# Pre-Lab 12:
# MOSFET Amplifier

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ECEN 325 Section 514

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## Calculation

Choose $\hat{V_o} = 2.3V$ , $R_i = 11k\Omega$

$I_X \geq \frac{2.3}{100} = 23mA \Rightarrow I_X = 40mA$

$I_{D2} = I_{D3} = I_X = 45mA$

$I_{D2} = \frac{\beta}{2} V_{ov}^2 \Rightarrow 45mA = \frac{95.464\ mA/V^2}{2} V_{ov2}^2$

$\Rightarrow V_{ov2} = 0.971V = V_{ov3}$

$g_{m2} = \beta V_{ov2} = 95.464 \cdot 0.971 = 92.69\ mA/V$

$A_{v2} = \frac{R_L}{\frac{1}{g_{m2}} + R_L} = \frac{100}{\frac{1}{92.69} + 100} = 1$

$\hat{V_d} = \frac{\hat{V_o}}{A_{v2}} = \frac{2.3}{1} = 2.3V$

Choose $V_{RX} = 0.55V$ $V_{RS} = 0.6V$

$V_{DD} + V_{SS} - \hat{V_d} - V_{RS} - V_{ov1} \geq V_{RD} \geq V_{RX} + V_{ov3} + \hat{V_o} + V_{tn} + V_{ov2}$

$5 + 5 - 2.3 - 0.55 - \frac{2V_{RD}}{50} \cdot 1 \geq V_{RD} \geq 0.6 + 0.971 + 2.3 + 2 + 0.971$

$6.875 \geq V_{RD} \geq 6.84 \Rightarrow V_{RD} = 6.875V$

$V_{ov1} = \frac{2 \cdot 6.875}{50} = 0.275V$

$I_{D1} = \frac{\beta}{2} V_{ov1}^2 = \frac{1.11}{2} \cdot 0.275^2 = 0.042mA = 42\mu A$

$R_D = \frac{V_{RD}}{I_{D1}} = \frac{6.875}{42\mu A} = 163.69k\Omega$ $R_X = \frac{0.55V}{45mA} = 12\Omega$

$R_S = \frac{0.6V}{45mA} = 13\Omega$

$V_{RG2} = V_{RS} + |V_t| + V_{OV} = 0.6V + 1.5 + 0.275 = 2.375V$

$$\begin{cases} V_{RG2} = 10 \cdot \dfrac{R_{G2}}{R_{G1}+R_{G2}} = 2.375V \\ R_1 = 11K = \dfrac{R_{G1}\cdot R_{G2}}{R_{G1}+R_{G2}} \end{cases} \Rightarrow \underline{R_{G1} = 46315.8\Omega}, \underline{R_{G2} = 14426.2\Omega}$$

$$V_{RG4} = 0.55 + 2 + 0.971 = 3.521V$$

$$V_{RG4} = 3.521 = 10 \cdot \frac{R_{G4}}{R_{G3}+R_{G4}}$$

$$\Rightarrow \frac{352.1}{1000} = \frac{R_{G4}}{R_{G3}+R_{G4}} \Rightarrow \underline{R_{G4} = 352.1\Omega} \quad \underline{R_{G3} = 647.9\Omega}$$

## Simulation

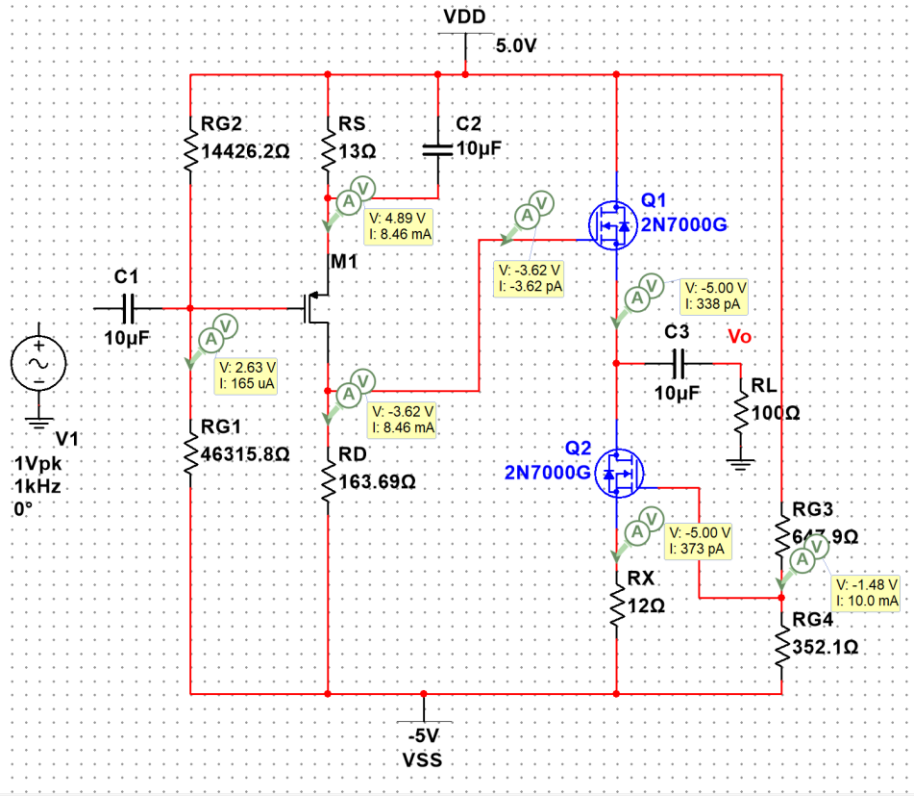


**Figure 1:** DC Solution for MOSFET amplifier ▲

| | | |
|---|---|---|
| $V_{RG1}$ = 7.63V | $V_{RS}$ = 0.11V | $I_{D1}$ = 8.46mA |
| $V_{RG2}$ = 2.37V | $V_{RD}$ = 1.38V | $I_{D2}$ = 338pA |
| $V_{RG3}$ = 6.48V | | $I_{D3}$ = 373pA |
| $V_{RG4}$ = 3.52V | | |

For this circuit, I got a gain of 0. So I rework the circuit.

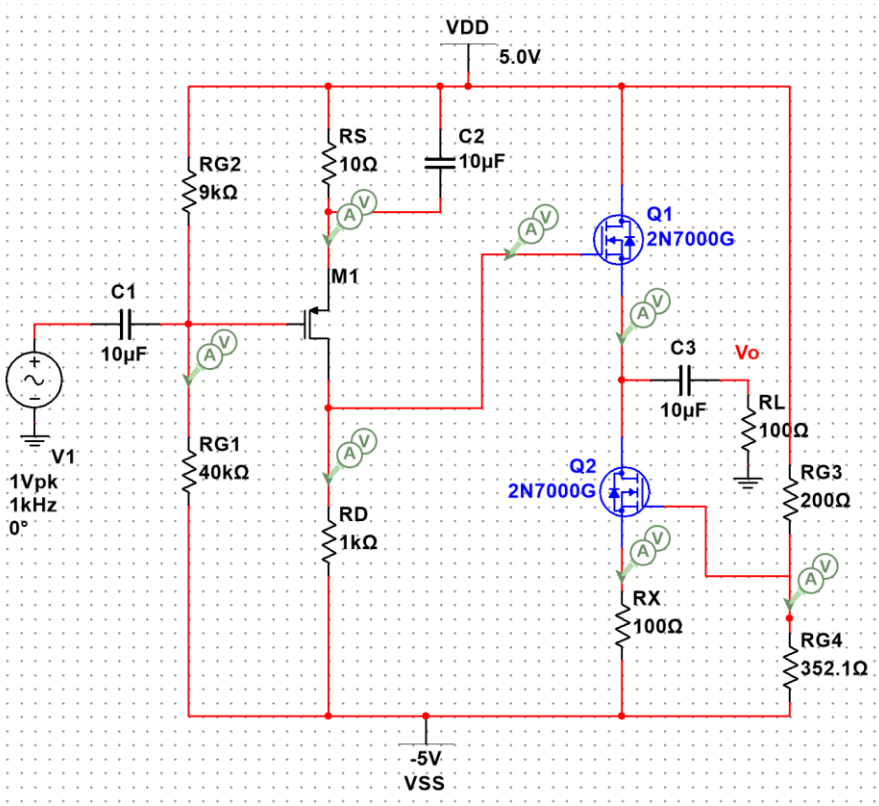


**Figure 1.1:** New circuit for MOSFET amplifier ▲

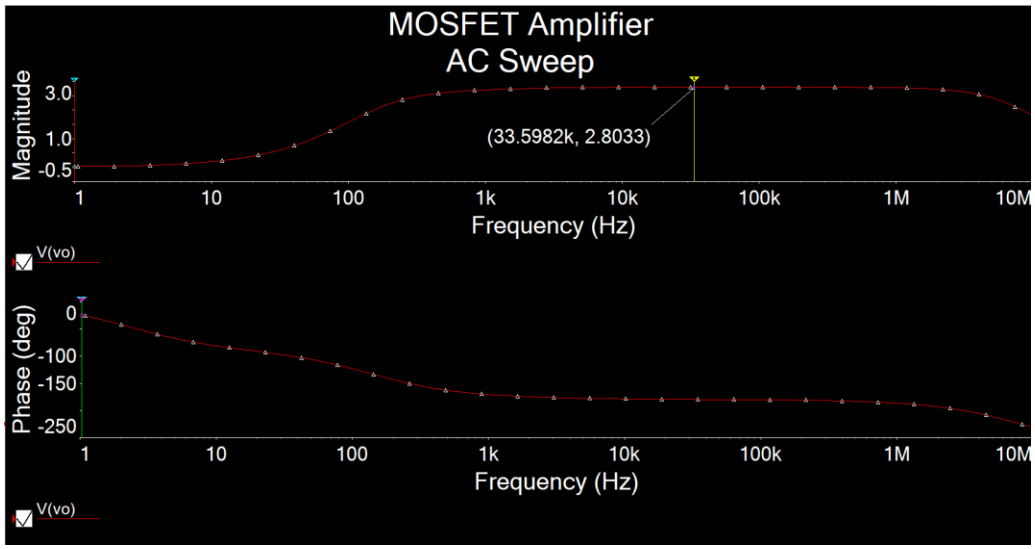


**Figure 2.1:** AC Simulation of $A_V$ for MOSFET amplifier ▲

$A_V = 2.8033$

Even I rework the circuit, the best gain I can get is 2.8033.

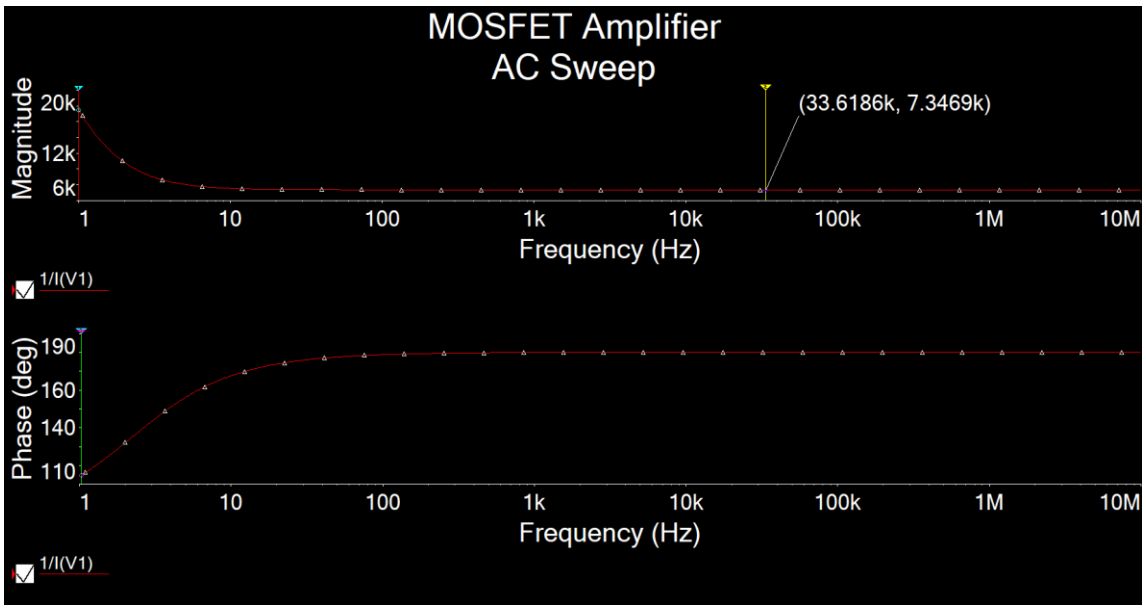


**Figure 2.2:** AC Simulation of $R_i$ for MOSFET amplifier ▲

$R_i = 7.3469k\Omega$

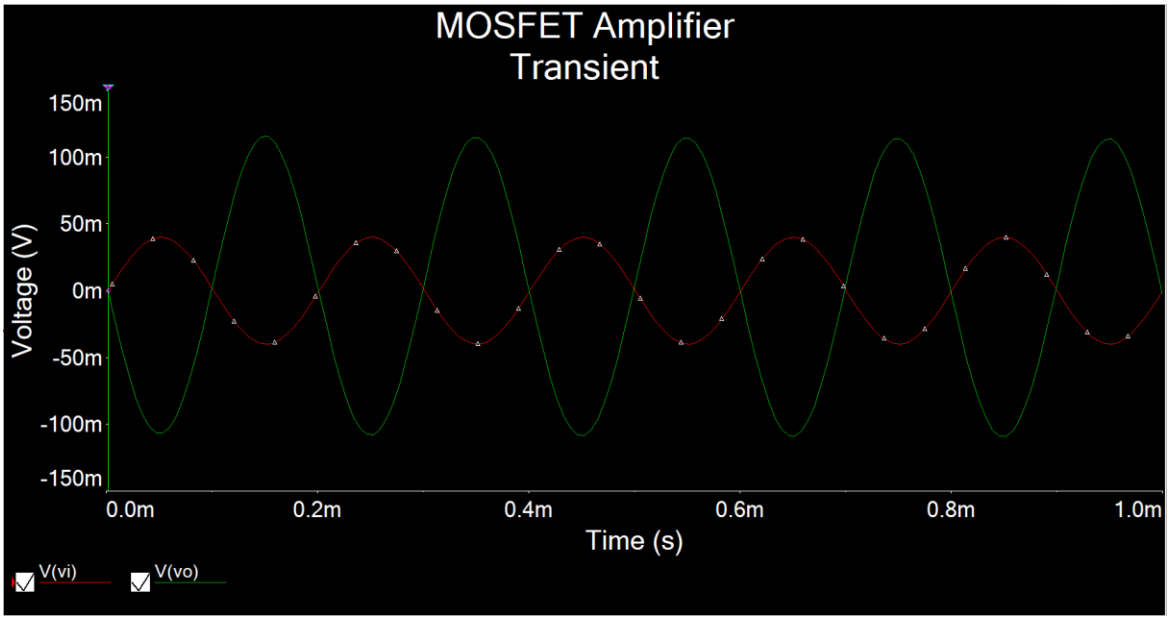


**Figure 3:** Time-domain waveform of $V_i$ = 40mV 5kHz for MOSFET amplifier ▲

$A_V \approx 2$

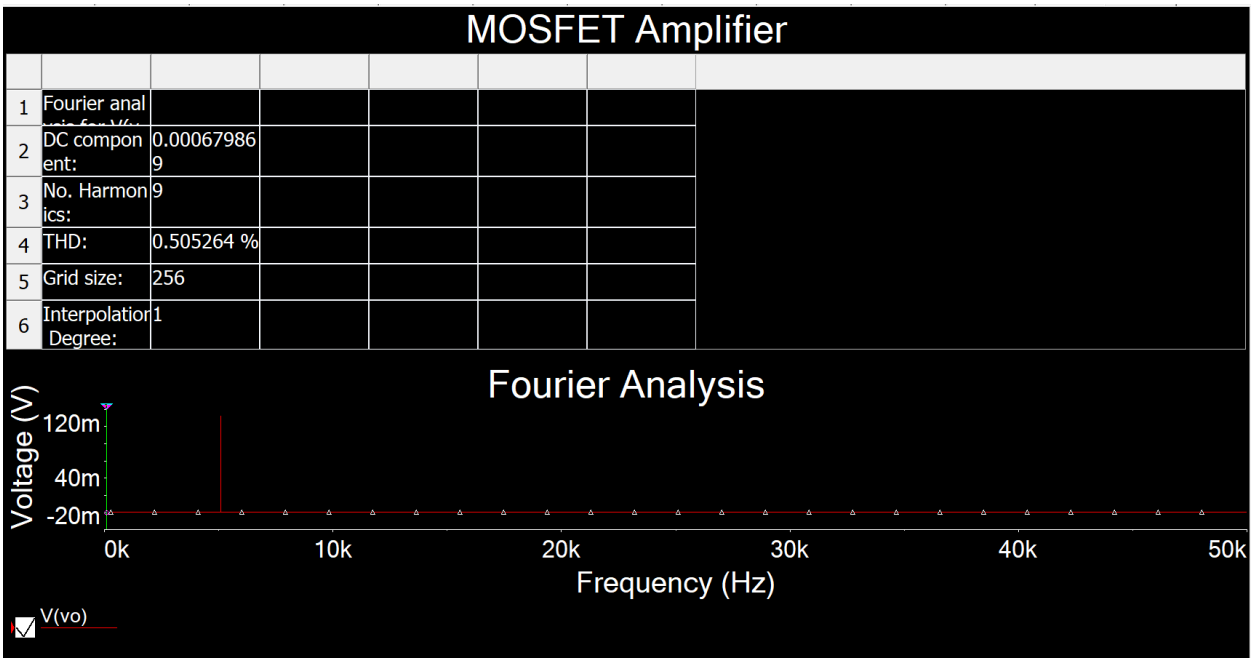


**Figure 4:** Total harmonic distortion (THD) for MOSFET amplifier ▲

THD = 0.5053%