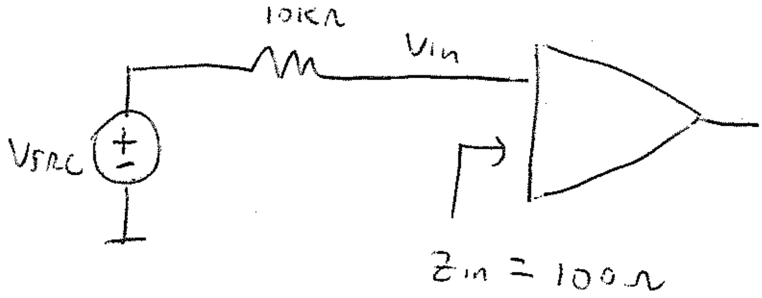
M.H. PERROTT

LECTURE 5

SLIDE 6)

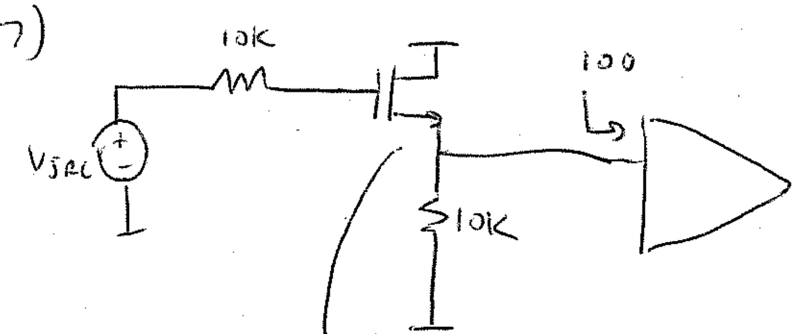


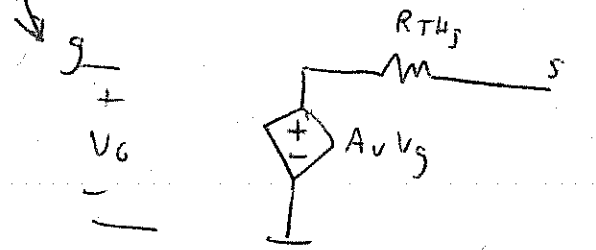
$$V_{in} = \frac{100}{10K + 100} V_{SRC} \simeq \frac{100}{10K} V_{SRC} = \frac{1}{100} V_{SRC}$$

$$\Rightarrow \boxed{\text{GAIN} = \frac{1}{100}}$$

⇒ IMPACT OF LOW Z_{in} AND HIGH Z_{SRC} IS HIGH ATTENUATION OF THE SOURCE SIGNAL

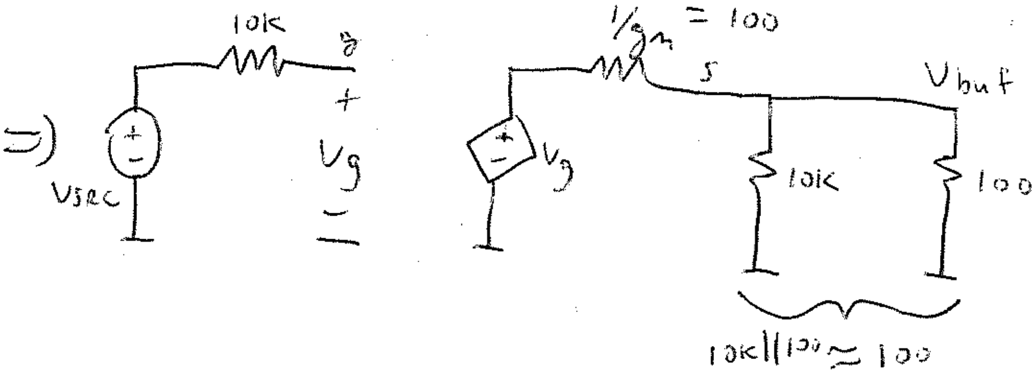
SLIDE 7)

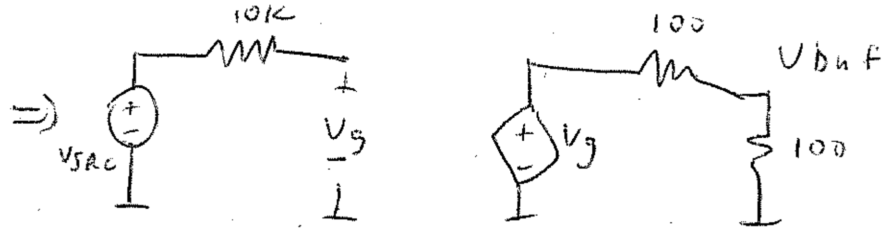




$$A_v = g_m r_o \| \frac{g_m}{g_m + g_{mb}} = \frac{1}{100} 100k \| \frac{g_m}{g_m + 0} \simeq 1$$

$$R_{THs} = \left(1 + \frac{R_D \to 0}{r_o}\right)\left(r_o \| \frac{1}{g_m + g_{mb} \to 0}\right) \simeq \frac{1}{g_m}$$

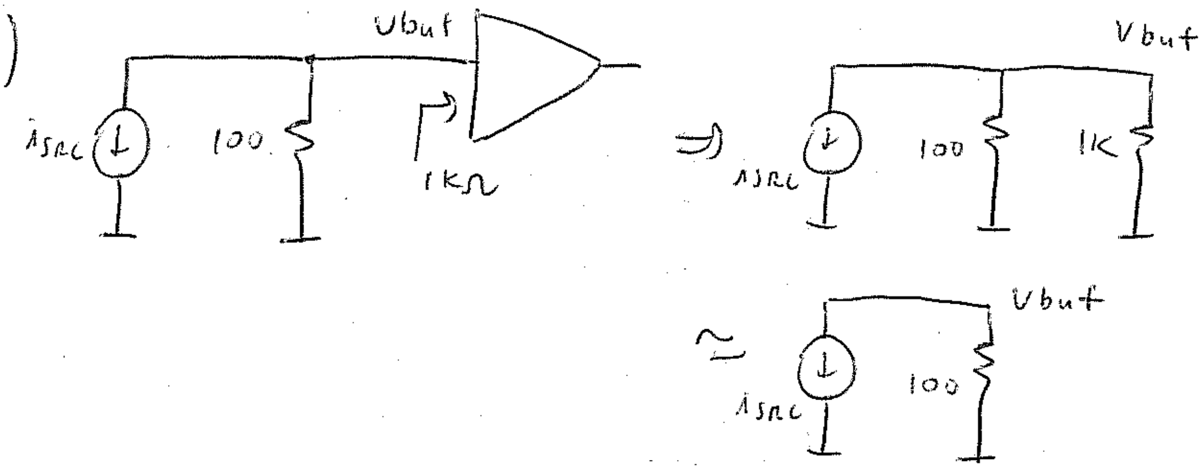




$$\Rightarrow V_{buf} = \frac{100}{100+100} V_g = \frac{1}{2} V_{SRC} \Rightarrow \boxed{GAIN \approx \frac{1}{2}}$$

THE SOURCE FOLLOWER DRAMATICALLY REDUCED THE ATTENUATION CAUSED BY THE LOW INPUT IMPEDANCE BY PROVIDING A HIGH IMPEDANCE TO THE SOURCE AND A LOW OUTPUT IMPEDANCE TO DRIVE THE Z_{in} LOAD

SLIDE 8)



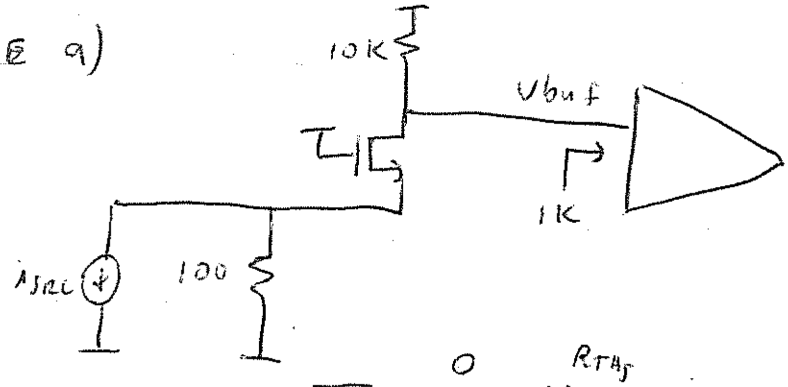
$\Rightarrow V_{buf} \simeq -100 \cdot i_{SRC}$

$\Rightarrow$ GAIN (TRANSIMPEDANCE) $= \boxed{-100\,\Omega}$

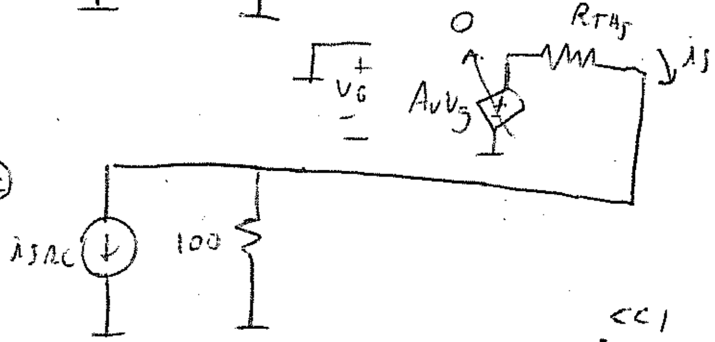
IN THIS CASE, LOW SOURCE IMPEDANCE RESULTS IN LOW TRANSIMPEDANCE GAIN

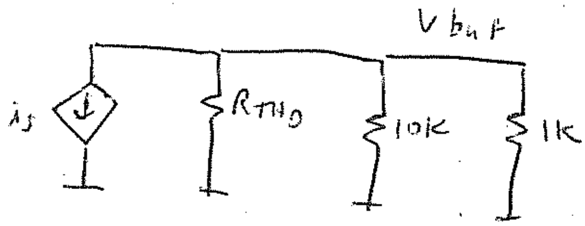
IN THIS CASE, USING A SOURCE FOLLOWER WILL NOT HELP SINCE THE SOURCE IMPEDANCE WILL STILL LIMIT THE TRANSIMPEDANCE GAIN.

SLIDE 9)



$\Rightarrow$



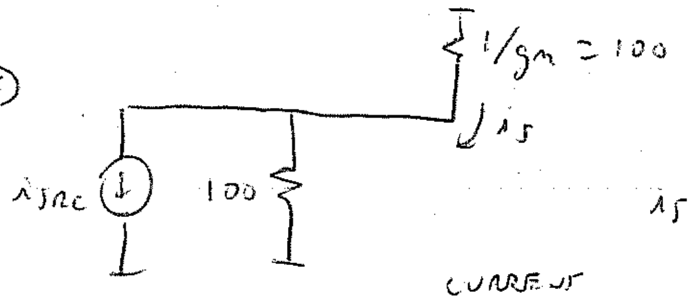


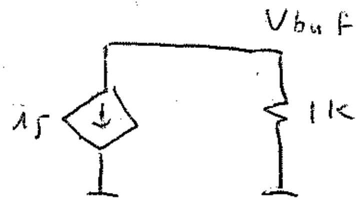
$$R_{THS} = \Big(1+\underbrace{\frac{R_D}{r_o}}_{<<1}\Big)\Big(r_o \,\|\, \frac{1}{g_m+\underbrace{g_{mb}}_{0}}\Big) \simeq \frac{1}{g_m} = 100$$

$$R_{THD} = r_o\big(1+(g_m+\underbrace{g_{mb}}_{0})\underbrace{R_S}_{100}\big) + \underbrace{R_S}_{100}$$

$$\simeq \boxed{\text{ro(1 + 1/100*100) = 2*ro = 200 kOhms}}$$

$\Rightarrow$





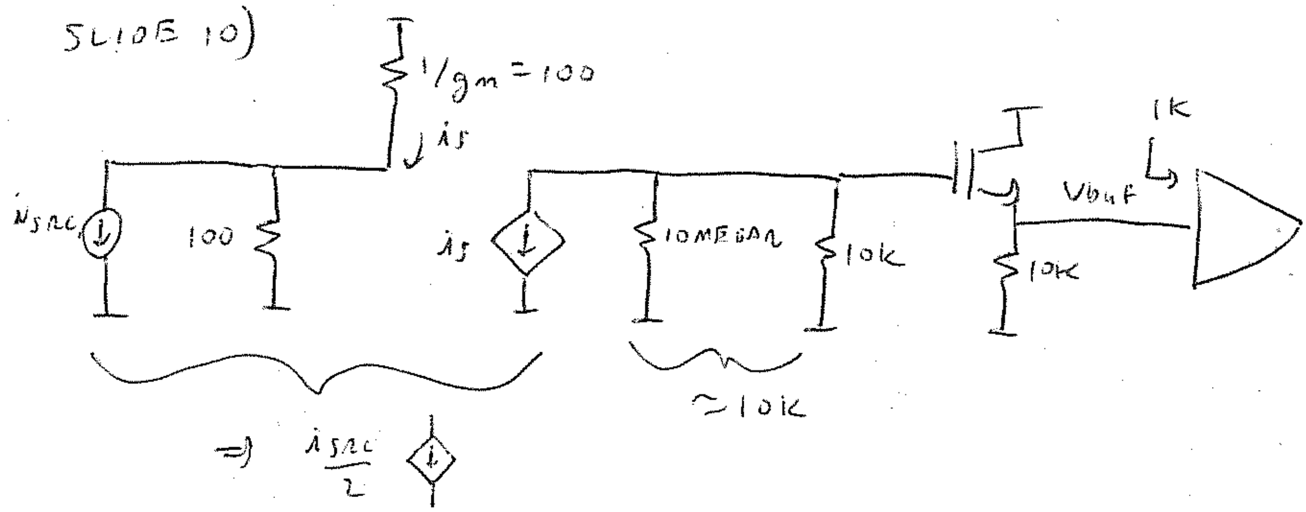
CURRENT DIVIDER

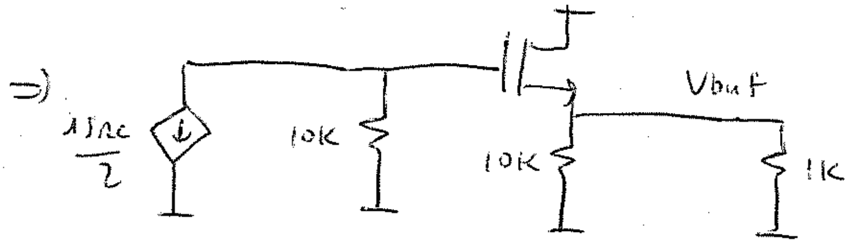
$$V_{buf} \approx -i_S \, 1K = -i_{SRC}\frac{100}{100+100}\,1K = -i_{SRC}\,500$$

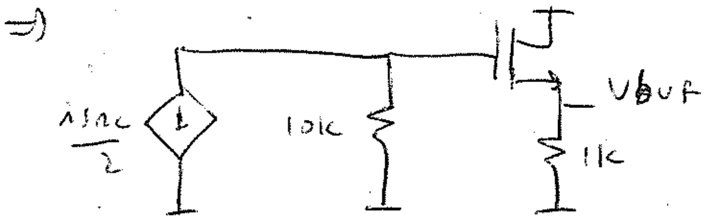
$\Rightarrow$ TRANSIMPEDANCE GAIN IS INCREASED TO

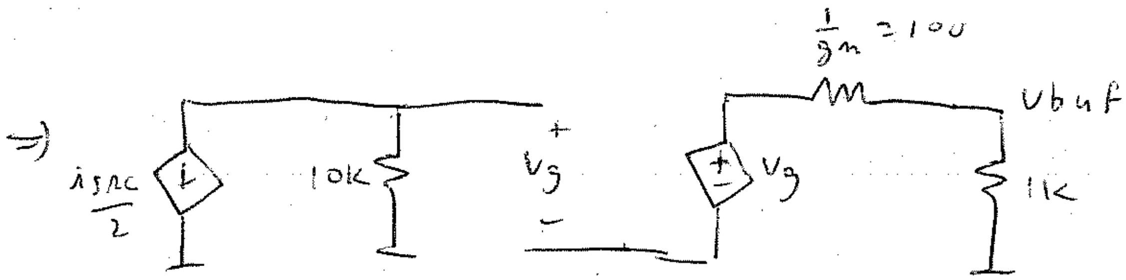
$\boxed{-500}$ (NOTE THAT THE SIGN OF THE GAIN HAS ~~[illegible]~~ STAYED THE SAME)

SLIDE 10)









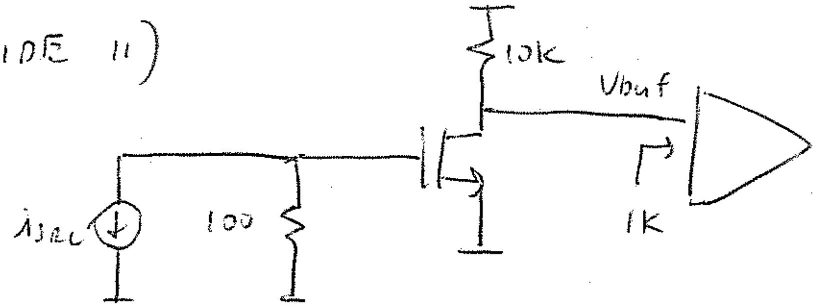
$$\Rightarrow V_{buf} \simeq \frac{1K}{1K+100} V_G \approxeq V_G = -\frac{i_{src}}{2} 10K = -5000\, i_{src}$$

⇒ TRANSIMPEDANCE GAIN IS NOW INCREASED TO $\boxed{-5000}$

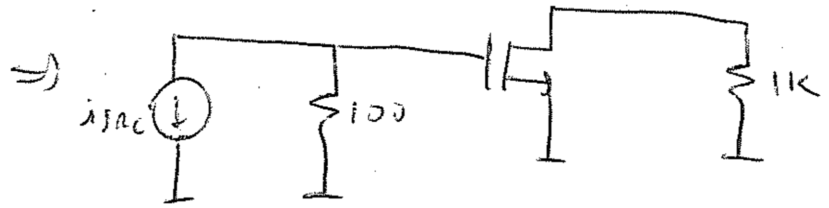
⇒ THE SOURCE FOLLOWER PROVIDED AN EFFECTIVE INCREASE IN TRANSIMPEDANCE GAIN BY LOWERING ATTENUATION DUE TO LOW Zin

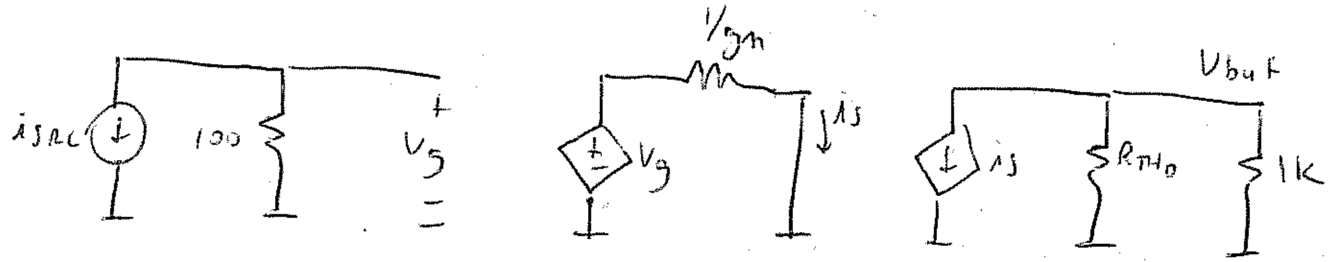
SLIDE 11)

NOTE: $1K \| 10K \simeq 1K$

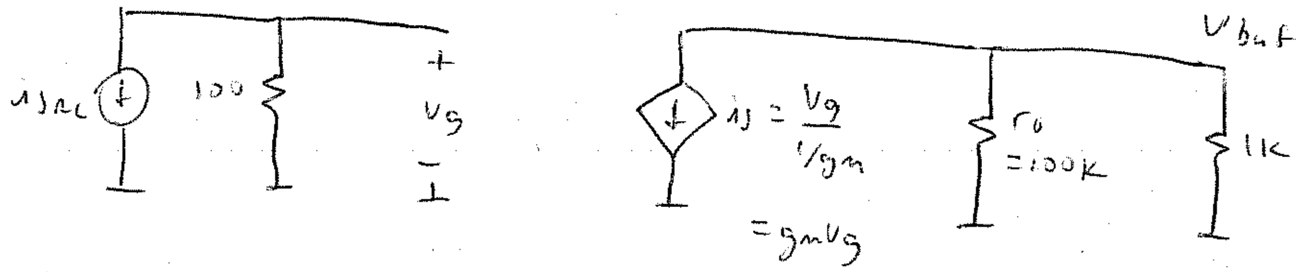


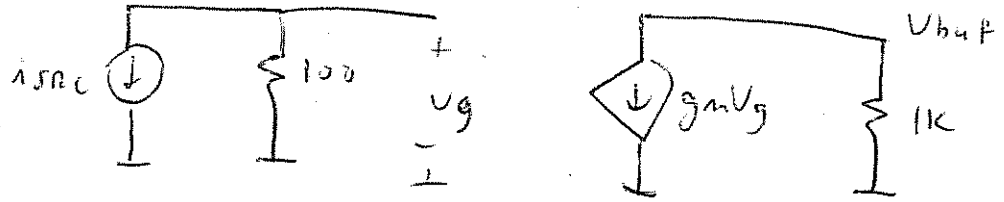
$\Rightarrow$





$$R_{THD} = r_o\left(1+(g_m+\underbrace{\cancel{g_{mb}}}_{0})\underbrace{\cancel{R_s}}_{0}\right)+\underbrace{\cancel{R_s}}_{0} = r_o = 100K$$





$$\Rightarrow V_{buf} \simeq -1K\, g_m V_g = -1K \overbrace{g_m}^{1/100}(-i_{SRC}\, 100)$$

$$= 1K\, i_{SRC}$$

$\Rightarrow$ TRANSIMPEDANCE $\boxed{\text{GAIN} = 1K}$ (NOTE THAT THE SIGN OF THE GAIN IS FLIPPED COMPARED TO COMMON GATE)

1) COMMON GATE + SOURCE FOLLOWER OFFER BETTER GAIN THAN SINGLE COMMON SOURCE AMPLIFIER

2) TWO STAGE COMMON SOURCE AMPLIFIER COULD YIELD MUCH HIGHER GAIN THAN COMMON GATE + COMMON SOURCE

HOWEVER, THERE ARE MANY OTHER ISSUES IN DESIGNING THE AMPLIFIER ~~OTH~~ BEYOND JUST GAIN, INCLUDING:

1) BANDWIDTH

2) NOISE

WE WILL DISCUSS THESE TWO ~~THINGS~~ TOPICS (AND MORE) IN FUTURE LECTURES