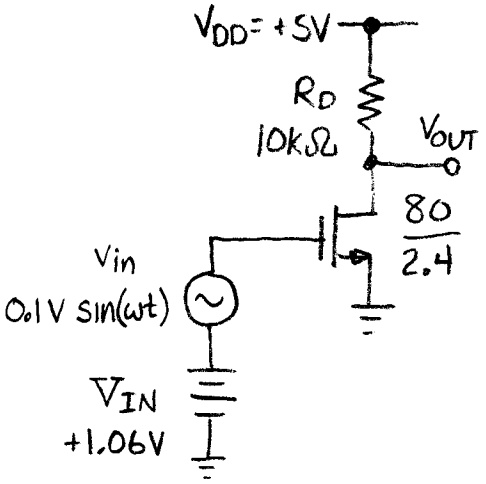
SMALL SIGNAL ANALYSIS SUMMARY

CIRCUIT

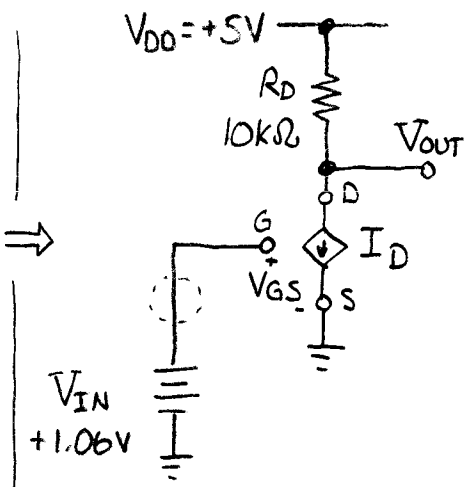


MOSFET:

$\mu C_{ox} = 7.42E\text{-}5 \frac{A}{V^2}$

$V_t = 0.61V$

LARGE SIGNAL MODEL



ACTIVE (SQ LAW) FOR I_D

$I_D = \frac{7.42E\text{-}5}{2} \frac{80}{2.4} \underbrace{(1.06-0.61)^2}_{V_{eff}}$

$V_{eff} = 0.45V$

$\boxed{I_D = 251\mu A}$

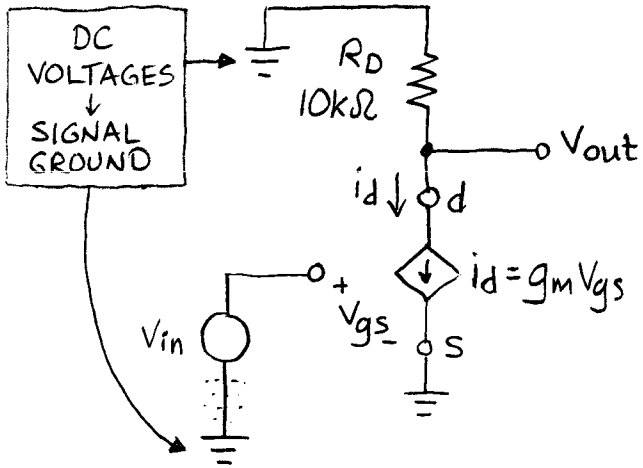
$V_{OUT} = 5V - (251\mu A)(10k\Omega)$

$\boxed{V_{OUT} = +2.49\ V}$

$V_{DS} > V_{eff}$ ✓

$2.49V > 0.45V$

SMALL SIGNAL MODEL



TRANSCONDUCTANCE g_m FROM DC BIAS

$g_m = 7.42E\text{-}5 \frac{80}{2.4} (1.06 - 0.61)$

$\boxed{g_m = 1.11\ mA/V}$

-SIGN: INVERTING AMPLIFIER

$V_{out} = -i_d R_D = -g_m \underbrace{V_{gs}}_{V_{in}} R_D = \underbrace{(-g_m R_D)}_{-11.1} V_{in}$

small signal gain

$\boxed{\frac{V_{out}}{V_{in}} = -g_m R_D}$

"BUILD UP" OUTPUT FROM DC, SMALL SIGNAL "PIECES"

AT INPUT:

$$\underbrace{V_{IN}}_{\text{TOTAL}} = \underbrace{+1.06\,V}_{V_{IN}} + \underbrace{(0.1V)\sin\omega t}_{v_{in}}$$

OUTPUT ⇓ ⇓ CHANGE ⇓ PROPORTIONAL GAIN

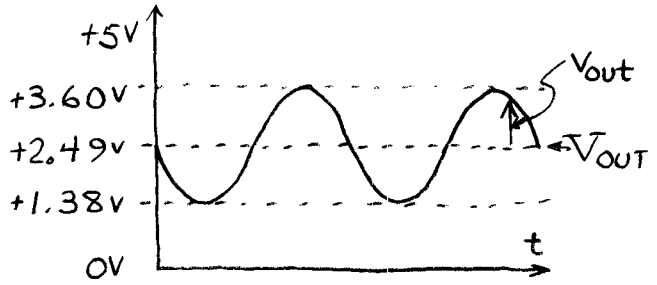
$$\underbrace{V_{OUT}}_{\text{TOTAL}} = \underbrace{+2.49V}_{V_{OUT}} + \underbrace{(-1.11\,V)\sin\omega t}_{v_{out} = (-g_m R_D) v_{in}}$$

-11.1 FROM SMALL-SIGNAL ANALYSIS

IN GENERAL

$$\underbrace{V_{OUT}}_{\text{TOTAL OUTPUT}} = \underbrace{V_{OUT}}_{\text{OUTPUT DC OPERATING POINT}} + \underbrace{A_v}_{\text{SMALL SIGNAL GAIN}}\ \underbrace{v_{in}}_{\text{SMALL SIGNAL INPUT}}$$

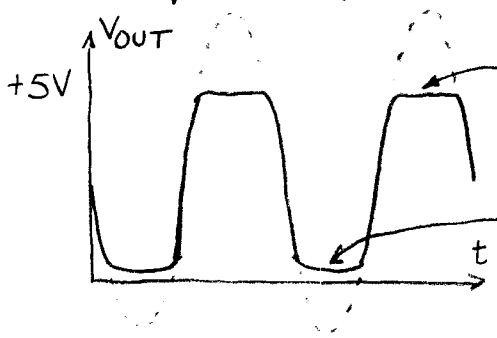
SKETCH V_{OUT}



CHECK MAX, MIN PEAKS: MEETS ACTIVE REGION CONDITIONS FOR ALL V_{OUT}

WHAT IF $v_{in} = (1.0\,V)\sin\omega t$? SMALL SIGNAL MODEL PREDICTS

$V_{OUT} = 2.49 + (-1.1)\sin\omega t$



CUTOFF ⇐ MAX PEAK = 13.6 V ?

CHECK PEAK VALUES

TRIODE ⇐ MIN PEAK = −8.6 V ?