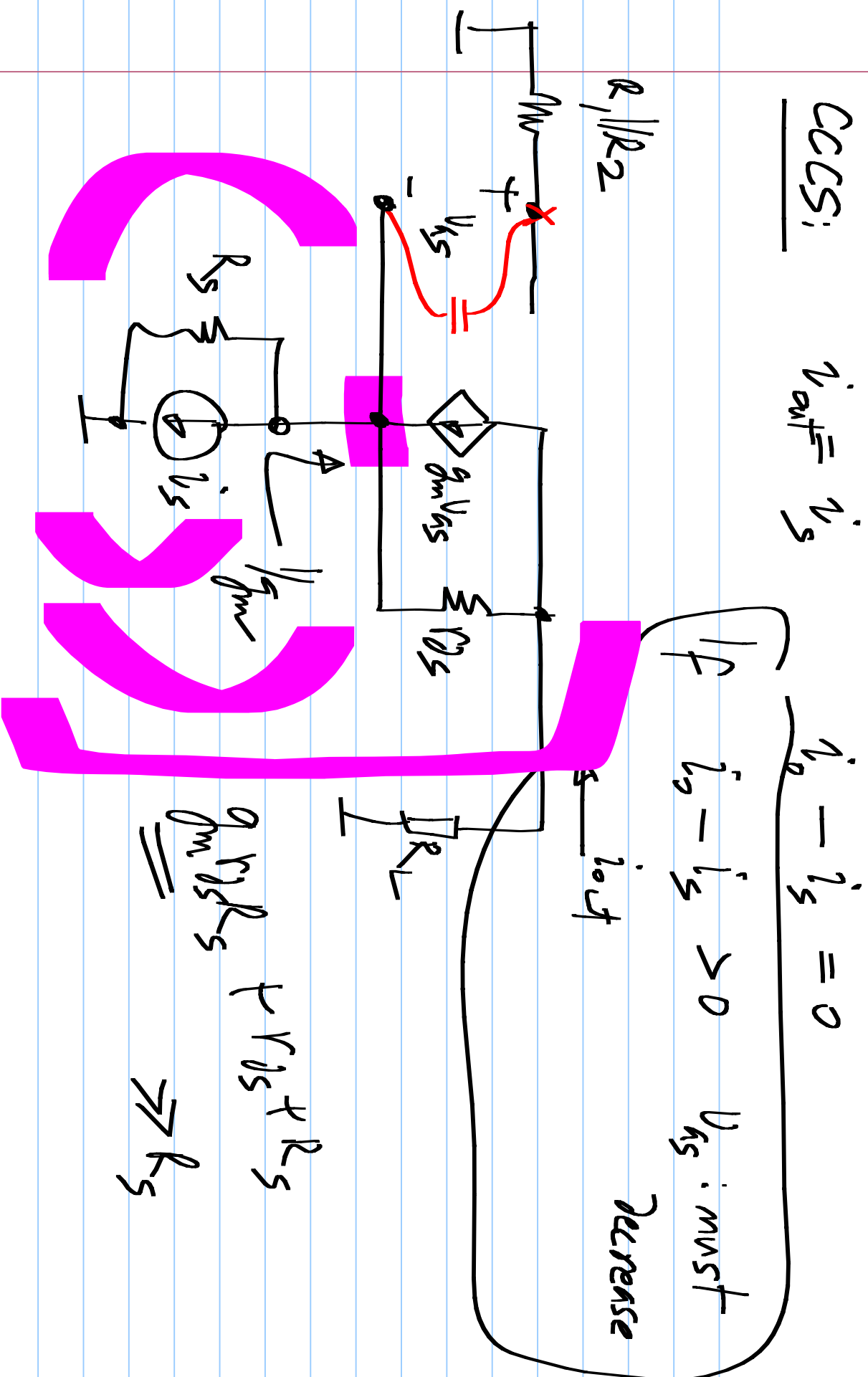
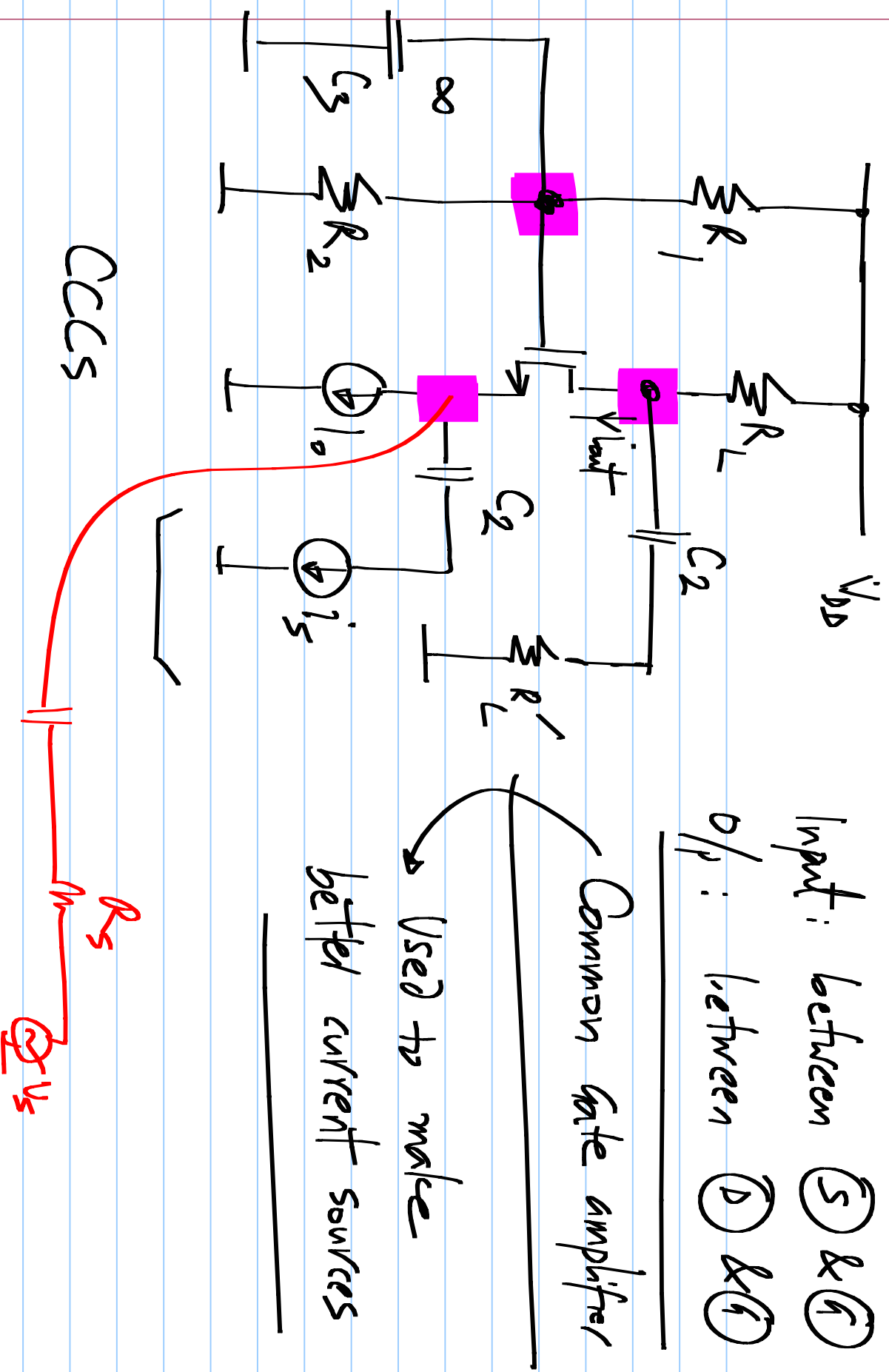


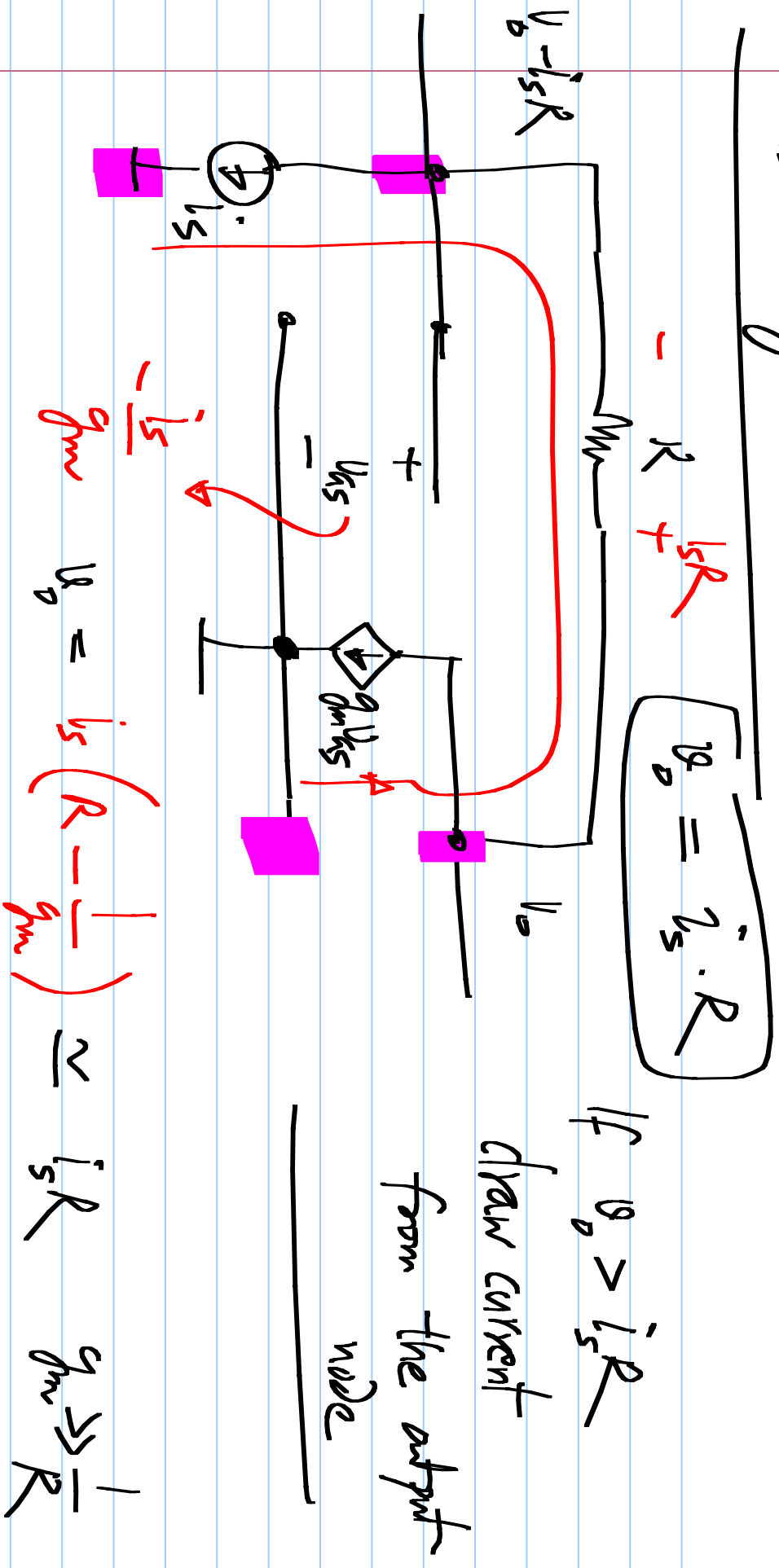
CCCS:

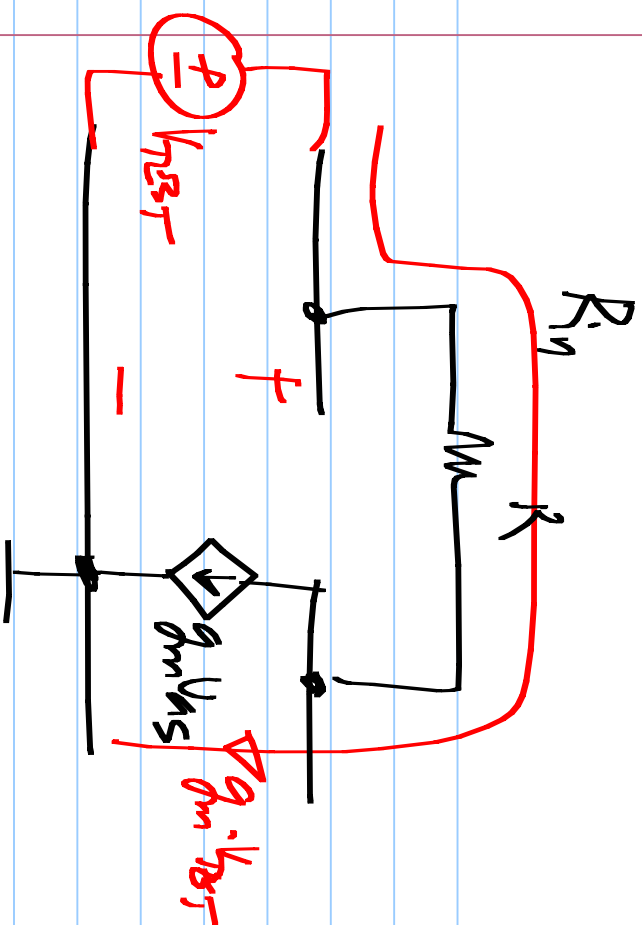
$$i_{out} = i_s$$



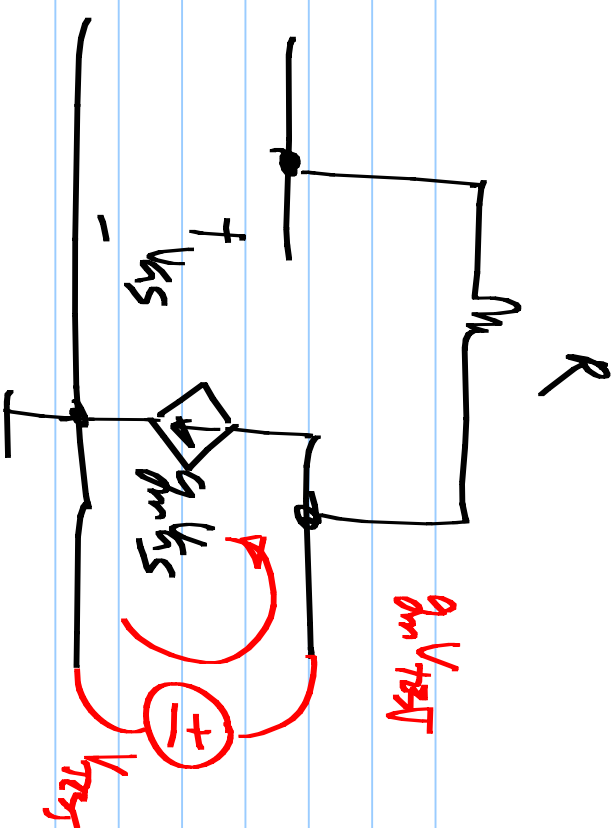


CCVS using a transistor:

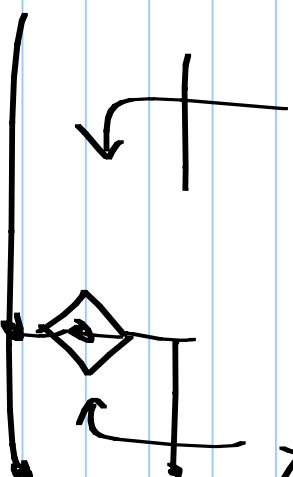


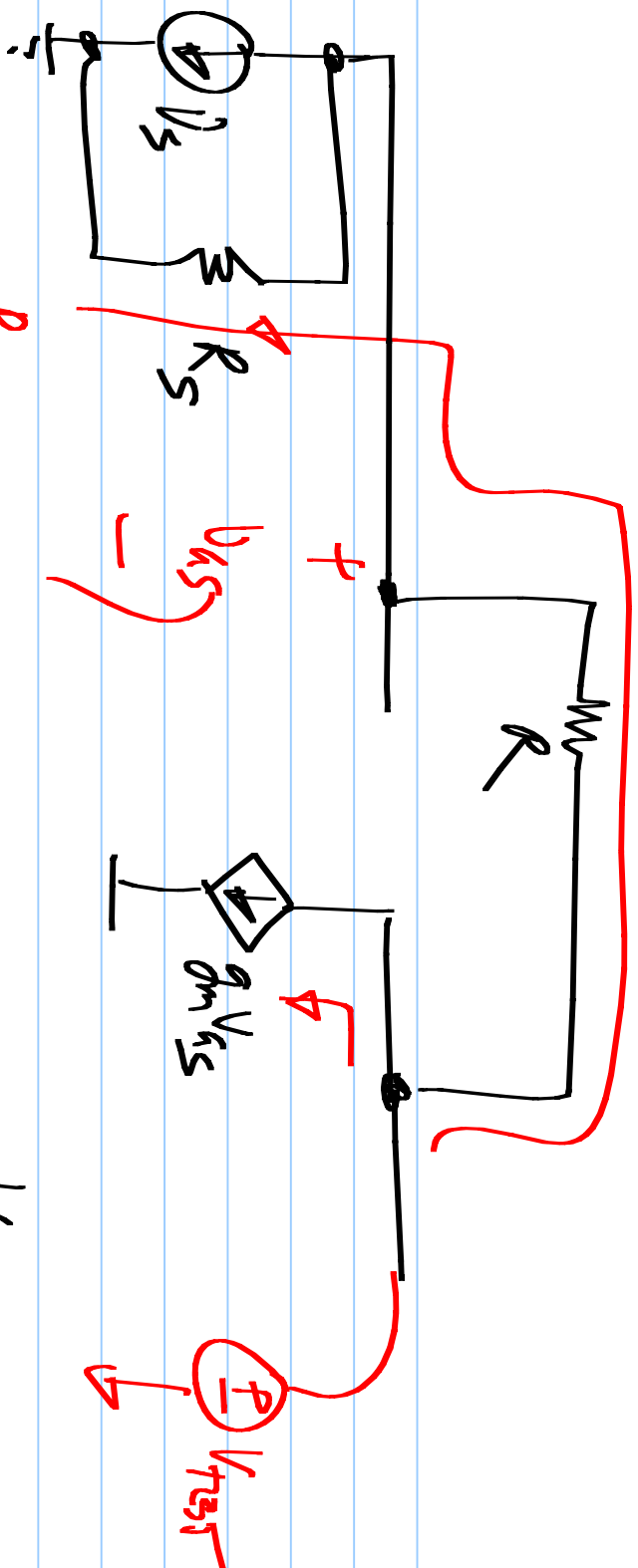


$$R_{in} = \frac{V_{test}}{g_m V_{test}} = \frac{1}{g_m}$$



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

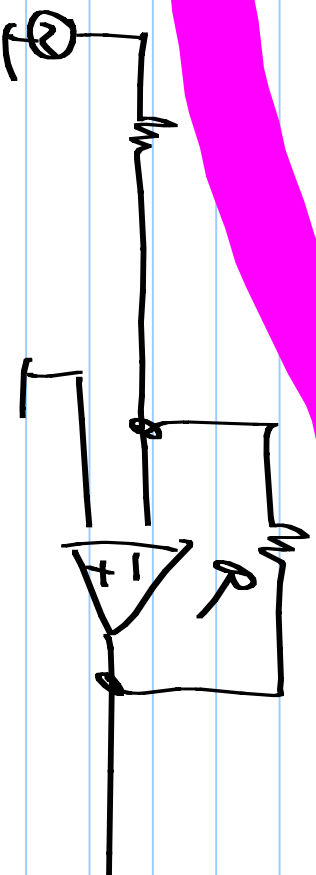
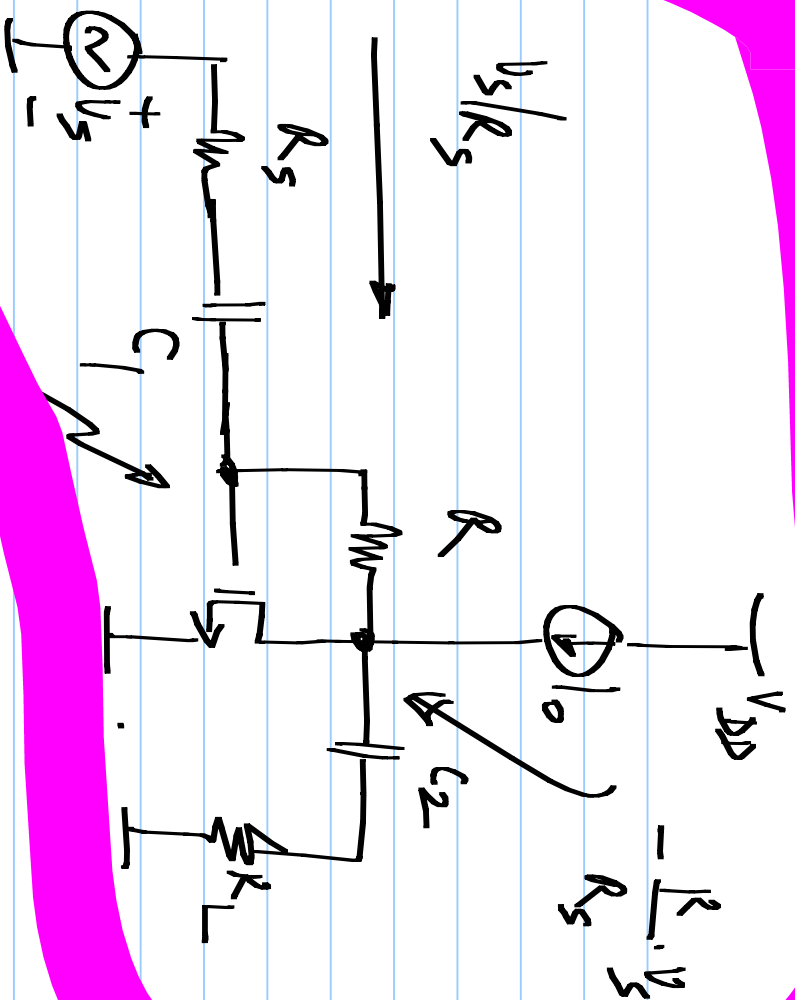
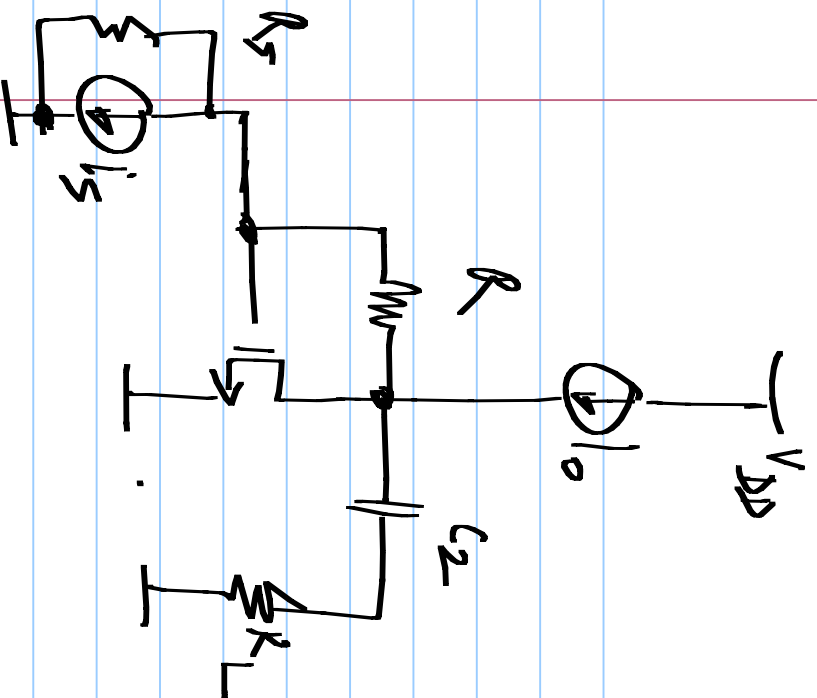




$$V_{test} \frac{R_S}{R + R_S}$$

$$R_S \rightarrow \infty \quad R_{out} = 1/g_m$$

$$\frac{V_{test}}{R + R_S} + \frac{g_m R_S \cdot V_{test}}{R + R_S} \quad R_{out} = \frac{R + R_S}{1 + g_m R_S}$$



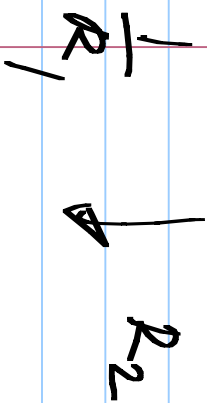
Controlled sources using opamps & transistors

$V_{CCS} + CCVS$

$VCCVS$



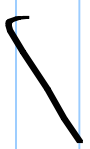
✓ (But 1x)



$VCCS$



$CCVS$



$CCVS + V_{CCS}$

$CCCS$

$A \cdot V_x$

✓ (But 1x)

