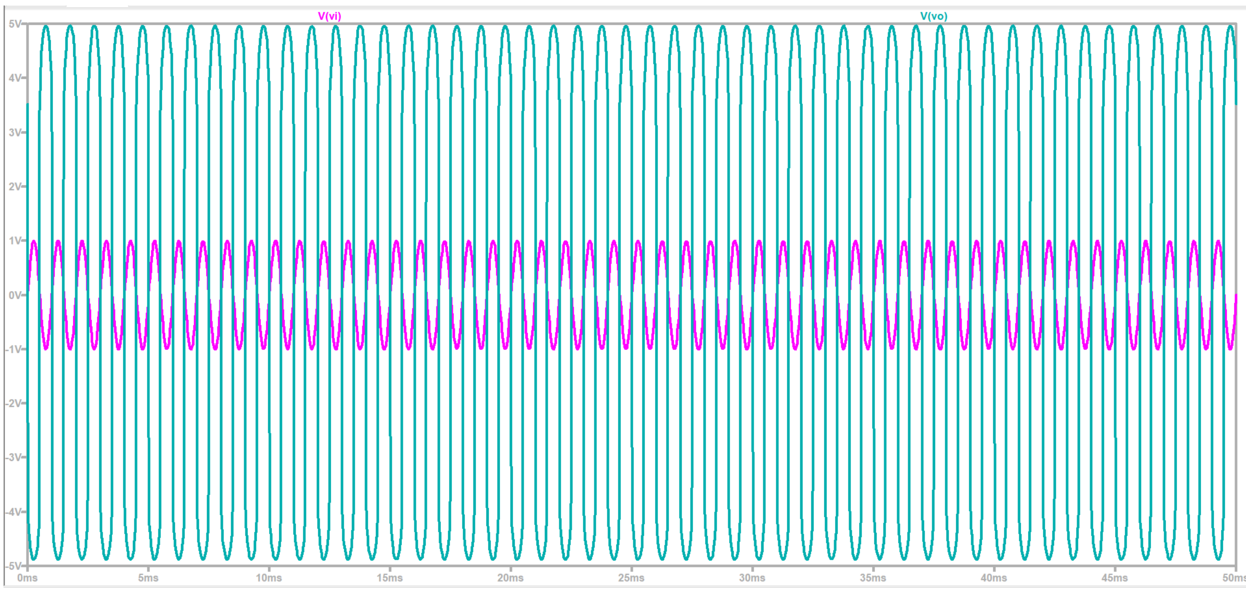
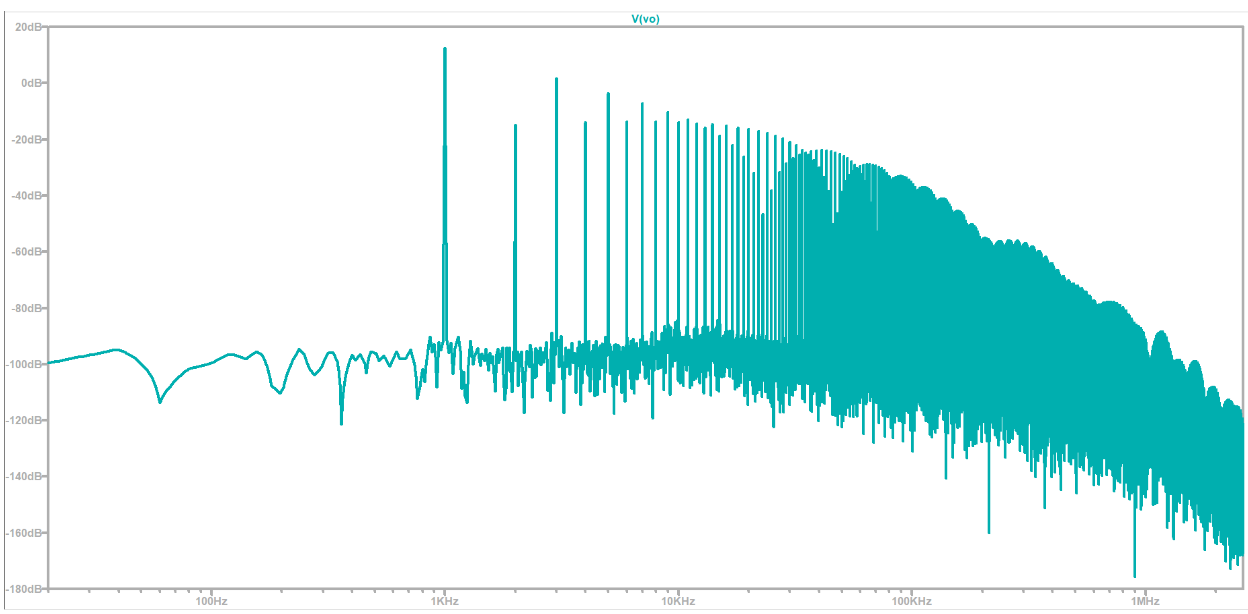
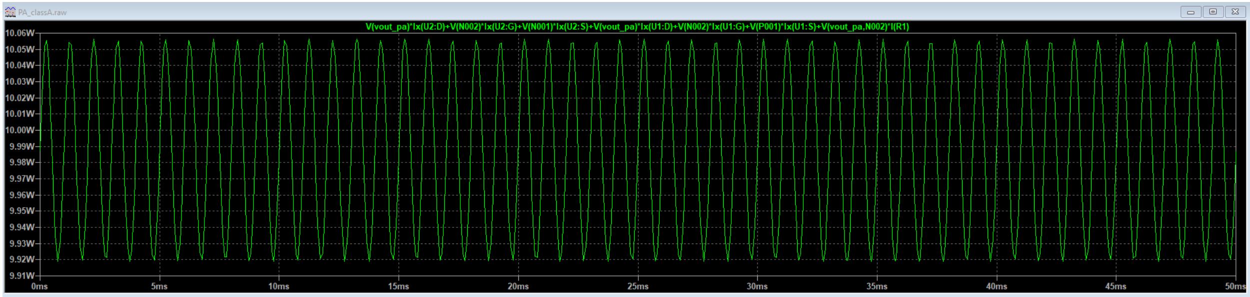
Preparation

1. Run a 50-ms transient simulation for the Class-A output stage in Figure 2 (a) with 1-kHz 1-Vpp input. Show the input voltage and output voltage waveform. Set the maximum time step of the transient simulation to 1 μs. Plot the output spectrum using the FFT function of the simulator. Find the power consumption of the amplifier when the input signal amplitude is 10 mVpp and when it is 1Vpp.

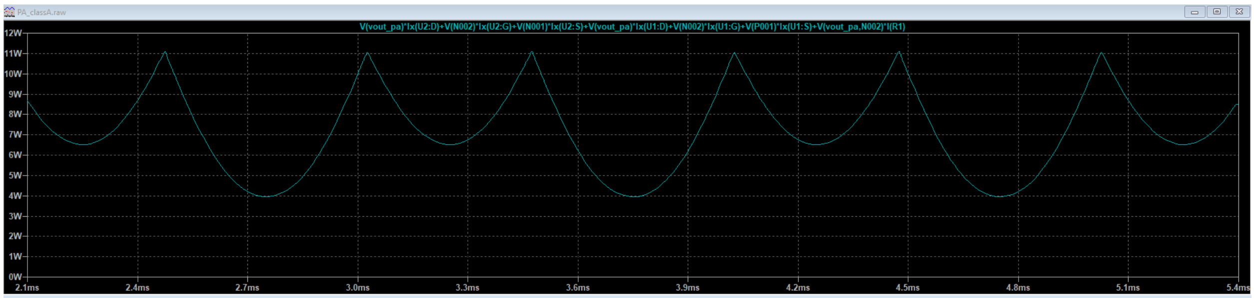




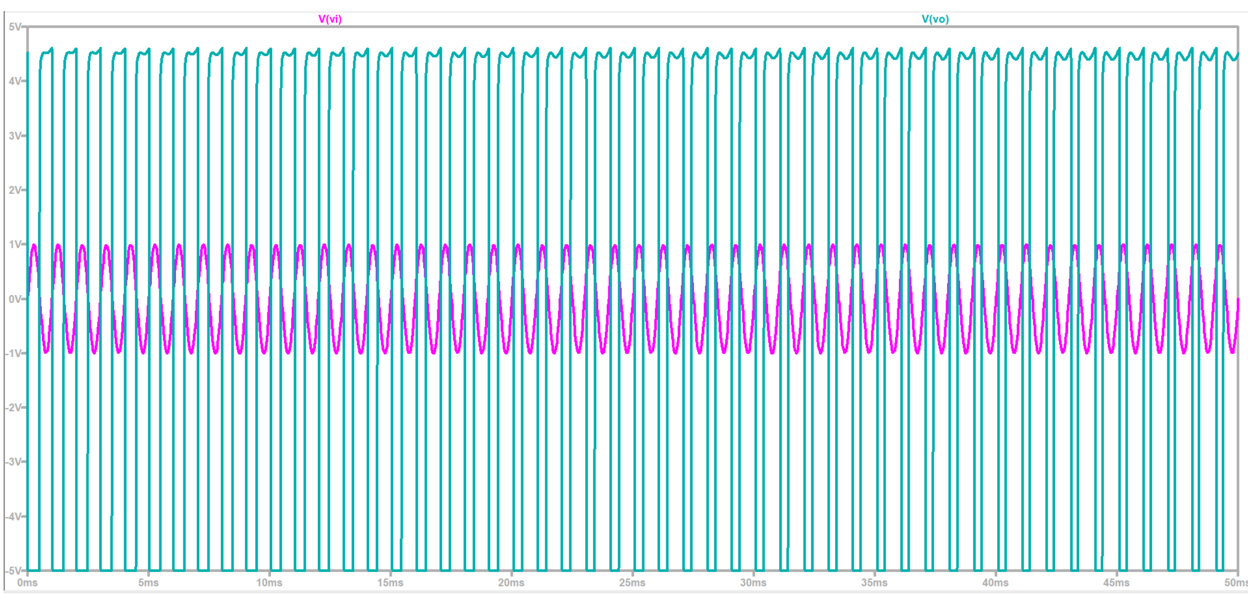
Power consumption when input signal amplitude is 10 mVpp



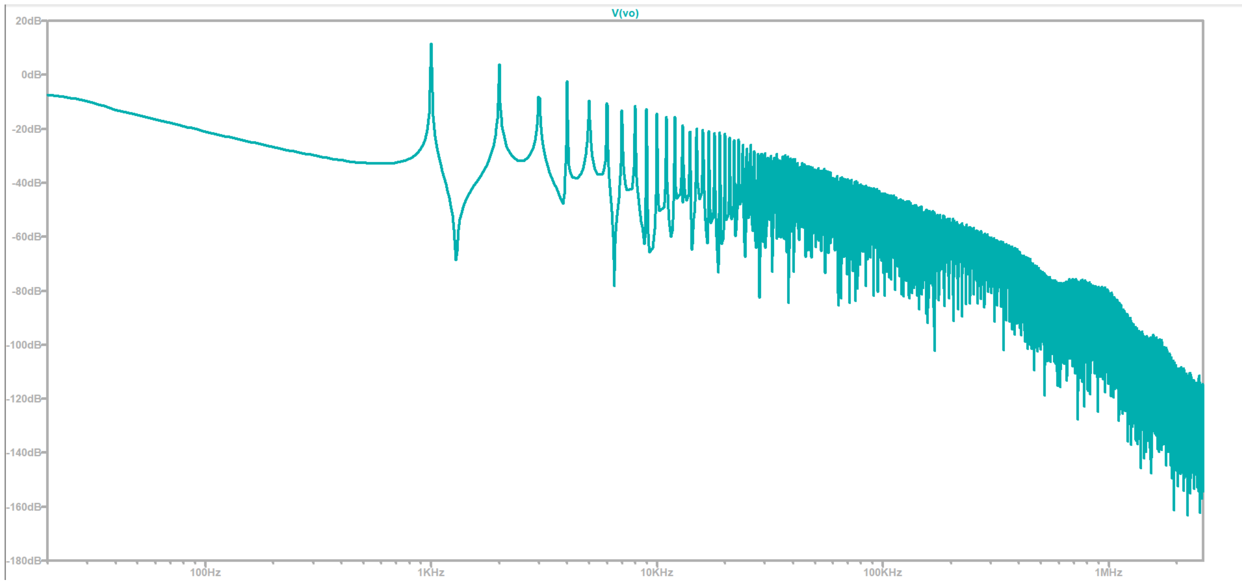
Power consumption when input signal amplitude is 1Vpp



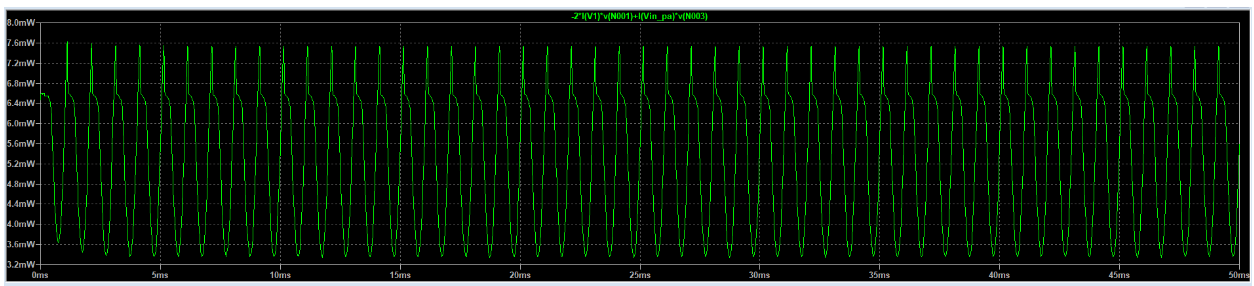
2. Repeat step 1 for the Class-B output stage in Figure 2 (b). Use the value for R1, R2, R3, and R4 determined in lab 3 such that both the p-MOSFET and the n-MOSFET are biased at threshold (little or no current flowing through them).



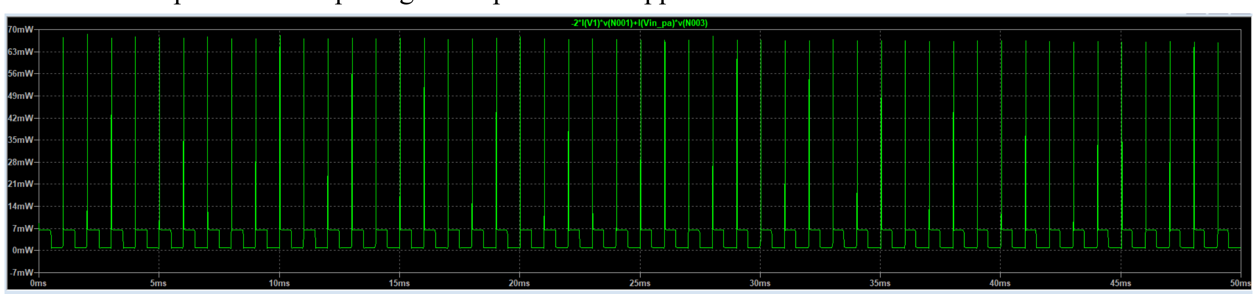
Input between -0.5V and 0.5V
Output saturates at -5V and 5V



Power consumption when input signal amplitude is 10 mVpp =



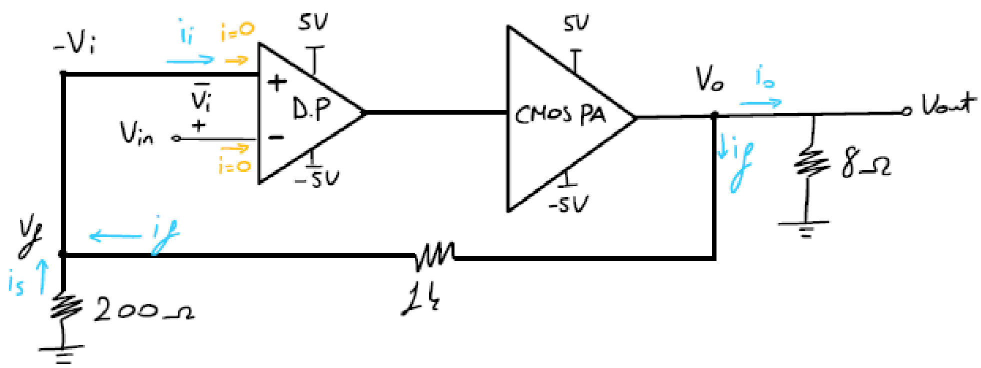
Power consumption when input signal amplitude is 1Vpp =



3. Determine the gain of the amplifier in Figure 1. What happens to the volume that the speaker would produce when the 1-kΩ feedback resistor value is varied?

$R_S = 200\,\Omega \quad R_f = 1k\,\Omega \quad R_L = 8\,\Omega$

Series-shunt feedback (Voltage Amplifier)



$$\beta = \frac{V_f}{V_o} = \frac{R_S}{R_F + R_S} = \frac{200\,\Omega}{1k\,\Omega + 200\,\Omega} = \frac{1}{6} \simeq 0.167$$

$$A = \frac{V_o}{V_{in}} = -\left(1 + \frac{R_f}{R_S}\right) = -\left(1 + \frac{1k\,\Omega}{200\,\Omega}\right) = -6$$

$$A_f = \frac{V_o}{V_s} = \frac{A}{1 + \beta A} = \frac{-6}{1 + \frac{1}{6}\cdot(-6)} \rightarrow \infty$$

If the feedback resistor value is changed the volume that the speaker will produce would be decreased as long as the feedback remains as negative feedback (A < 0). However, if the feedback resistor is changed to a value that the system would provide positive feedback, the volume would increase (A > 0).

4. The schematics in Figures 2 (a) and (b) use two supplies, 5V and -5V. This arrangement centers the output at 0V and allows us to DC couple the output stage directly to the speaker. There are cases where only a single supply is available and the speaker has to be AC coupled through a series capacitor (Cs) since the output is no longer at 0V. Determine the value for Cs for a cutoff frequency of 50 Hz or less (Hint: $f_{3dB} = 1/2\pi R_L Cs$ where R_L represents the load resistance).

$f_{3dB} = 1/2\pi R_L Cs = 50$ Hz
For $R_L = 8\ \Omega$ (resistance of the speaker)
$Cs = 1/2\pi R_L f_{3dB} = 1 / ((2\pi) * 8 * 50)$
Cs = 398 µF