

Pre-Lab 11:

MOSFET Amplifier Configurations

Name: Wan-Yu Liao

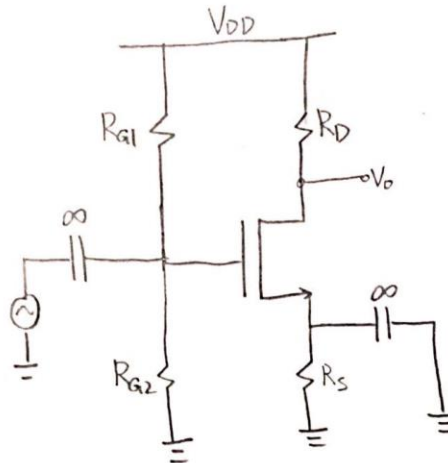
ECEN 325 Section 514

TA: Mandela

Date: November 15, 2019

Calculation

Common - Source



$$V_{DD} = 5V$$

$$|A_v| = 25$$

from last lab:

$$V_T = 2.23V$$

$$K'_L = 0.0895 A/V^2$$

$$V_{RS} = 1V \quad \text{choose } \hat{V}_o = 1.3V, R_i = 11k\Omega$$

$$V_{RD} = \frac{V_{DD} - \hat{V}_o - V_{RS}}{1 + \frac{2}{|A_v|}} = \frac{5 - 1.3 - 1}{1 + \frac{2}{25}} = 2.5V$$

$$V_{ov} = \frac{2 \cdot V_{RD}}{|A_v|} = \frac{2 \cdot 2.5}{25} = 0.2V$$

$$I_D = \frac{K'}{2} \frac{W}{L} V_{ov}^2 = \frac{0.0895}{2} \cdot (0.2)^2 = 1.79 mA$$

$$R_D = \frac{V_{RD}}{I_D} = \frac{2.5}{1.79m} = 1.4k\Omega \quad R_S = \frac{V_{RS}}{I_D} = \frac{1}{1.79m} = 559\Omega$$

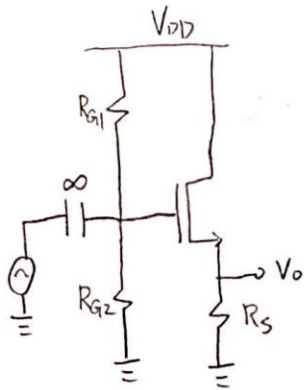
$$V_{RG2} = V_{RS} + |V_T| + V_{ov} = 1 + 2.23 + 0.2 = 3.43V$$

$$R_{G1} = \frac{R_i V_{DD}}{V_{RS} + |V_T| + V_{ov}} = \frac{11k \cdot 5}{3.43} = 16035\Omega$$

$$R_{G2} = \frac{16035 \cdot 11000}{16035 + 11000} = 35032\Omega$$



Common-Drain



$$V_{DD} = 5V$$

$$R_{G1} = 16035\Omega$$

$$R_{G2} = 35032\Omega$$

$$R_S = 559\Omega$$

$$V_{ov} = 0.2V$$

$$g_m = k' \frac{W}{L} V_{ov} = 0.0895 \cdot 0.2 = 0.0179 \text{ A/V}$$

$$A_v = \frac{R_S}{\frac{1}{g_m} + R_S} = \frac{559}{\frac{1}{0.0179} + 559} = 0.909$$

$$R_i = R_{G1} \parallel R_{G2} = 11 \text{ k}\Omega$$

$$R_o = R_S \parallel \frac{1}{g_m} = \frac{559 \cdot \frac{1}{0.0179}}{559 + \frac{1}{0.0179}} = 50.79\Omega$$



Simulation

Common-Source Amplifier

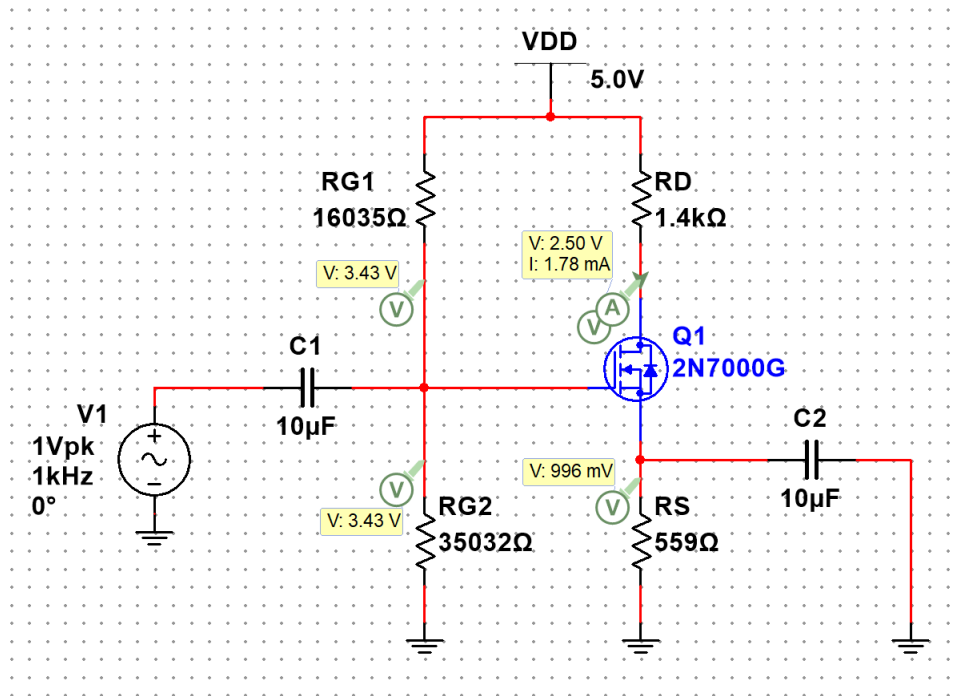


Figure 1: DC Solution for common-source amplifier ▲

$$V_{RG2} = 3.43V$$

$$V_{RS} = 0.996V$$

$$V_{RD} = 5 - 2.5 = 2.5V$$

$$V_{o,dc} = 2.5V$$

$$I_D = 1.78mA$$

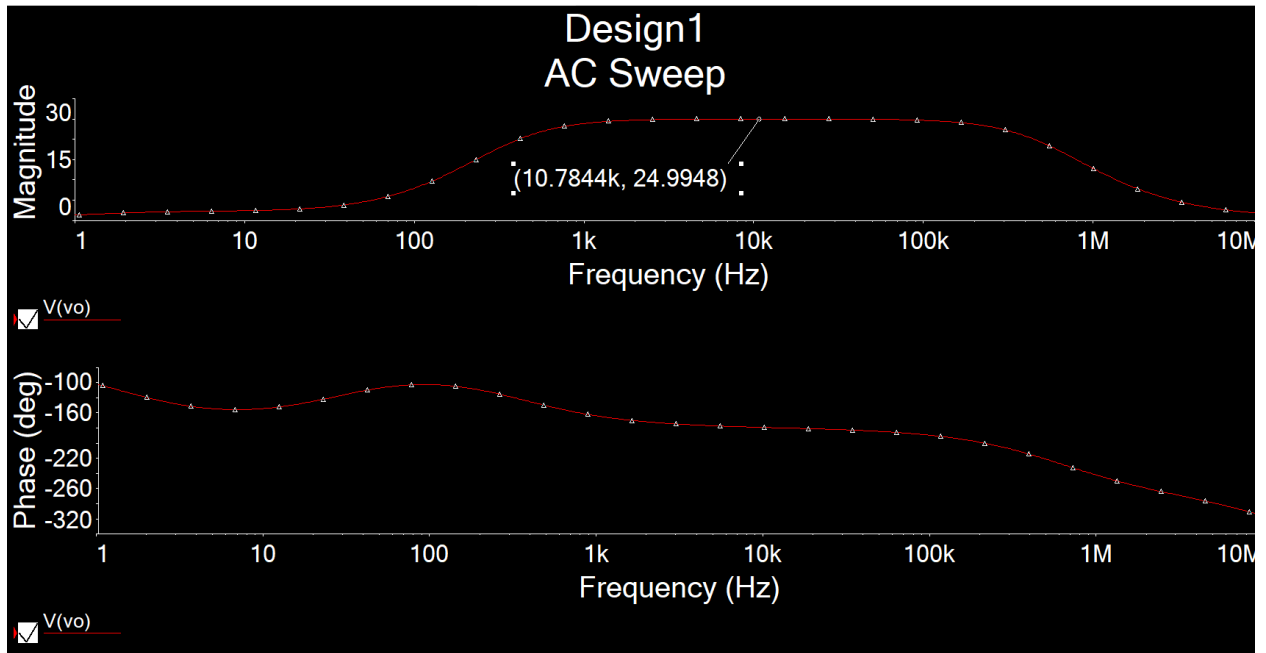


Figure 2.1: AC Simulation of A_V for common-source amplifier ▲

$$A_V = 24.9948$$

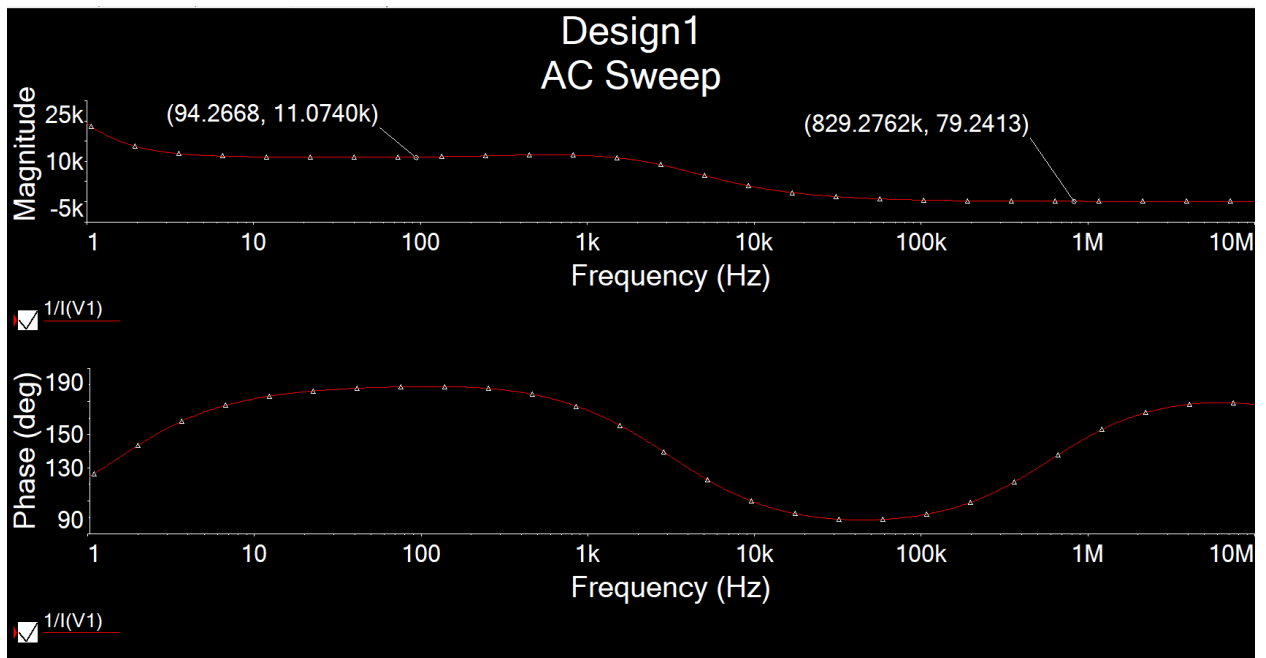


Figure 2.2: AC Simulation of R_i for common-source amplifier ▲

$$R_i = 11.0740k\Omega$$

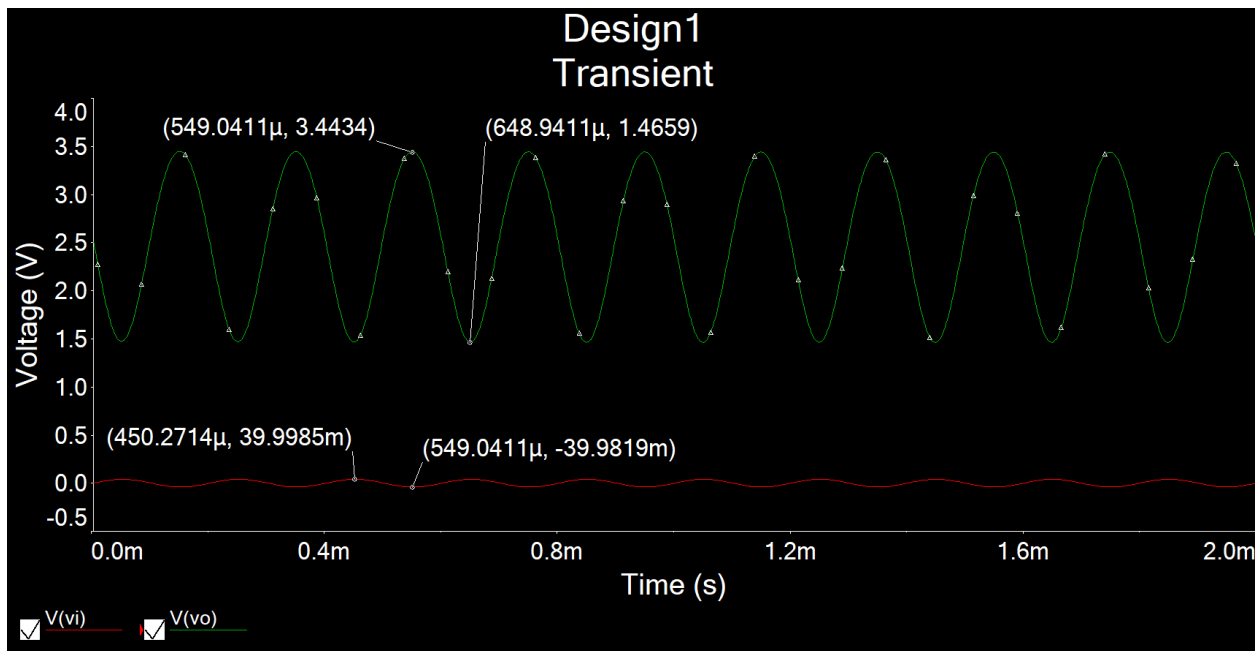


Figure 3: Time-domain waveform of $V_i = 40\text{mV}$ for common-source amplifier ▲

$$A_v = \frac{3.4434 - 1.4659}{0.039 - (-0.039)} = 25.35 \approx 25$$

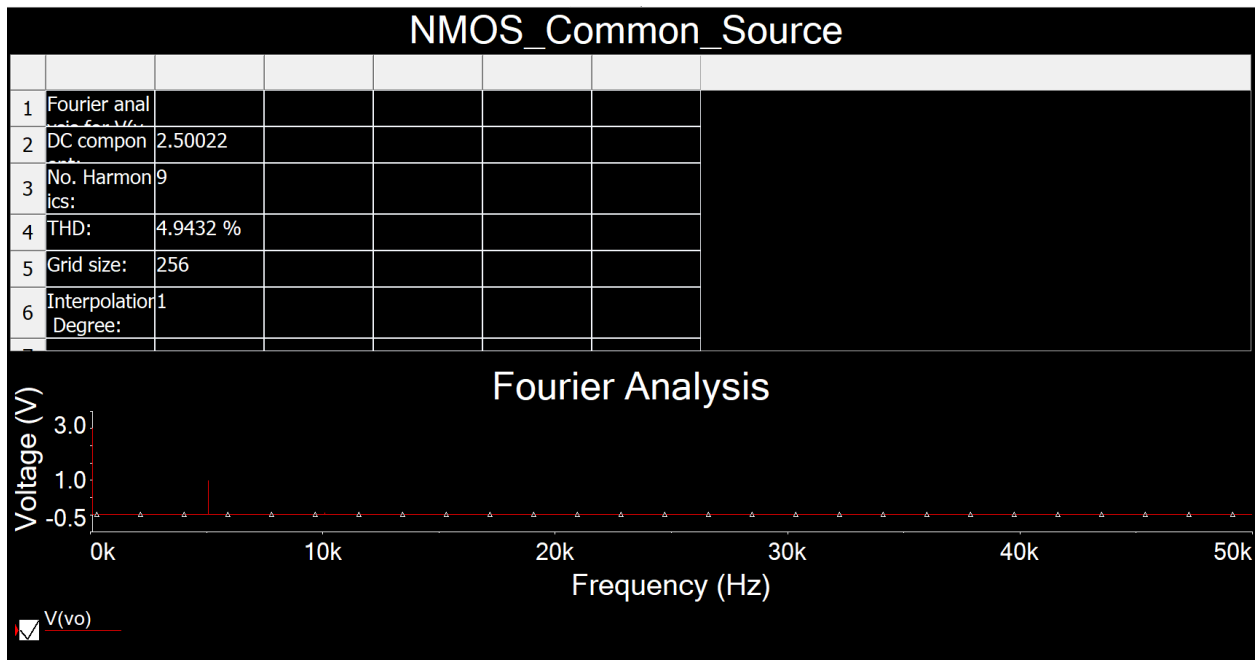


Figure 4: Total harmonic distortion (THD) for common-source amplifier ▲

$$\text{THD} = 4.9432\% \leq 5\%$$

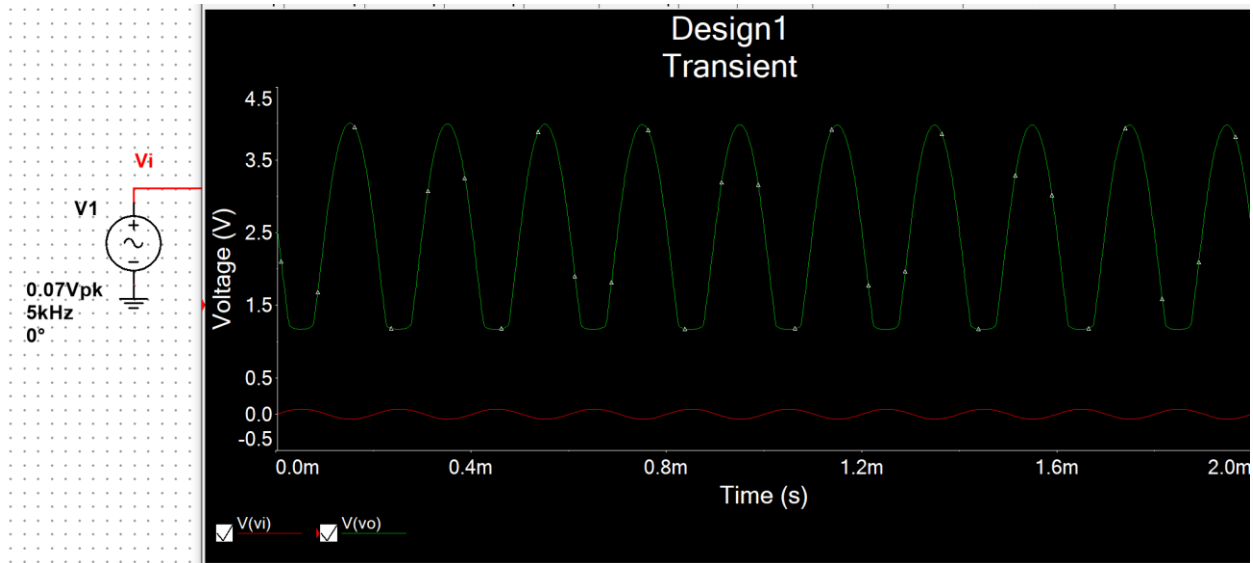


Figure 5: Clipping voltage for common-source amplifier ▲

Clipping voltage = 70mV

Common-Drain Amplifier

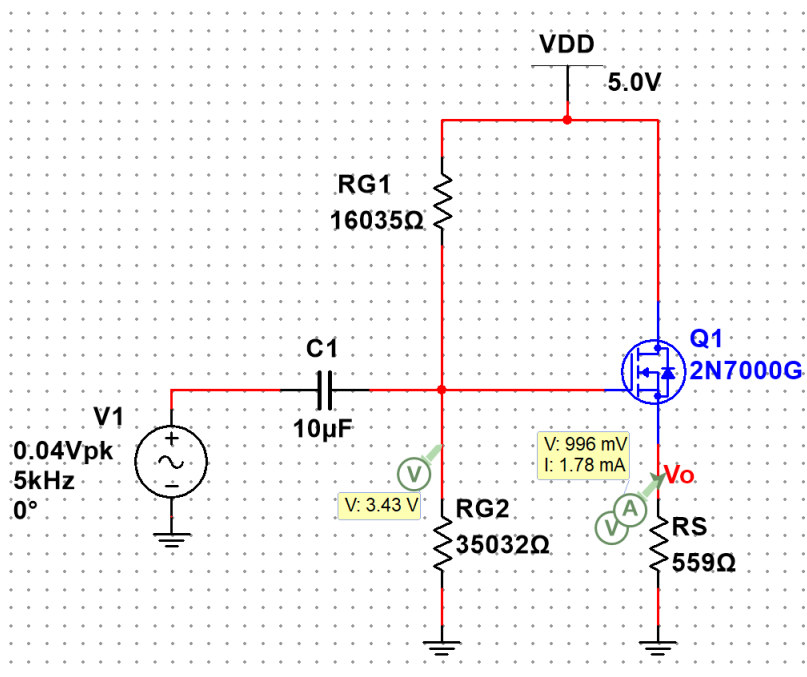


Figure 6: DC Solution for common-drain amplifier ▲

$$V_{RG2} = 3.43V$$

$$V_{RS} = 0.996V$$

$$I_D = 1.78mA$$

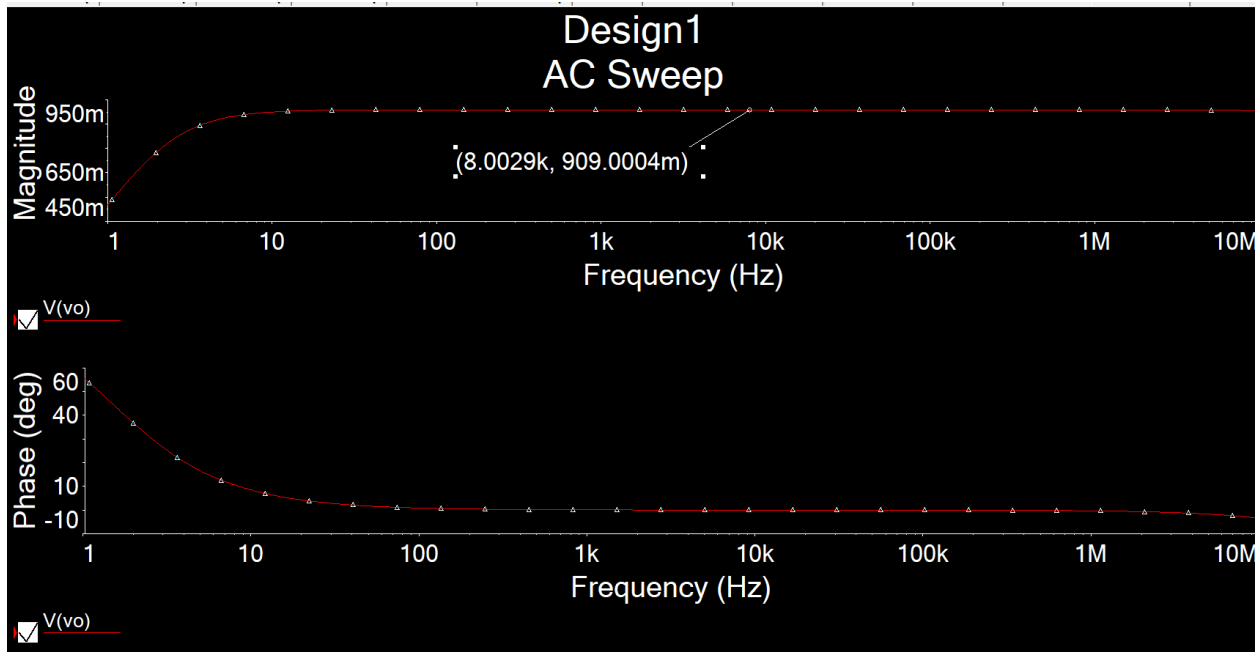


Figure 7.1: AC Simulation of A_v for common-drain amplifier ▲

$$A_v = 0.909$$

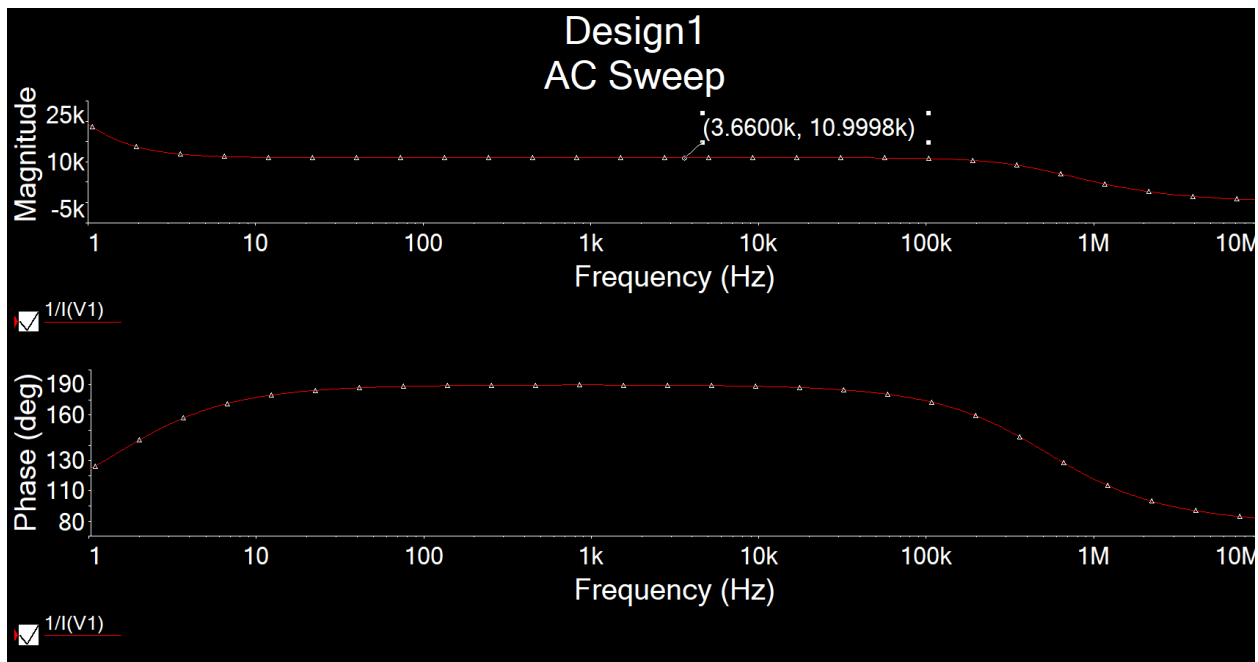


Figure 7.2: AC Simulation of R_i for common-drain amplifier ▲

$$R_i = 10.9998k\Omega$$

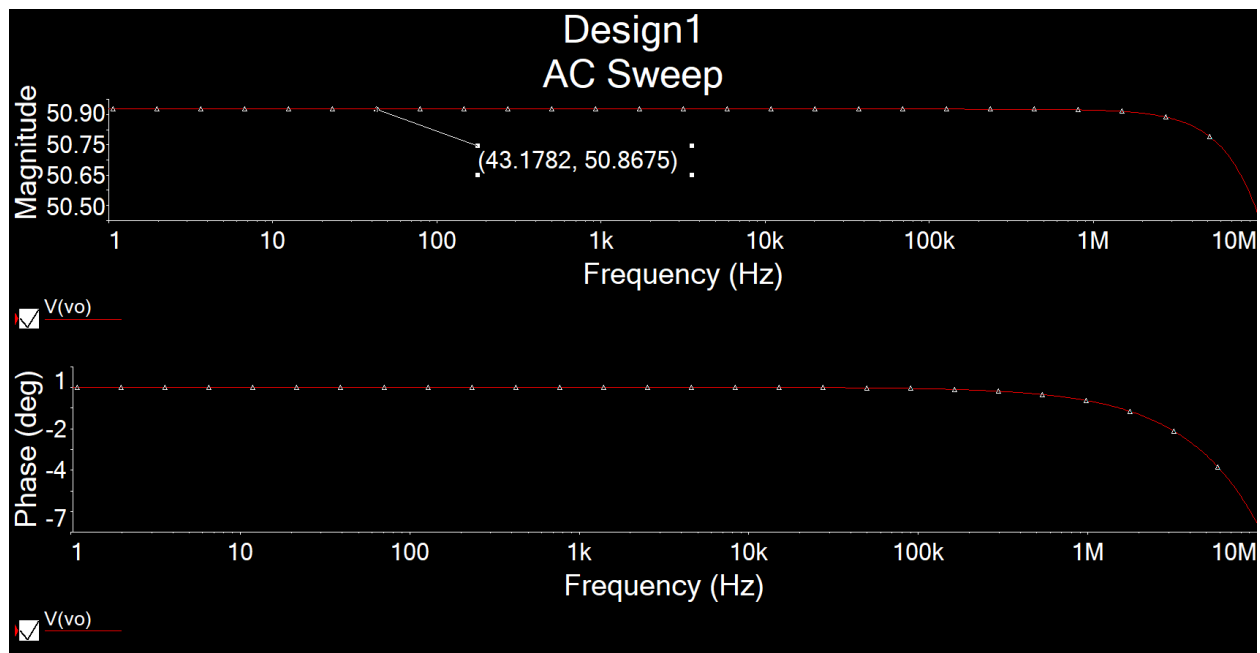


Figure 7.3: AC Simulation of R_o for common-drain amplifier ▲

$$R_o = 50.8675\Omega$$

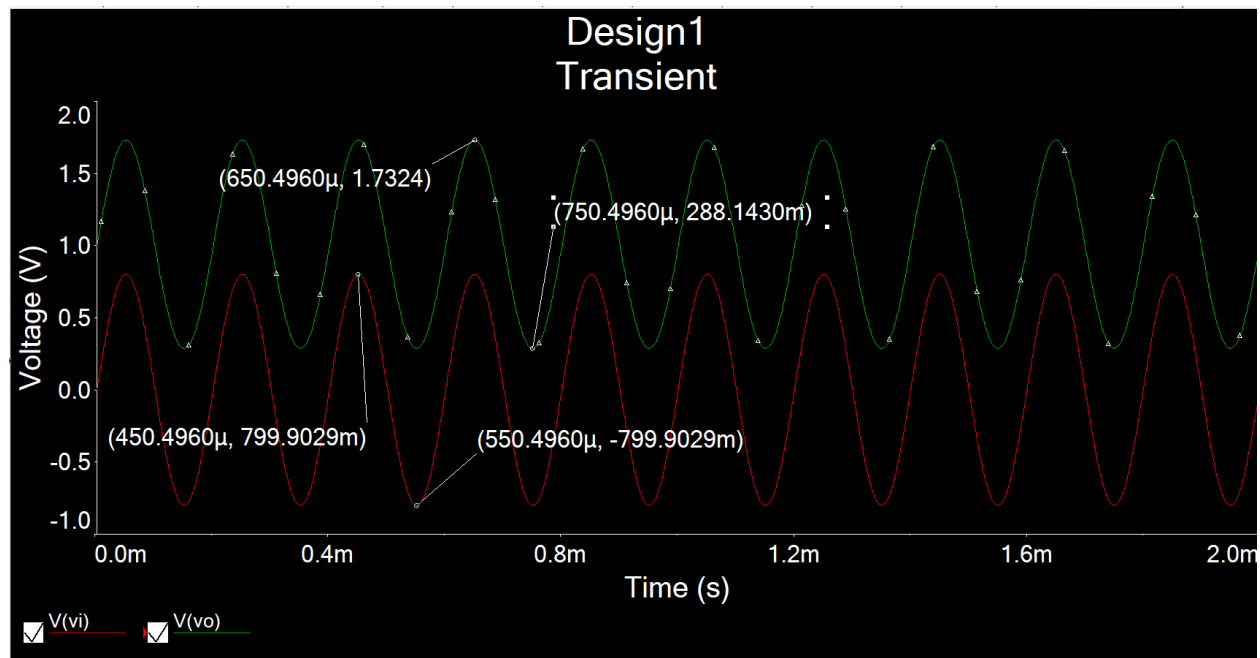


Figure 8: Time-domain waveform of $V_i = 0.8V$ for common-drain amplifier ▲

$$A_v = \frac{1.7324 - 0.2881}{0.7999 - (-0.7999)} = 0.903$$

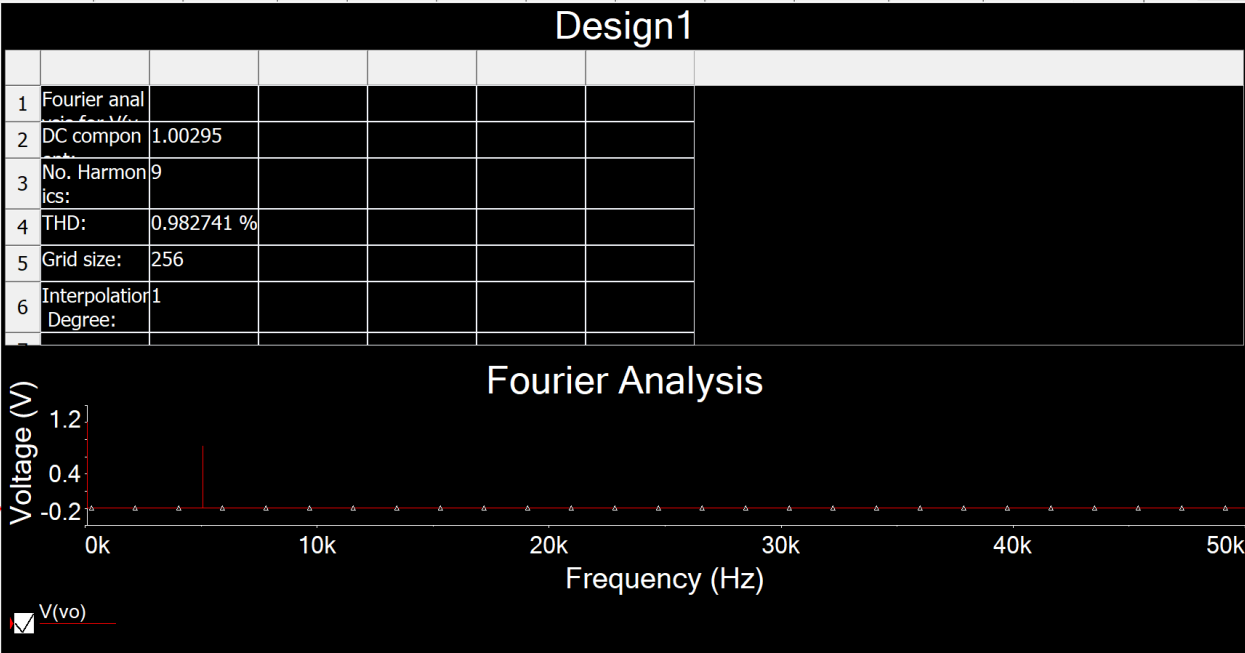


Figure 9: Total harmonic distortion (THD) for common-drain amplifier ▲

THD = 0.983%

Table

Common-Source Amplifier

	Calculation	Simulation	Measurement
V_{RG2}	3.43V	3.43V	
V_{RS}	1V	0.996V	
V_{RD}	2.5V	2.5V	
$V_{o,dc}$	2.5V	2.5V	
I_D	1.79mA	1.78mA	
A_v	25	24.9948	
R_i	11k Ω	11.0740k Ω	
THD		4.9432%	

Common-Drain Amplifier

	Calculation	Simulation	Measurement
V_{RG2}	3.43V	3.43V	
V_{RS}	1V	0.996V	
I_D	1.79mA	1.78mA	
A_v	0.909	0.909	
R_i	11k Ω	10.9998k Ω	
R_o	50.97 Ω	50.8675 Ω	
THD		0.983%	