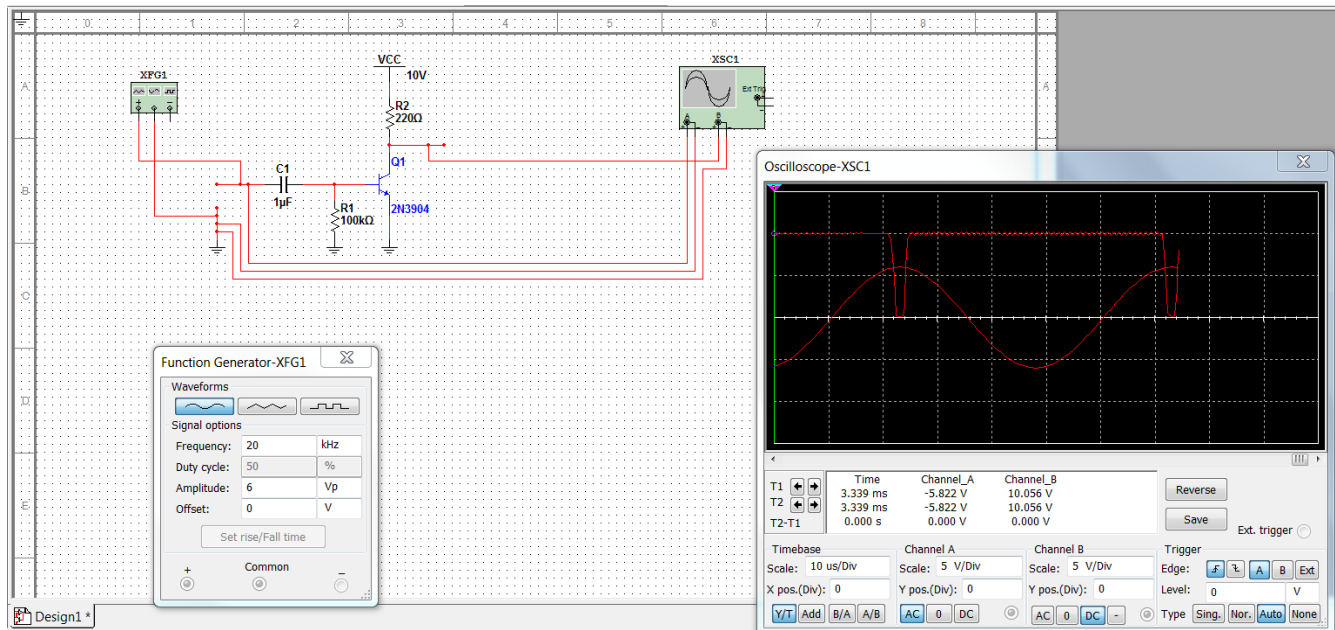


Sarom Chhin
ET-341, Lab 2, Experiment 31
Class C Amplifier



In this lab, we have built the circuit above from the lab manual Figure 31-1. Shown are both input and output waves with the help of Multisim. With the square-looking wave as the output, and the sine-wave as the input.

At 10us per division, we end-up with a wave-length (T) of approximately 50us, and a pulse-width (W) of about 47.2us. The duty-cycle (D) would be $47.2\mu s / 50\mu s = 94.4\%$. With a peak voltage of 11.25V for each peaks; for a total of $22.5V_{p-p}$.

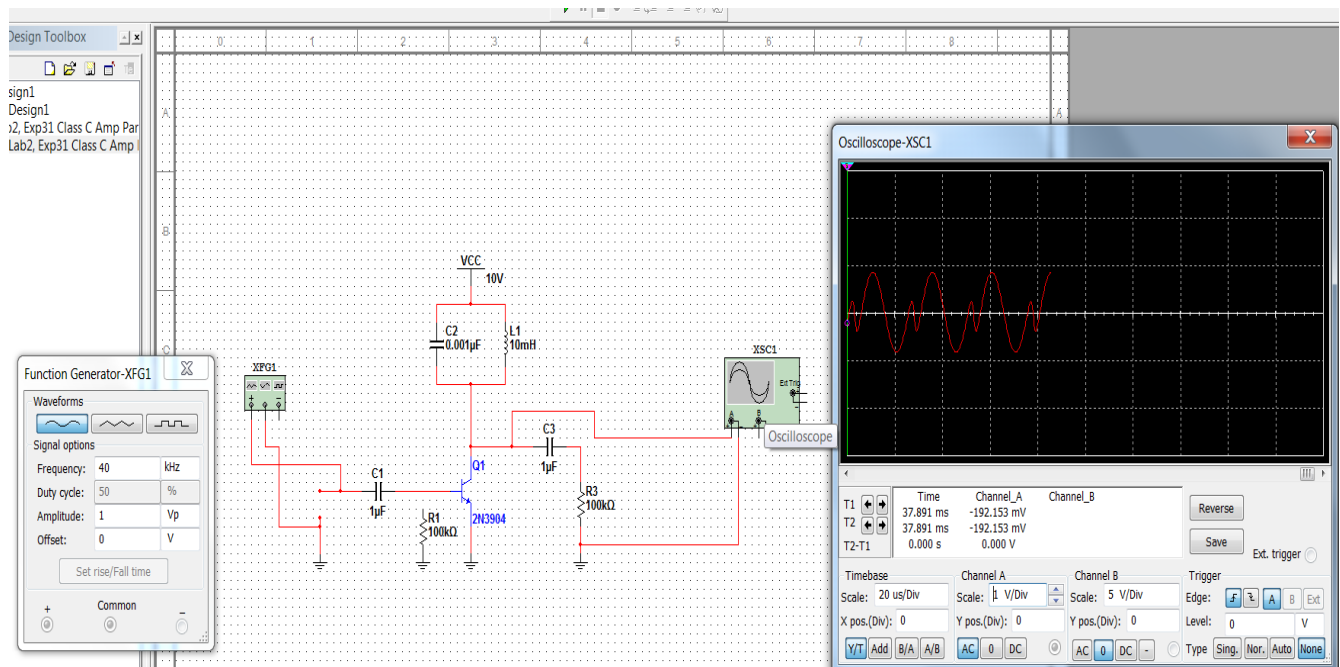
Notes & Explanations

In a class C amp., the flat part at 10V is when the transistor is OFF. So, those quick drips are when the transistor are actually ON. We can see that it is ON, when the input sine-wave is at its peaks. The reality is, the output wave have moved down to the -3V spot. Why? It is because our input is $6V_{p-p}$ (+3V peak, and -3V peak), and in theory, the wave should not peak beyond where the 0V is right? But in actuality, it does (peak a bit above 0V) for a limited time—that is why we have those quick drips. So we can see that duty-cycle, is very high around 90%.

Duty-cycle: http://en.wikipedia.org/wiki/Duty_cycle

Tuned Circuit

A tuned circuit is used in radios and such; when we tune to the correct frequency, the wave (shown below) will spike to its maximum voltage.

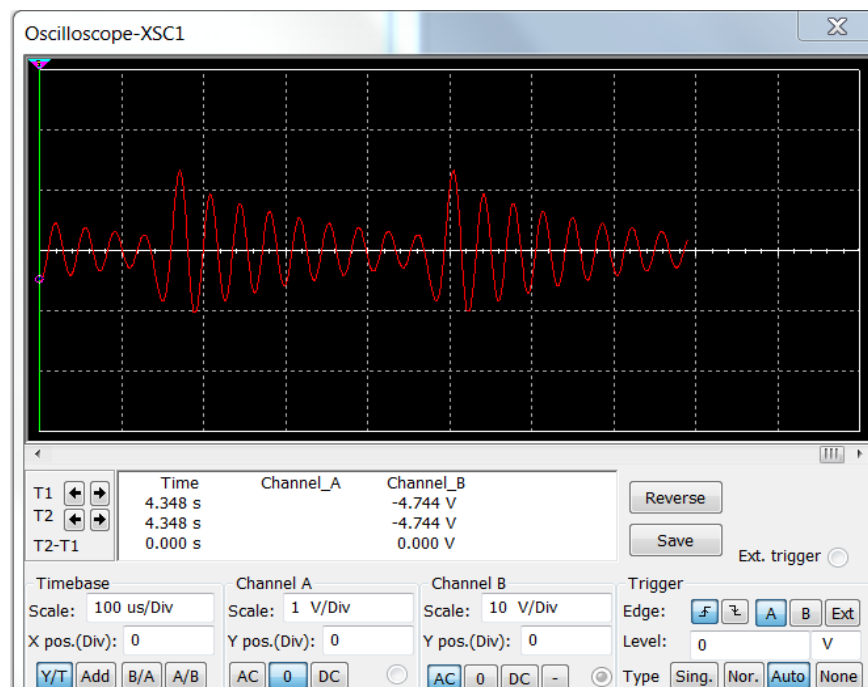


This is the input sine-wave is set at 40kHz and $2V_{p-p}$.

We can see that it does output about $2V_{p-p}$, but we don't see the “damped oscillation” yet.

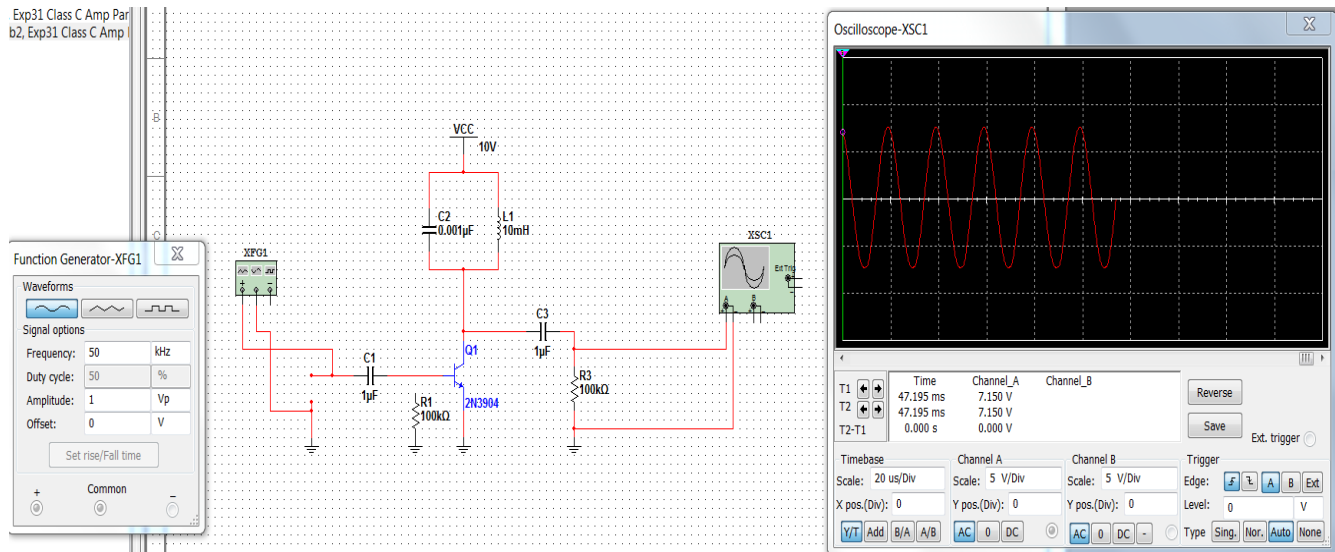
http://en.wikipedia.org/wiki/Damped_wave

The damped waves will become more visible in the oscilloscope at around only a few kHz. Below is an example shown at 3kHz.



Resonant Frequency (f_r)

Now, we will be looking the f_r = Resonant Frequency. We will know it when the output wave max-outs at around 15-20V_{p-p} (from 2V_{p-p}). Now, we have calculated for the f_r . All calculation are shown below. Based off that, it should peak around 50kHz. Below is the output wave at 50kHz—which is its maximum voltage and f_r .



At 5V per divisions, we can see the output voltage is at approximately $(4)0.625V + 10V = 12.5V$ --that is our f_r . To find our Bandwidth (BW), first we need to find the lower frequency (f_L) and higher frequency bandwidth (f_H) limits. To do this, we take our maximum voltage value of $12.5V \cdot 0.707 = 8.84V$, then so we would have to decrease the frequency from its f_r (at 50kHz) till we see about 8.84V to find our f_L , and then repeat again by increasing the frequencies instead beyond its f_r , to about 8.84V to find the f_H limit.

To calculate the Resonant Frequency (f_r), we would do the following:

$$\begin{aligned} f_r &= \frac{1}{2\pi\sqrt{LC}} \\ &= \frac{1}{2\pi\sqrt{10mH \cdot 0.001\mu F}} \\ &= 50kHz. \end{aligned}$$

To calculate for Inductive Reactance (X_L):

$$\begin{aligned} X_L &= 2\pi \cdot f_r \cdot L \\ &= 2\pi(50kHz \cdot 10mH) \\ &= 3.14k\Omega \end{aligned}$$

For the Series Resistance (R_S), we measured the inductor with an DMM, and got 37.6 Ω .

For the Parallel Resistance (R_P), we first need to find the Quality Factor (Q), by doing the following below:

$$\begin{aligned} Q &= X_L / R_S \\ &= 3.14k\Omega / 37.6\Omega \\ &= 83.51 \end{aligned}$$

$$\begin{aligned} R_P &= Q \cdot X_L \\ &= 83.51 \cdot 3.14k\Omega \\ &= 262.22k\Omega \end{aligned}$$

For the total AC resistance (r_c) is:

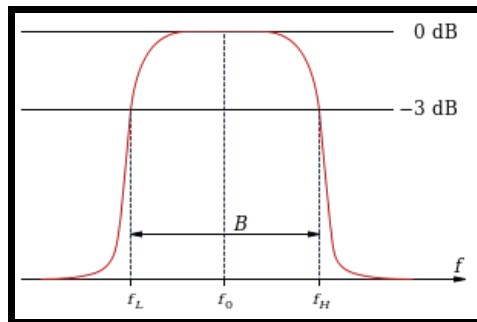
$$\begin{aligned}
 r_c &= R_P // R_L \\
 &= 262.22k\Omega // 100k\Omega \\
 &= \frac{262.22k\Omega \cdot 100k\Omega}{262.22k\Omega + 100k\Omega} = \frac{26.222G\Omega}{362.22k\Omega} \\
 &= 72.4k\Omega
 \end{aligned}$$

To find our ideal Bandwidth (**BW**), first we would need to find our Overall Q , which is similar but different to our previous Q value. (http://en.wikipedia.org/wiki/Q_factor)

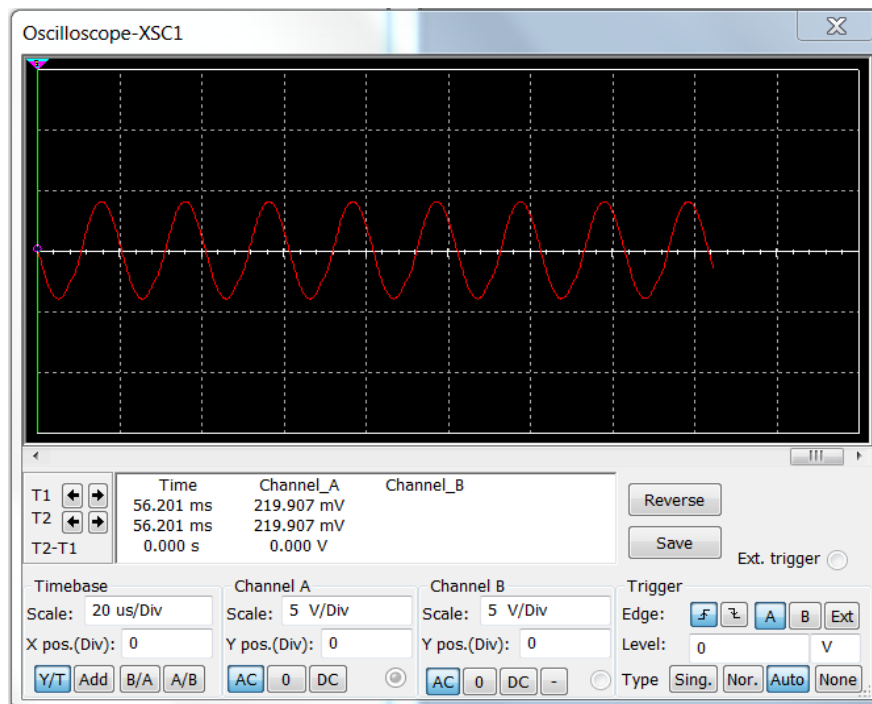
$$Q^{overall} = r_c / X_L = \frac{72.4k\Omega}{3.14k\Omega} = 23.06$$

$$\begin{aligned}
 BW &= f_r / Q^{overall} \\
 &= 50kHz / 23.06 \\
 &= 2.17kHz
 \end{aligned}$$

The BW is shown below, and appears like a flat-hill in a graph. Again, it is when we get the peak voltage output or the f_r , that we would have to lower our frequencies by 3dB or 0.707V of the f_r , we'll get our f_L and f_H as explained before.

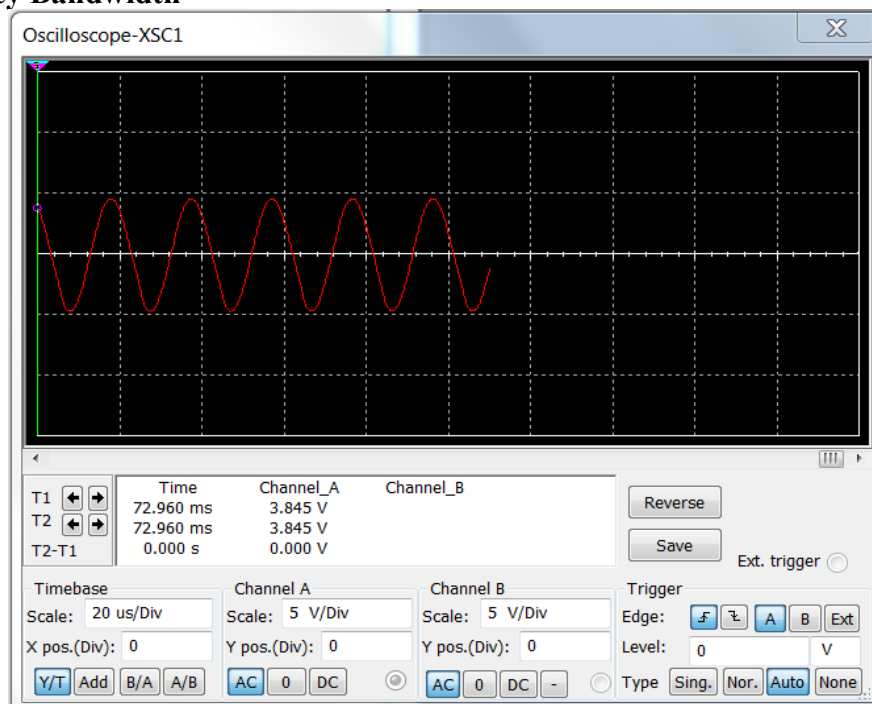


Lower Frequency Bandwidth



At 49kHz, we found our lower bandwidth limit. At 5V/Div, we have $(13)0.625 = 8.15\text{V}$. If we were to lower the frequency even more, our voltage would decrease dramatically.

Upper Frequency Bandwidth



At 49kHz, we found our lower bandwidth limit. At 5V/Div, we have $(14)0.625 = 8.75\text{V}$. If we were to higher the frequency even more, our voltage would increase dramatically.

Questions: