CS1025 Lab Report n°3

Samuel Petit

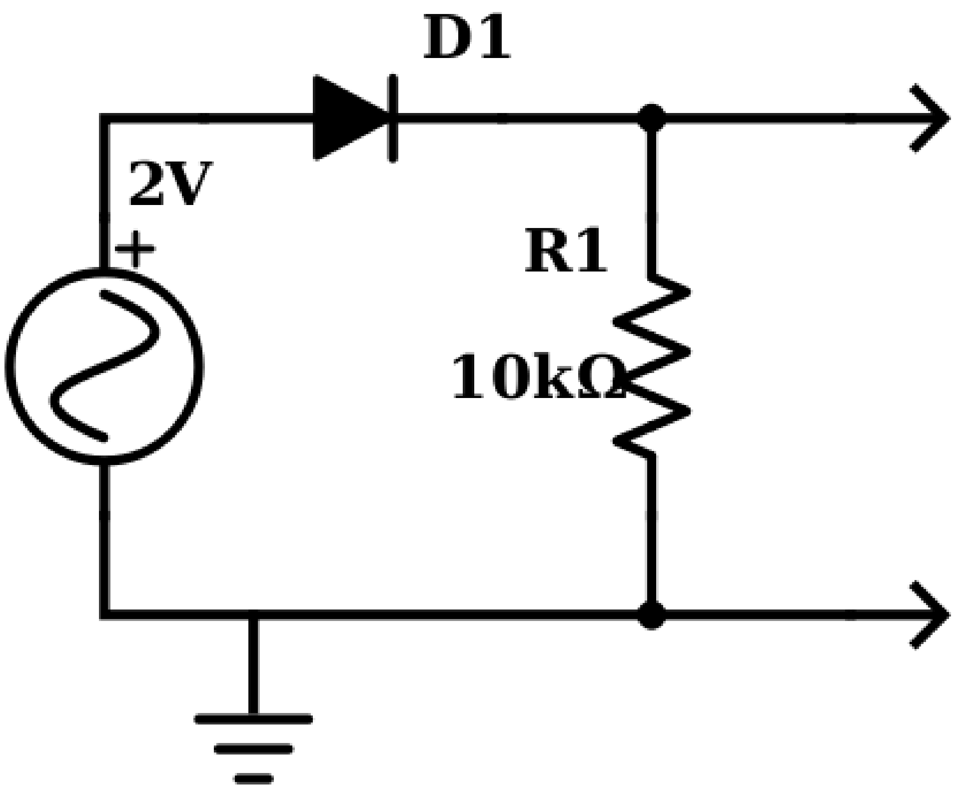
Student Number: 17333946

Performed on 24/11/17, session 4pm – 6pm

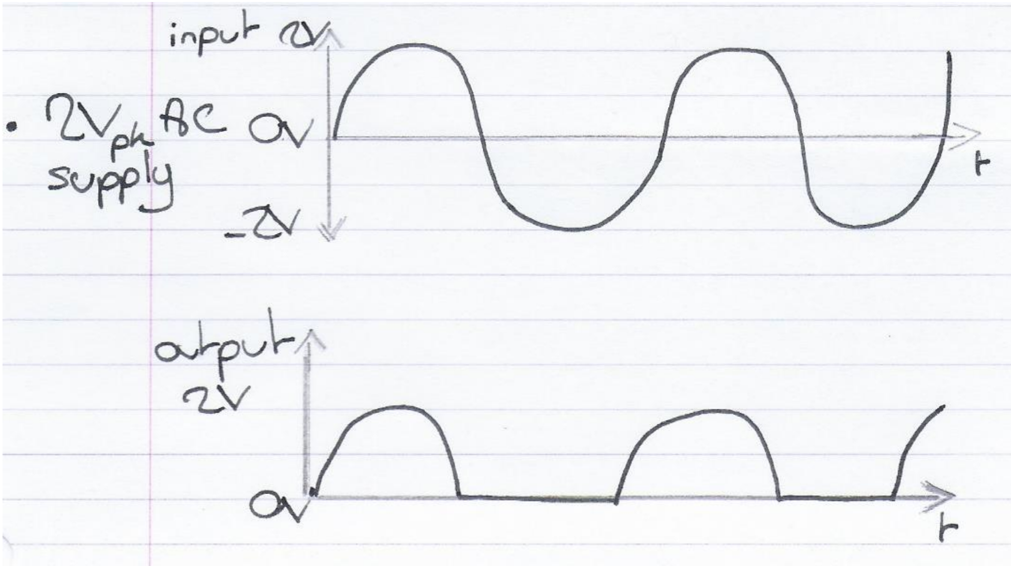
Using Capacitors to convert an AC to a DC signal

During this lab, 3 circuits were built, all 3 using an AC power supply set to 2 Volts. All circuits contained also a 10k Ohms resistor, a diode as well as a capacitor (of 1 uF and 10uF).

First Circuit



First Circuit built for this lab. Includes a 2V AC power supply, a diode and a 10k Ohms resistor.

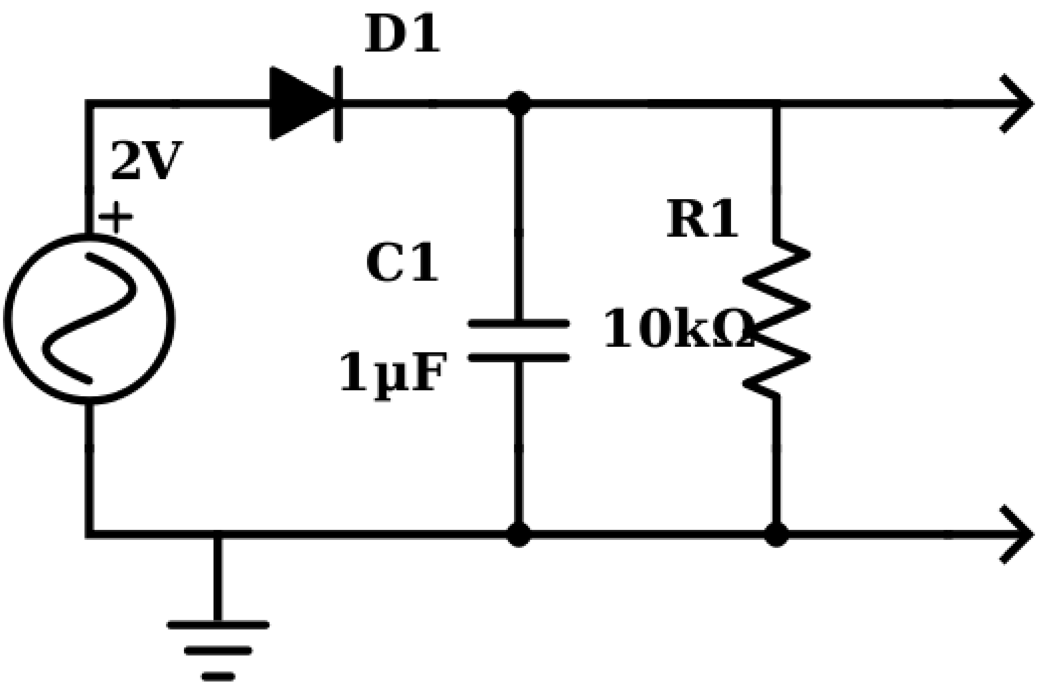


Inputs and outputs observed on the oscilloscope for the first circuit built

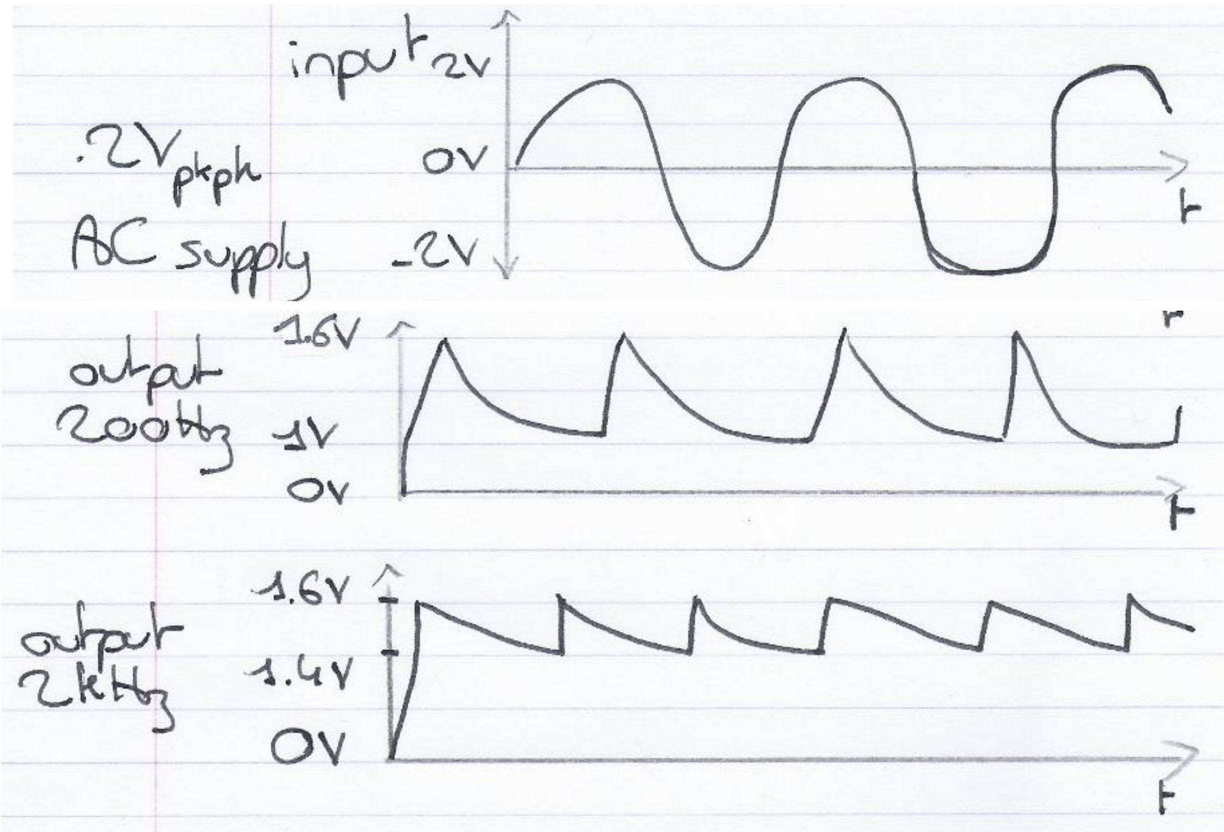
This first circuit brings us back to the previous lab. The 2V AC power supply alternates between positive and negative shifts in a sinusoidal form (as you can see above in the input waveform). The output keeps then the same form as the input and varies from 0V to just under 2V.

In the positive half, the diode is positioned so it will let the current through and become a short circuit as current goes through the resistor. The output is then observed across the resistor. During the negative half cycle, the diode is in reverse-bias, so the current will not pass through it and therefore no current will travel across the resistor. Therefore, we can observe that the output during this negative cycle is constant and of 0V.

Second Circuit



Second Circuit built for this lab. Includes a 2V AC power supply, a diode, a 10k Ohms resistor and a 1uF capacitor connected in parallel to that resistor.



Input and outputs observed on an oscilloscope for the second circuit, observed at 2 different frequencies: 200Hz and 2kHz

It is important to note that this circuit includes a capacitor. Therefore, the current 'through' the capacitor follows the following expression:

$$I(t) = C * dv/dt$$

Therefore, the current flowing depends on the rate to which the voltage changes. This also means that DC power is filtered.

In this circuit (and the following), only AC power is used, however the rate of change of voltage still has an important impact on the actual current flowing. We observed the outputs for 200Hz and 2000Hz. This means that the time for a period were of:

1/200 = 5ms 1/2000 = 0.5ms

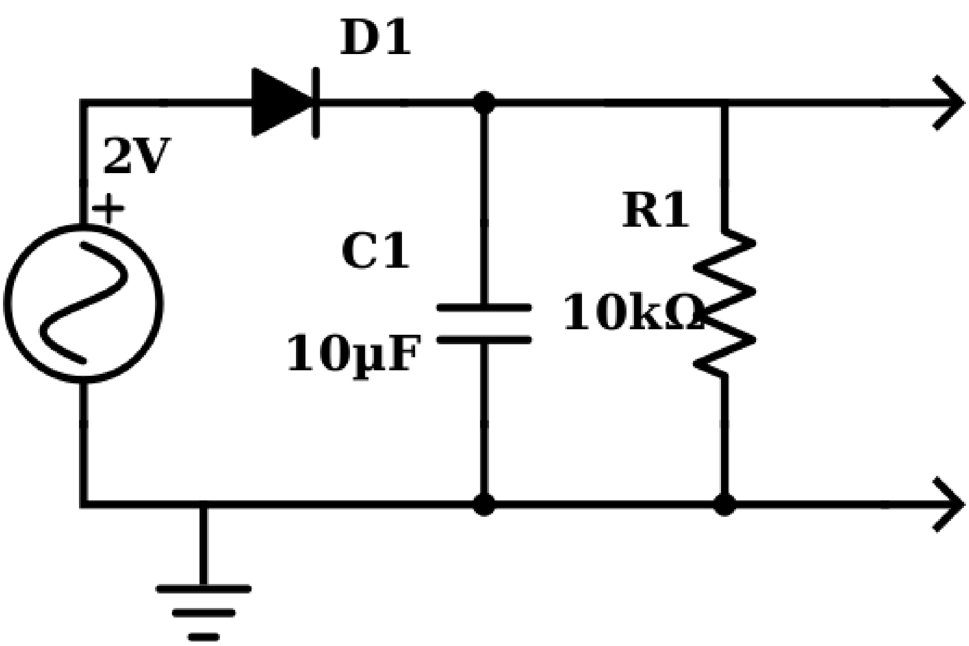
Where the period represents the time for the signal to go through both the positive and the negative half cycles.

Observing the first output (at 200Hz), we can see that the capacitor is charged during the positive cycle. During the negative half cycle, the capacitor does not charge as no current is flowing through the diode and so starts to discharge until the negative cycle is finished and the capacitor starts to charge again as current is flowing.

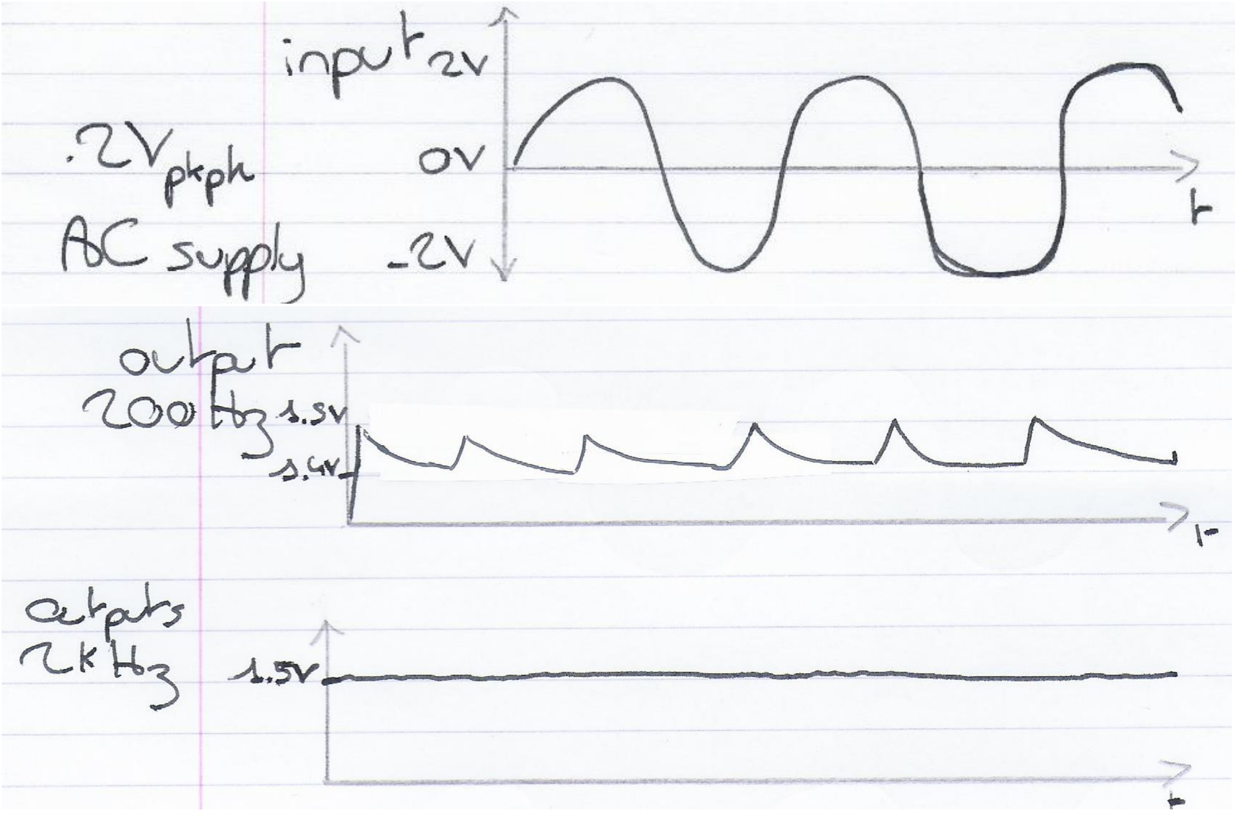
At 2000Hz: the exact same procedure is observed. However, it is clearly noticeable that as the frequency is much higher than at 200Hz, the capacitor has less time to discharge and therefore the voltage does not drop as low as it did at the lower frequency (1.4V at the higher frequency and about 1V at the lower frequency).

Finally, it is noticeable that the voltage does not reach 2V but more like 1.6V, that is because some amount is dropped across the diode.

Third Circuit



Second Circuit built for this lab. Includes a 2V AC power supply, a diode, a 10k Ohms resistor and a 1uF capacitor connected in parallel to that resistor.



Input and outputs observed on an oscilloscope for the second circuit, observed at 2 different frequencies: 200Hz and 2kHz

This time, a 10 uF Capacitor was used, as its capacitance is 10 times greater than the first one used, it can store 10 times more energy. Therefore, even with the 200Hz frequency, the capacitor will discharge but not as much (of course 'much' is relative to its capacity).

Finally, when the frequency is switched to 2kHz, the capacitor does not have the time to charge up to its full capacity. It is important to note that, even though it is not clearly shown here, the peak voltage increased over time as the capacitor charged over time the amounts it is charged and discharged get smaller and smaller (due to the frequency used being so high) to finally obtain an output which could be considered as a 1.5V DC voltage.

Conclusion

We now have learned that a circuit using a diode and a capacitor could transform an AC into a DC voltage. And that the capacitance of the capacitor used as well as the frequency used each have their impact on the output waveform. However it is important to note that this method was not entirely accurate as the output voltage increased over time in the last circuit (due to the frequency and capacity used).

Use of an AC to DC signal converter

To this day, many electronic devices/circuits require an AC power source. It is then often needed to convert that signal into DC to allow these devices to run correctly (smoothly).

Websites used:

For creating the diagrams of each circuit:

- https://www.digikey.com/schemeit/