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ECEN 325 Section 510

Lab date: 25 April 2024

Due date: 30 April 2024

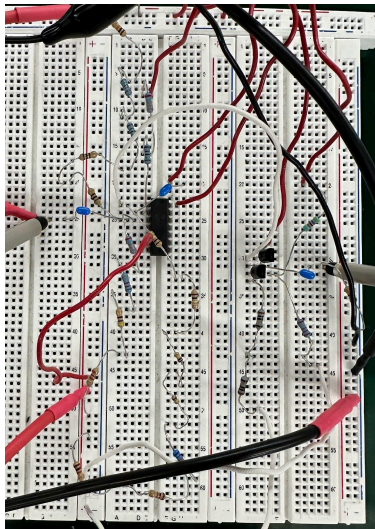
## **Lab 12: MOSFET Amplifier Design**

## Procedure:

For the lab procedure, I started by building the two-stage amplifier circuit with the current source implementation. I then measured the DC operating point for the circuit and recorded all node voltages and branch currents. After verifying the recorded values, I measured the gain and input resistance of the circuit. Next, I applied a 5 kHz, 40 mV input signal to the circuit and obtained a time-domain waveform showing the output voltage with an amplitude at 2 V. Finally, I measured the THD of the circuit and obtained the output waveforms.

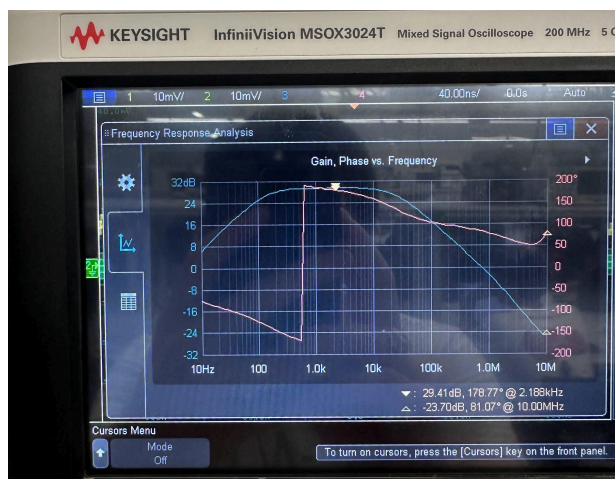
### Two-stage MOSFET amplifier circuit:

#### Breadboard

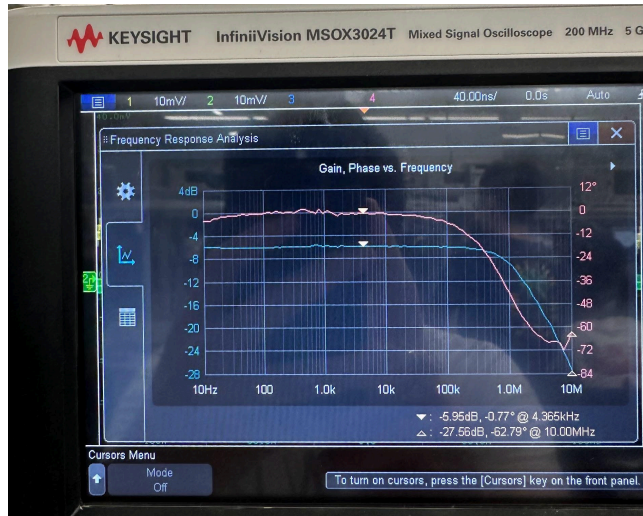


#### Bode Plots

Gain plot:

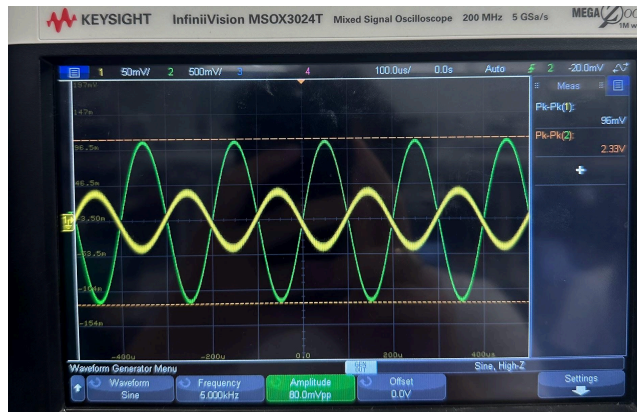


Ri plot:



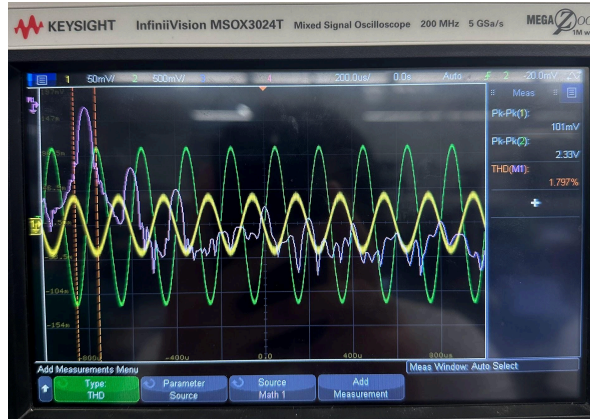
Time-domain and THD Waveforms

Transient waveform:



THD waveforms:





## Data Tables and Results:

Table 1:

Below is a table for the calculated, simulated and measured component values.

	$R_{G1}$ (k $\Omega$ )	$R_{G2}$ (k $\Omega$ )	$R_{G3}$ (k $\Omega$ )	$R_{G4}$ (k $\Omega$ )	$R_S$ (k $\Omega$ )	$R_D$ (k $\Omega$ )	$R_X$ ( $\Omega$ )
<b>Calculated</b>	41.841	13.141	2.81	1.5	34.483	479.31	20
<b>Simulated</b>	41.8	13.1	2.81	1.5	34.5	480	20
<b>Measured</b>	41.8	13.1	4.7	2.2	34.5	480	20

When measuring the DC operating point, I found that the current for  $I_{D3}$  was off by about 10 mA.

In order to compensate for this, I chose a smaller voltage at  $V_{G3}$  and changed the resistor values for  $R_{G3}$  and  $R_{G4}$ . This allowed for a more accurate value that was consistent with the calculated and simulated current value for  $I_{D3}$ .

Table 2:

Below is a table for the calculated, measured and simulated values for each circuit configuration.

	Node Voltages (V)	Branch Currents	$A_V$ (V/V)	$R_i$ (k $\Omega$ )	$V_{Out-(0-peak)}$ (V)	THD (%)
<b>Calculated</b>	$V_{G1} = 2.609 \text{ V}$ $V_{S1} = 4.5 \text{ V}$ $V_{D1} = V_{G2} = 1.95 \text{ V}$ $V_{D2} = 5 \text{ V}$ $V_{S2} = V_{D3} = -1 \text{ V}$ $V_{G3} = -1.52 \text{ V}$	$I_{RG2} = 181.95 \text{ uA}$ $I_{RG4} = 2.32 \text{ mA}$ $I_{D1} = 14.52 \text{ uA}$ $I_{D2} = 25 \text{ mA}$ $I_{D3} = 25 \text{ uA}$	50	10	2	N/A
<b>Simulated</b>	$V_{G1} = 2.61 \text{ V}$ $V_{S1} = 4.5 \text{ V}$ $V_{D1} = V_{G2} = 1.98 \text{ V}$ $V_{D2} = 5 \text{ V}$ $V_{S2} = V_{D3} = -1 \text{ V}$ $V_{G3} = -1.52 \text{ V}$	$I_{RG2} = 182.15 \text{ uA}$ $I_{RG4} = 2.32 \text{ mA}$ $I_{D1} = 14.52 \text{ uA}$ $I_{D2} = 24.56 \text{ mA}$ $I_{D3} = 24.56 \text{ mA}$	56.18	9.974	2.014	5.17
<b>Measured</b>	$V_{G1} = 2.626 \text{ V}$ $V_{S1} = 4.475 \text{ V}$ $V_{D1} = V_{G2} = 1.93 \text{ V}$ $V_{D2} = 5 \text{ V}$ $V_{S2} = V_{D3} = -0.688 \text{ V}$ $V_{G3} = -1.798 \text{ V}$	$I_{RG2} = 181.9 \text{ uA}$ $I_{RG4} = 1.543 \text{ mA}$ $I_{D1} = 14.94 \text{ uA}$ $I_{D2} = 25.5 \text{ mA}$ $I_{D3} = 25.5 \text{ mA}$	29.55	10.165	2.33	1.787

Here we can see that the calculated, simulated, and measured values are very similar to each other with the biggest difference being the gain that was measured during the lab. Due to the susceptible variation of the threshold voltage for the transistor used in the lab, this affects  $V_{GS/SG}$  as well as the overdrive voltage for the transistor. As a result, this affects  $A_{V1}$  and reduces the overall gain from 50 to 29.55. The rest of the values however satisfy the design specifications and verifies the simulated and calculated values.