Lab 3: Push-Pull Power Amplifier

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Preparation

1. Determine the value of Cs for the cut-off frequency of 50 Hz or less (f3dB = 1/2πRLCs). The power stage can be assumed as a dependent voltage source with zero output impedance. Show your hand calculation. Show your hand calculation.

1) $f_{3dB} = 50Hz$

$$f_{3dB} = \frac{1}{2\pi R_L C_S}$$

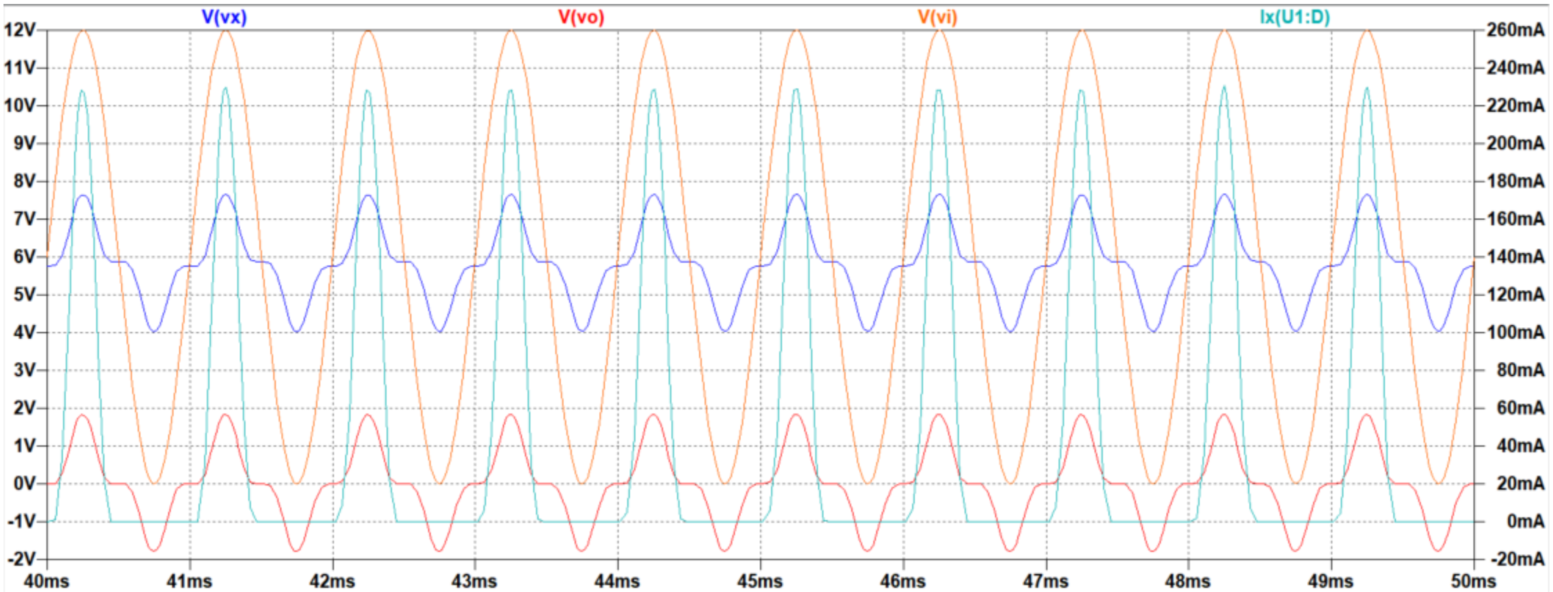
$$C_S = \frac{1}{2\pi R_L f_{3dB}}$$

$$= \frac{1}{2\pi (8)(50)}$$

$$= \frac{1}{800\pi}$$

$$= 0.398\ mF$$

2. Simulate the class-B push-pull power amplifier in Figure 1(a) with a 1-kHz 12-Vpp sinusoid input biased at 6 V and plot Vi, Vx, Vo, and ID1. Simulate the circuit long enough (about 50 ms) to let Cs settle and zoom in to the portion close to the end of the simulation to show a few cycles of the sinusoid.



3. Determine the value of V_{OS} and R_1 in Figure 1(c) required to cancel the dead zone using the plot in the previous step.

| Vtp | = |7.637 - 11.977| = 4.34 V

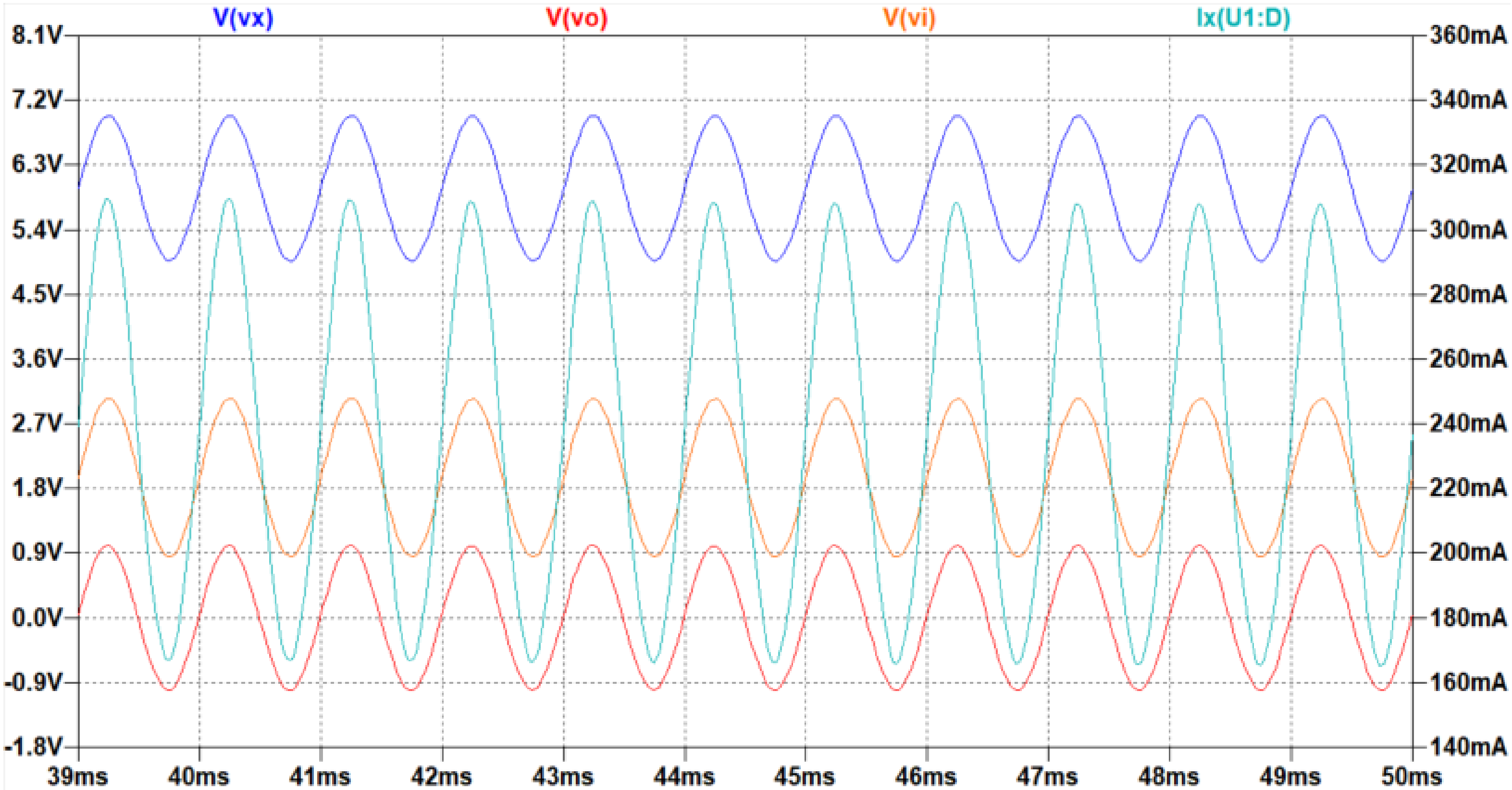
Vtn = 4.038 - 4.067x10^{-3} = 4.034 V

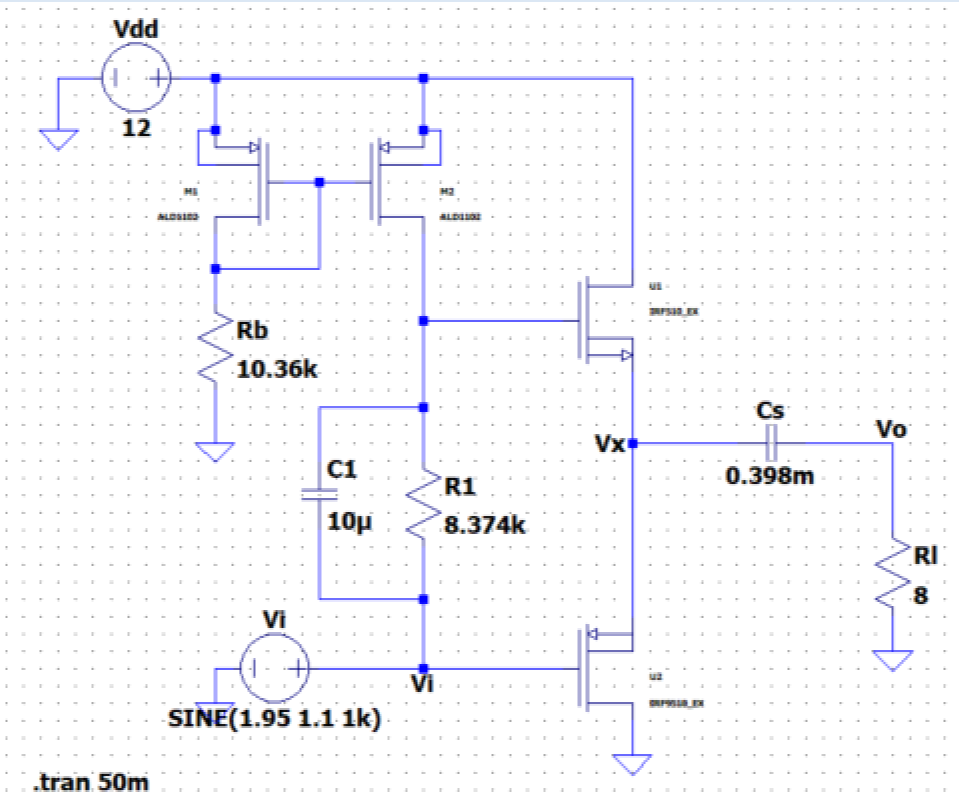
Vos = Vtn + |Vtp| = 8.374 V

R1 = Vos / Id4 = 8.314 / 1x10^{-3} = 8.314 kOhms

***CORRECT VALUE IS 7.2 kOhms ***

4. Simulate the class-AB push-pull amplifier in Figure 1(c) using the value of R_1 found in the previous step. Adjust the input signal source such that the output node, V_x is biased at 6 V with a 2-V_{pp} swing. Plot V_i, V_x, V_o, and I_{D1}. Simulate the circuit long enough (about 50 ms) to let C_s settle, and zoom in to the portion close to the end of the simulation to show a few cycles of the sinusoid. Make sure that the power transistors are biased just in class-AB region so the power consumption is kept minimum while the dead zone is cancelled. This step requires fine tuning of R_1 as well as the input signal source.


V(vx)
V(vo)
V(vi)
Ix(U1:D)
8.1V
7.2V
6.3V
5.4V
4.5V
3.6V
2.7V
1.8V
0.9V
0.0V
-0.9V
-1.8V
360mA
340mA
320mA
300mA
280mA
260mA
240mA
220mA
200mA
180mA
160mA
140mA
39ms
40ms
41ms
42ms
43ms
44ms
45ms
46ms
47ms
48ms
49ms
50ms


Vdd
12
Rb
10.36k
C1
10µ
R1
8.374k
Vx
Cs
0.398m
Vo
Rl
8
Vi
SINE(1.95 1.1 1k)
Vi
.tran 50m

5. Determine the voltage gain of the power amplifier

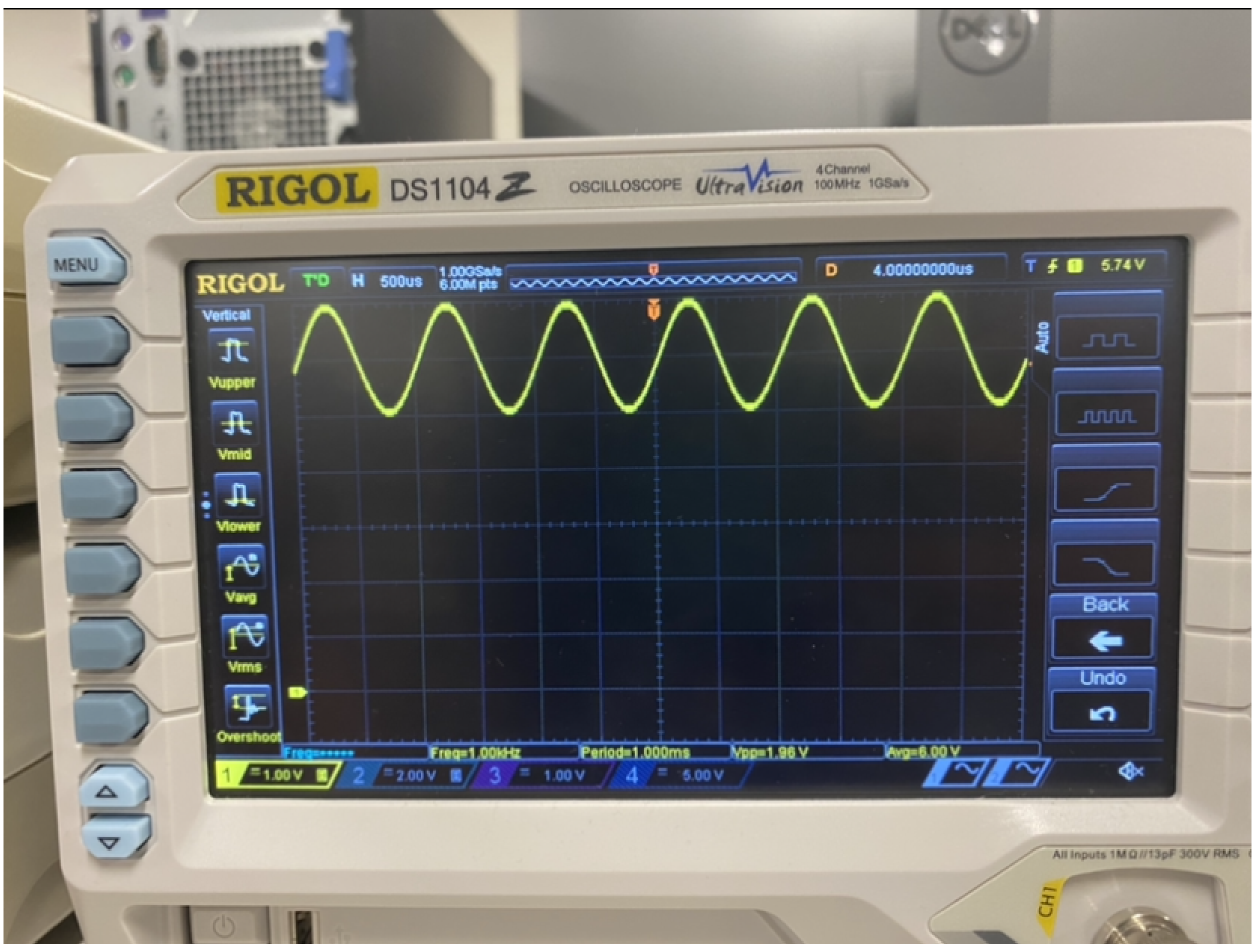
$Av = Vout_{pp} / Vin_{pp} = -2.016 / 2.2 = -0.916$ V/V

Lab - Part II: Class AB Power Amplifier Implementation

3. Adjust R_1 to put the amplifier just in the class-AB mode. This can be done by increasing R_1 and thus V_{OS} from its minimum while applying an input signal and monitoring the output on the oscilloscope until the dead zone disappears.

   Vos = 6.92 V

4. Adjust the signal generator for a 1-kHz 2-V_{pp} sinusoid biased at 6 V at the output. Show the waveforms.



5. Determine the voltage gain of the power amplifier

Vopp = 1.96 V
Vipp = 2.6 V

Av = Vopp / Vipp = 1.96 / 2.6 = 0.754 V/V