1/10/2024

Bio ca2

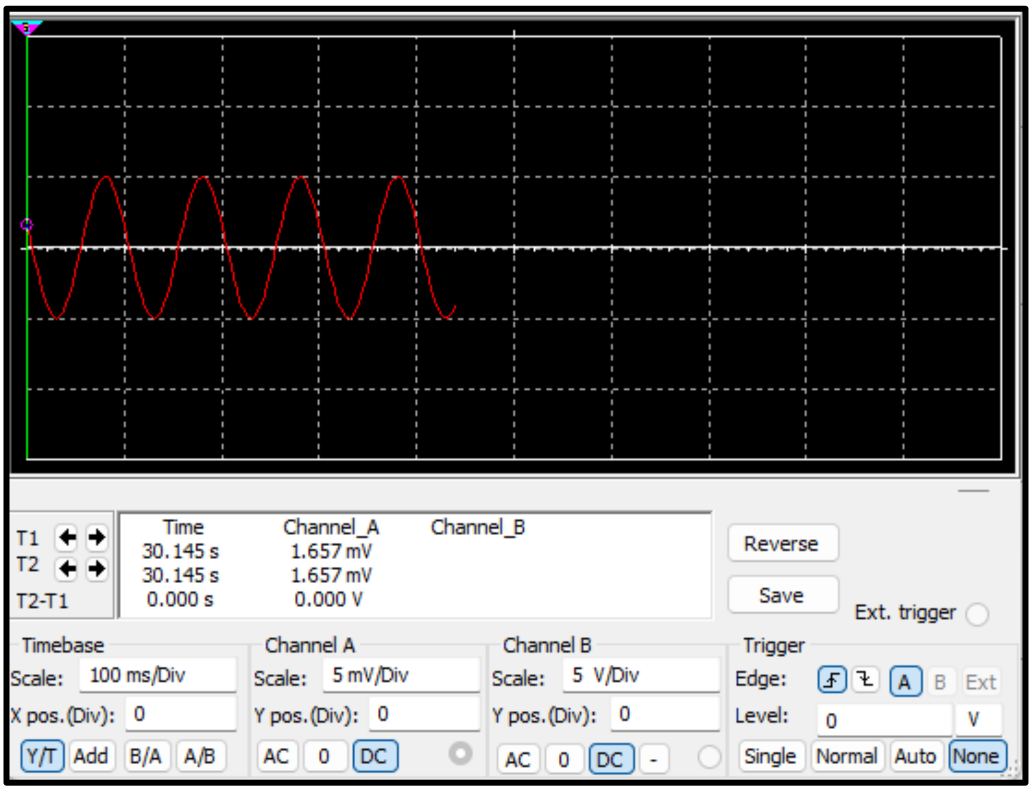
Mohammad Amin Kolahdoozan
810100257

m.aminkolahdoozan@gmail.com

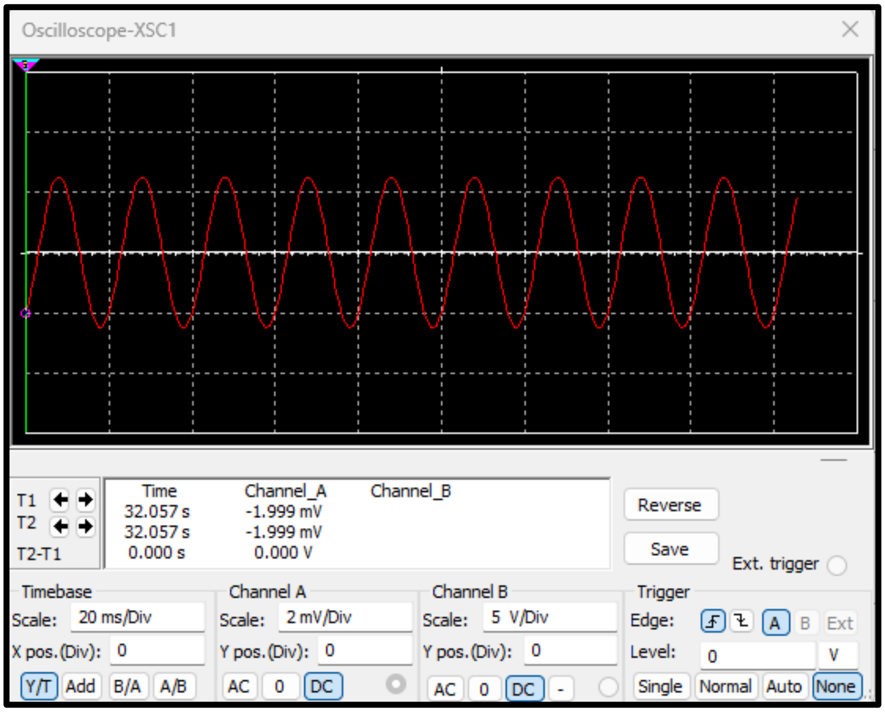
Part 1 (ECG Amplifier):

In this section, we address the elimination of city noise, which has a frequency of 50 Hz, as well as the elimination of another noise with a frequency of 1 MHz.
To eliminate the city noise, we use a notch filter, and to eliminate the other noise, we use a low-pass filter.
The process works as follows: first, the signals are combined and fed into an amplifier that provides the desired gain. Then, the signal is passed through a notch filter to remove the city noise. After that, it is passed through a low-pass filter to eliminate the other noise with a frequency of 1 MHz.
First, we display the input signals separately:

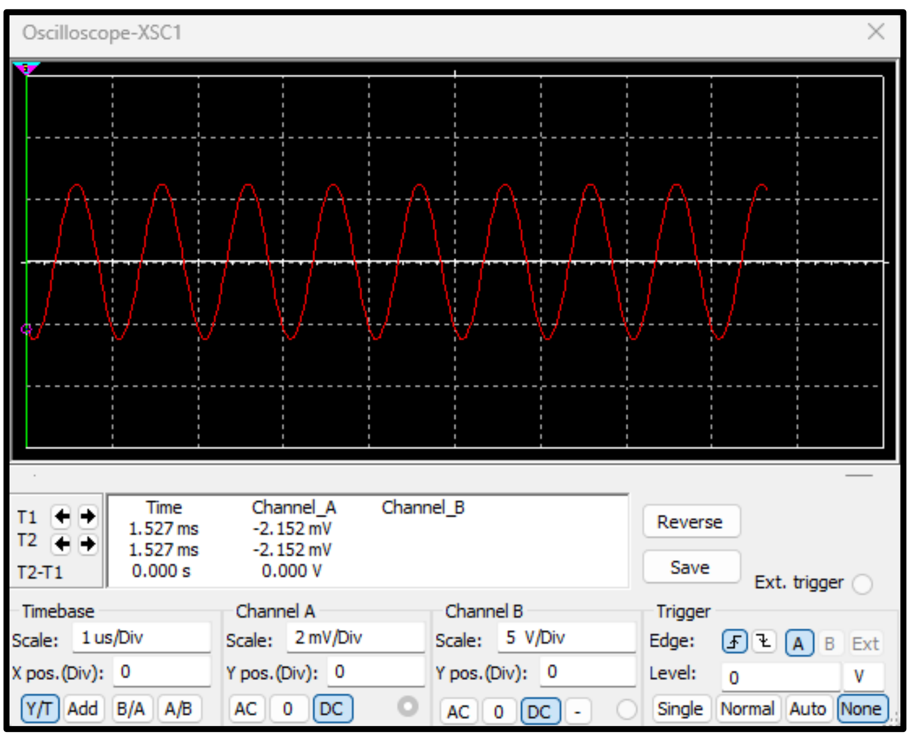
- Main signal (Amplitude: 5 mV, Frequency: 10 Hz):



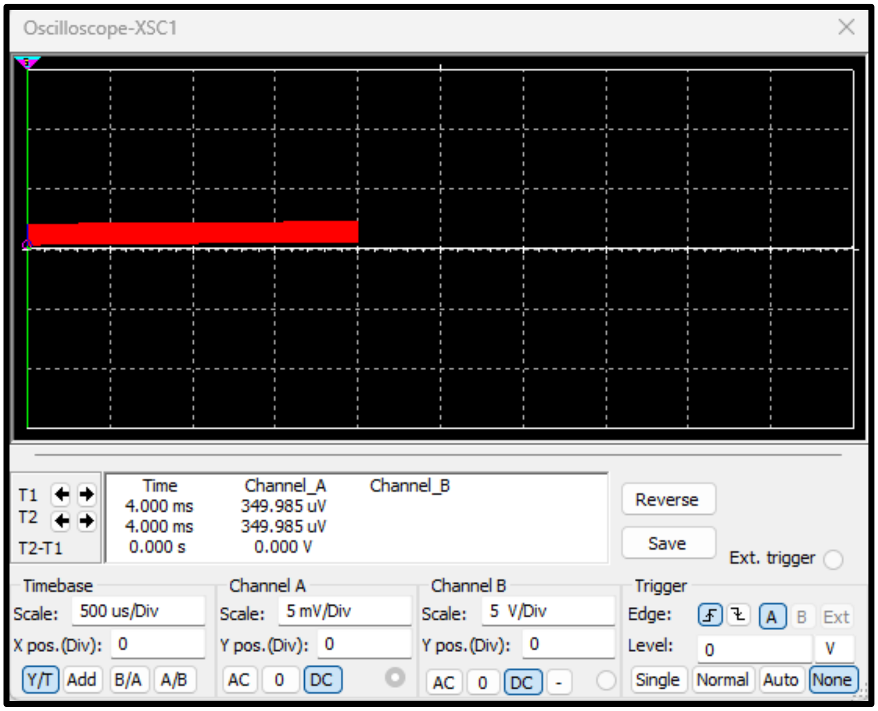
- City noise (Amplitude: 2.5 mV, Frequency: 50 Hz):



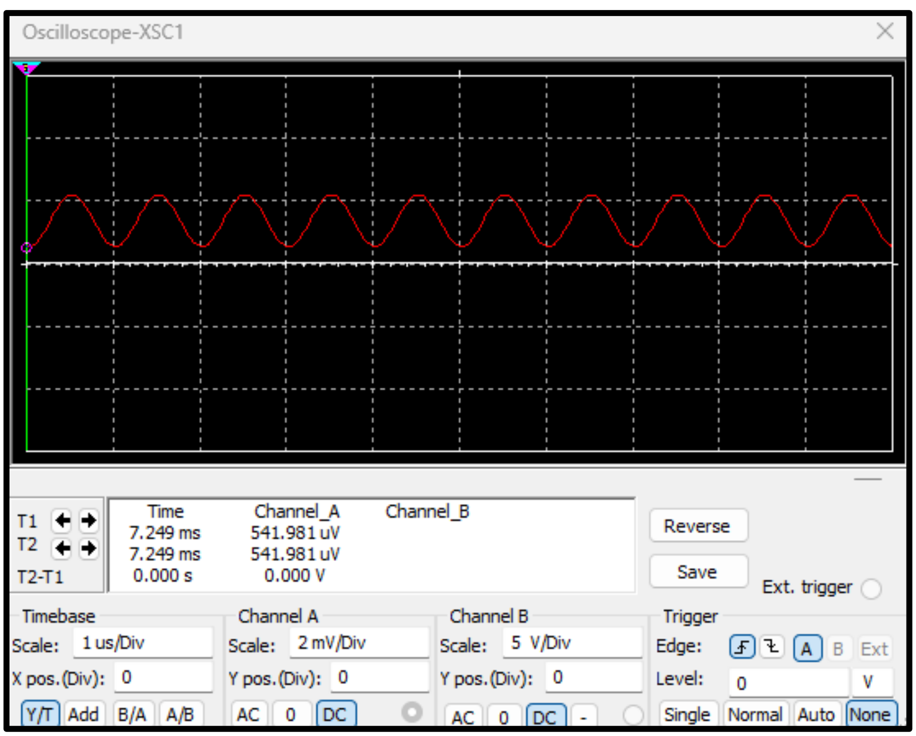
- Noise (Amplitude: 2.5 mV, Frequency: 1 MHz):



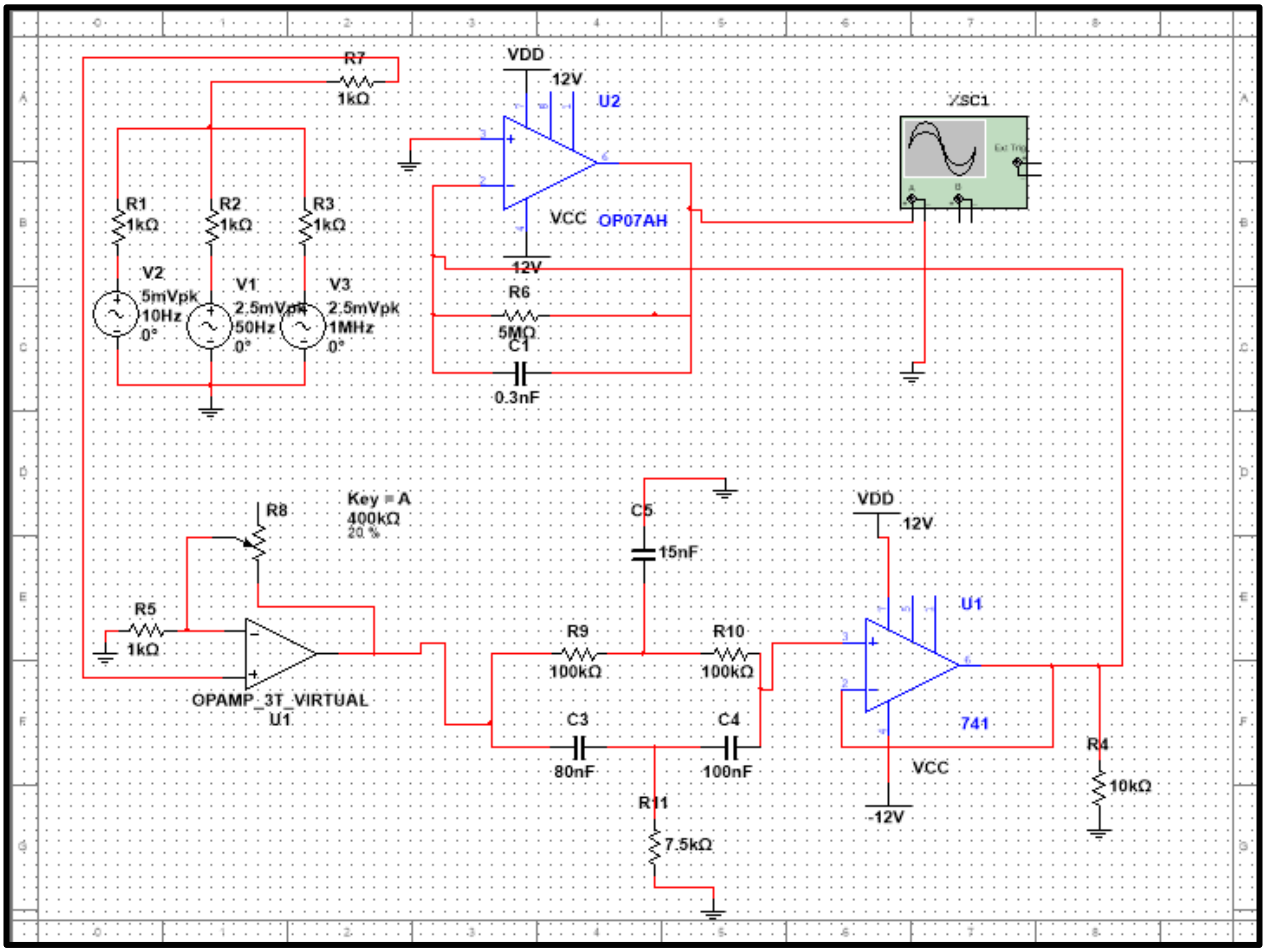
Now, we display the combined signal resulting from these three signals:



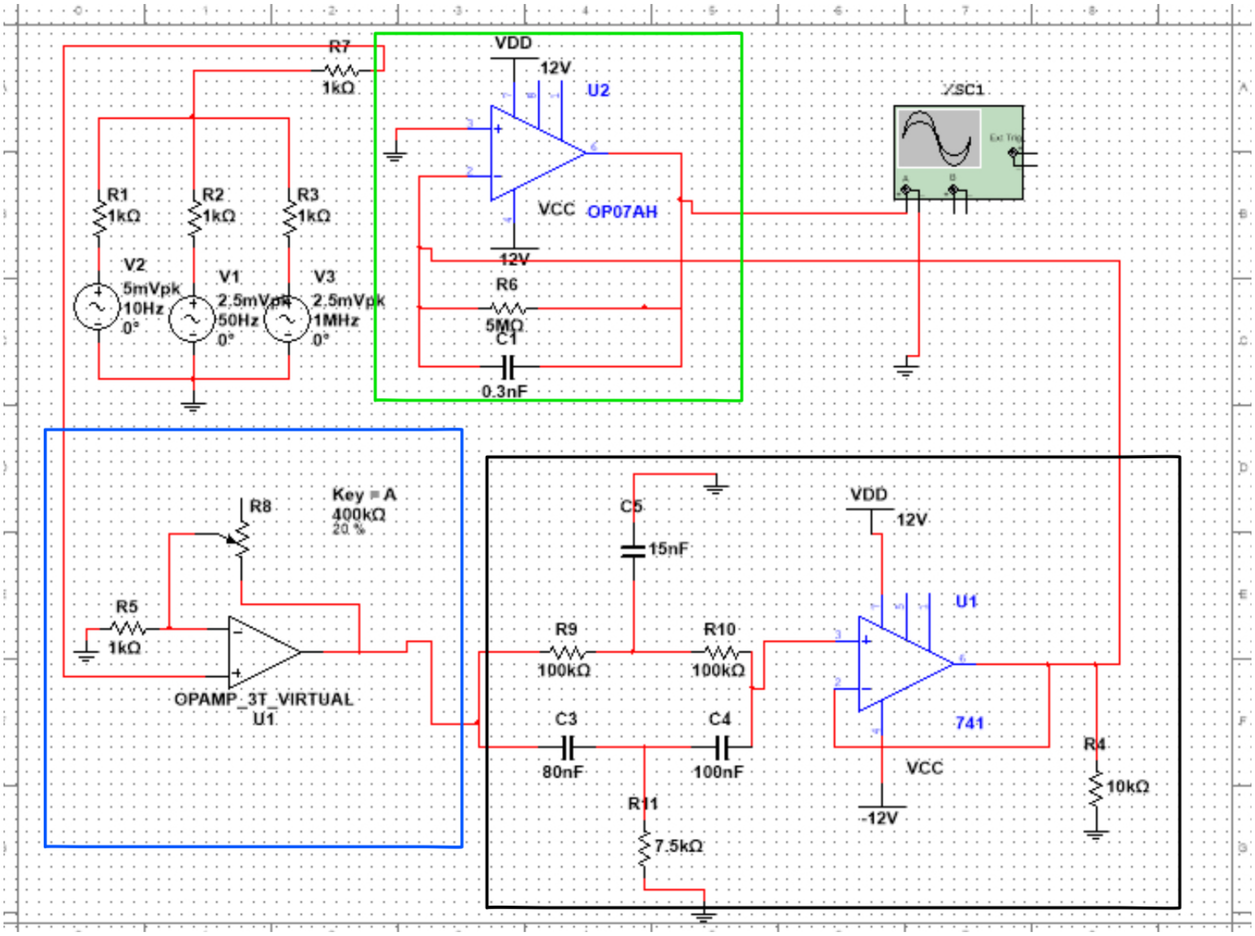
Now, if we reduce the time scale in this figure, we can observe the period of the sinusoidal signal.



As shown in the previous figure, this signal gradually increases over time and forms a sinusoidal signal.
In fact, the sum of sinusoidal signals results in another sinusoidal signal, but if we zoom in, we can also observe the 1 MHz signal.
Now, let's move on to the designed circuit diagram:

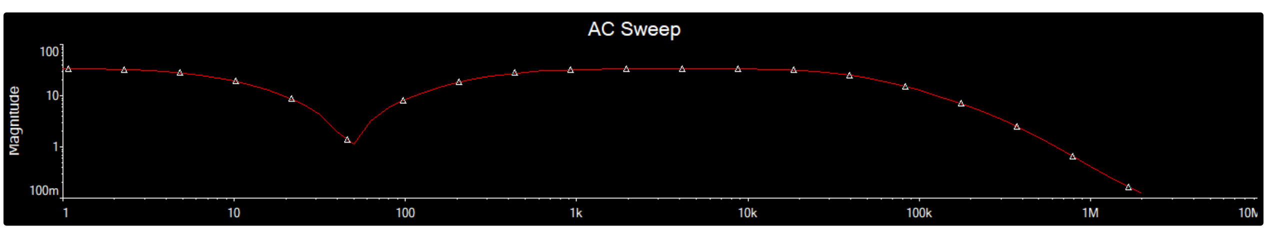


In the next figure, the various parts of the circuit are clearly indicated:



As mentioned, the blue section represents the amplifier providing the gain for the circuit, the black section is the notch filter, and the green section is the low-pass filter.

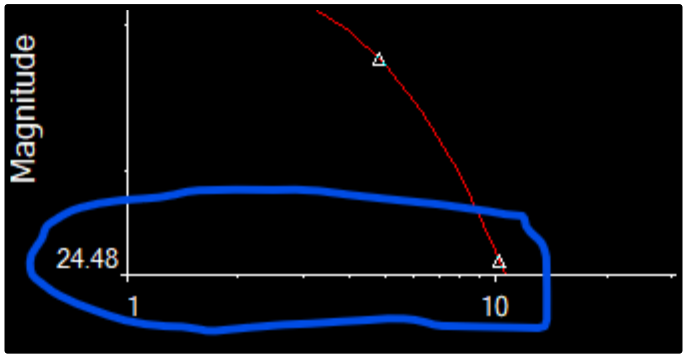
Now, let's move on to the final figure and analyze it at different frequencies:



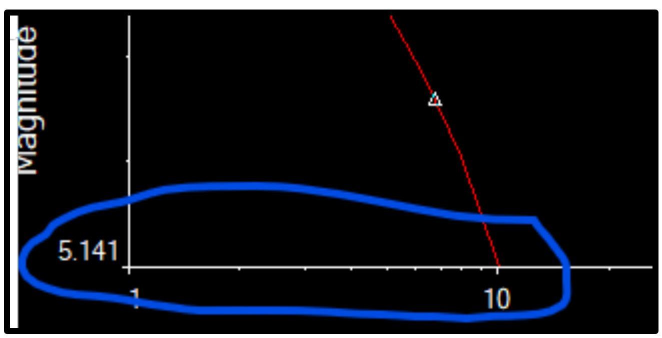
As we can see, at the frequency of 50 Hz, the notch filter has been applied. Additionally, at 1 MHz, the voltage is significantly lower compared to the initial voltage, which indicates that the signal has been filtered and attenuated.

Now, by using a potentiometer, we can adjust the gain.

If we zoom in on the frequency of 10 Hz in the above figure, the following shape is displayed:

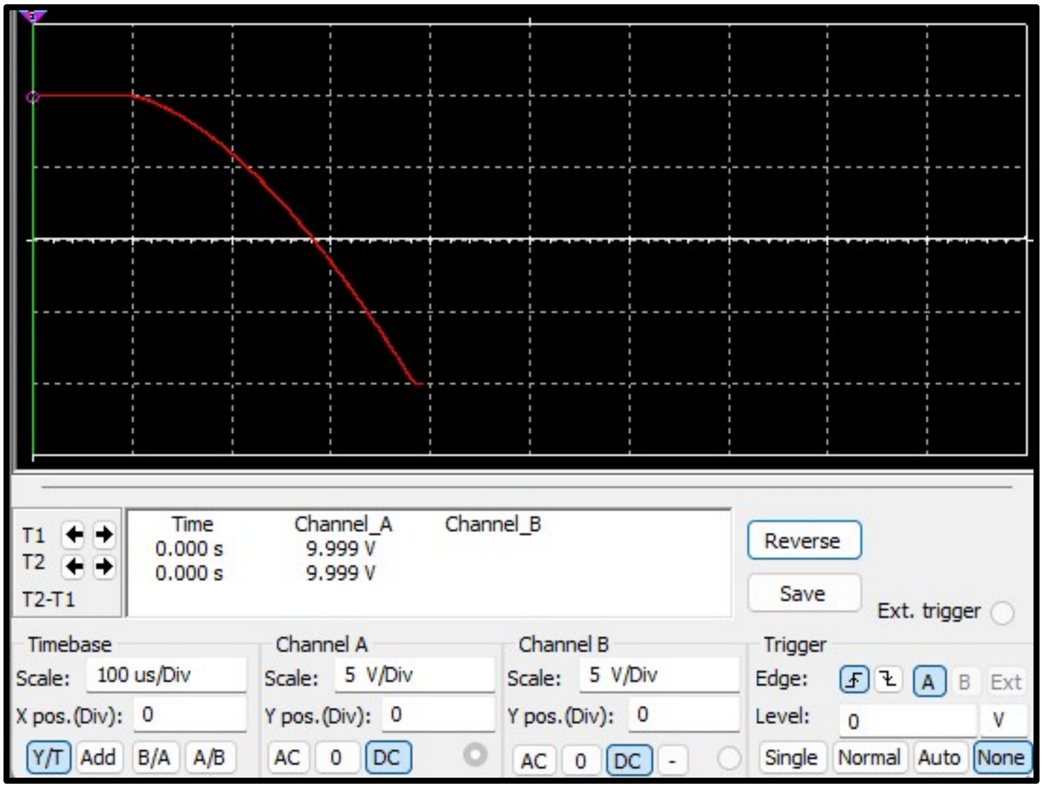


As expected, we now have a gain of approximately 5000 at a frequency of 10 Hz. Now, if we decrease the potentiometer setting, we can achieve a lower gain as well:



Here, we observe a gain of approximately 1000.

The shape displayed on the oscilloscope:



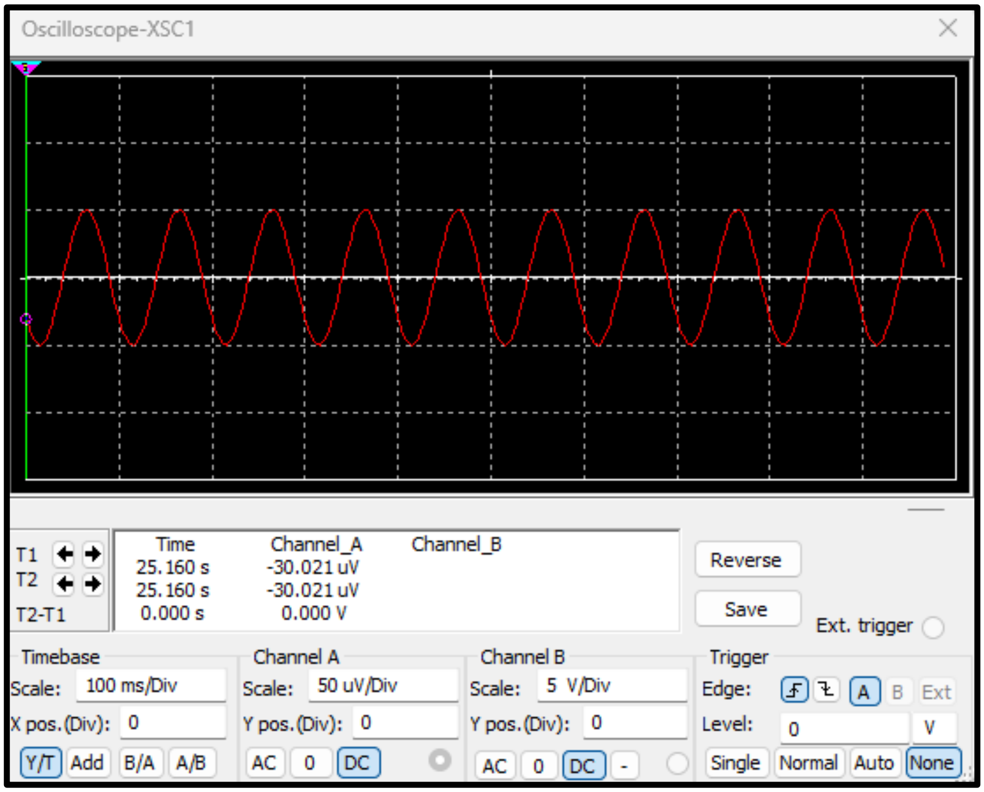
However, during discussions with the educational assistant, we concluded that there is an issue with the installed version of our Multisim software. In this section, the waveform is displayed very slowly and does not show the complete period. For this reason, we utilized the AC sweep section for the analyses.

Part 2 (EEG Amplifier):

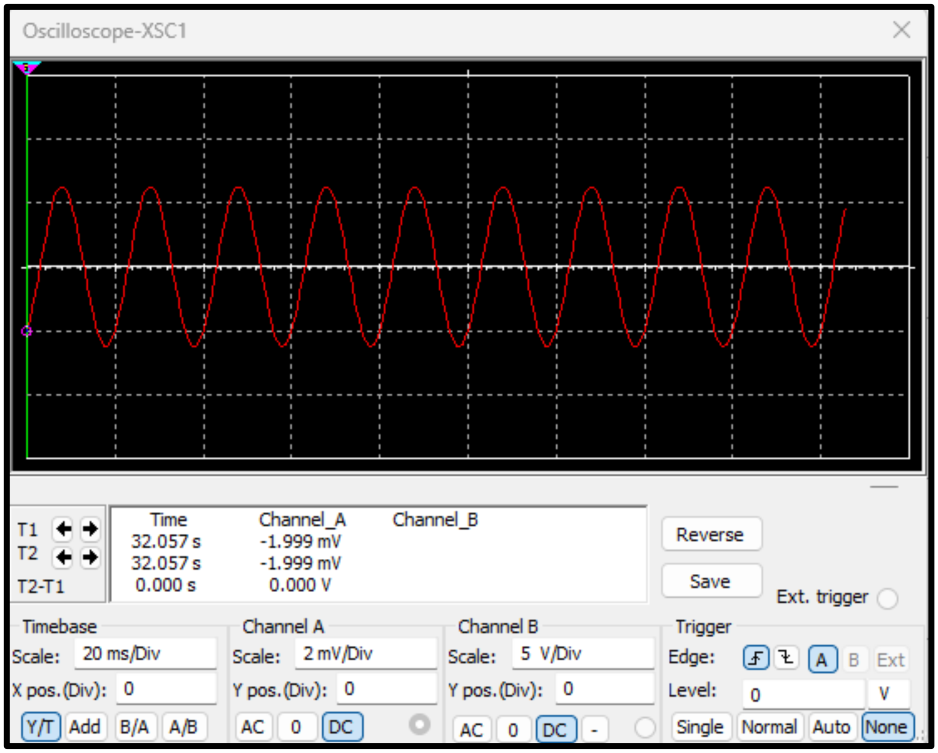
Here, the process is similar to the previous section, with only some values being different.

First, we display the input signals separately:

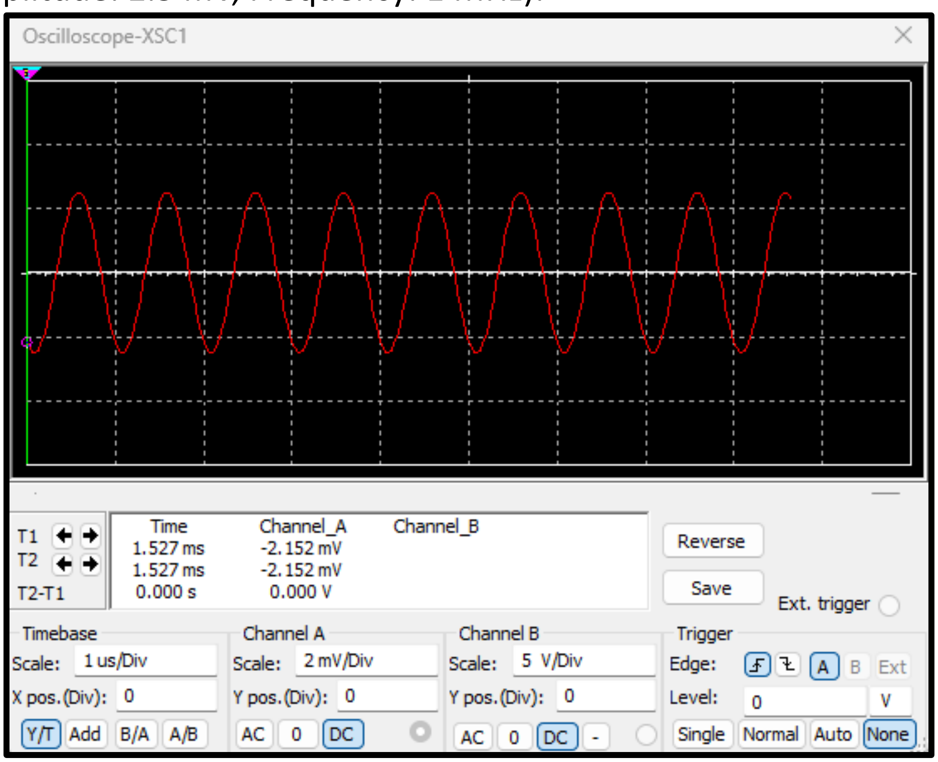
- Main signal (Amplitude: 0.05 mV, Frequency: 10 Hz):



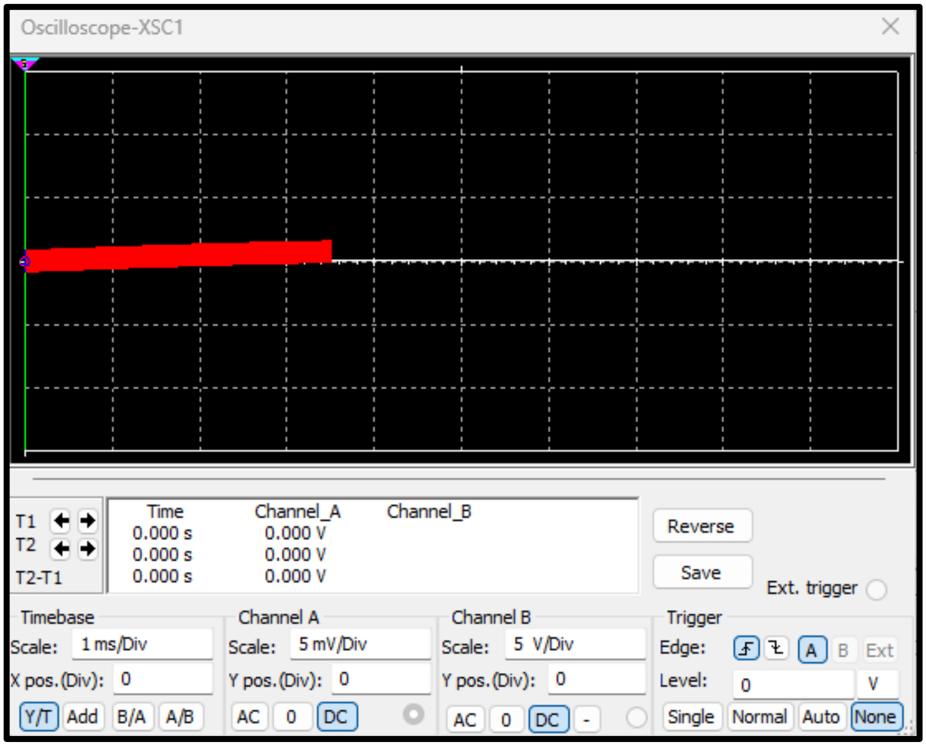
- City noise (Amplitude: 2.5 mV, Frequency: 50 Hz):



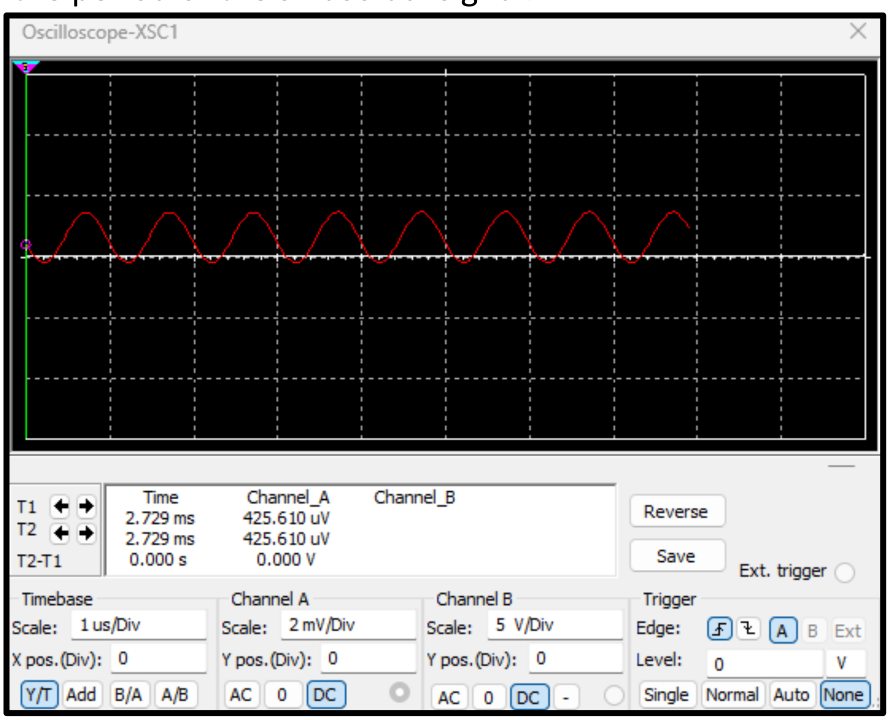
Noise (Amplitude: 2.5 mV, Frequency: 1 MHz):



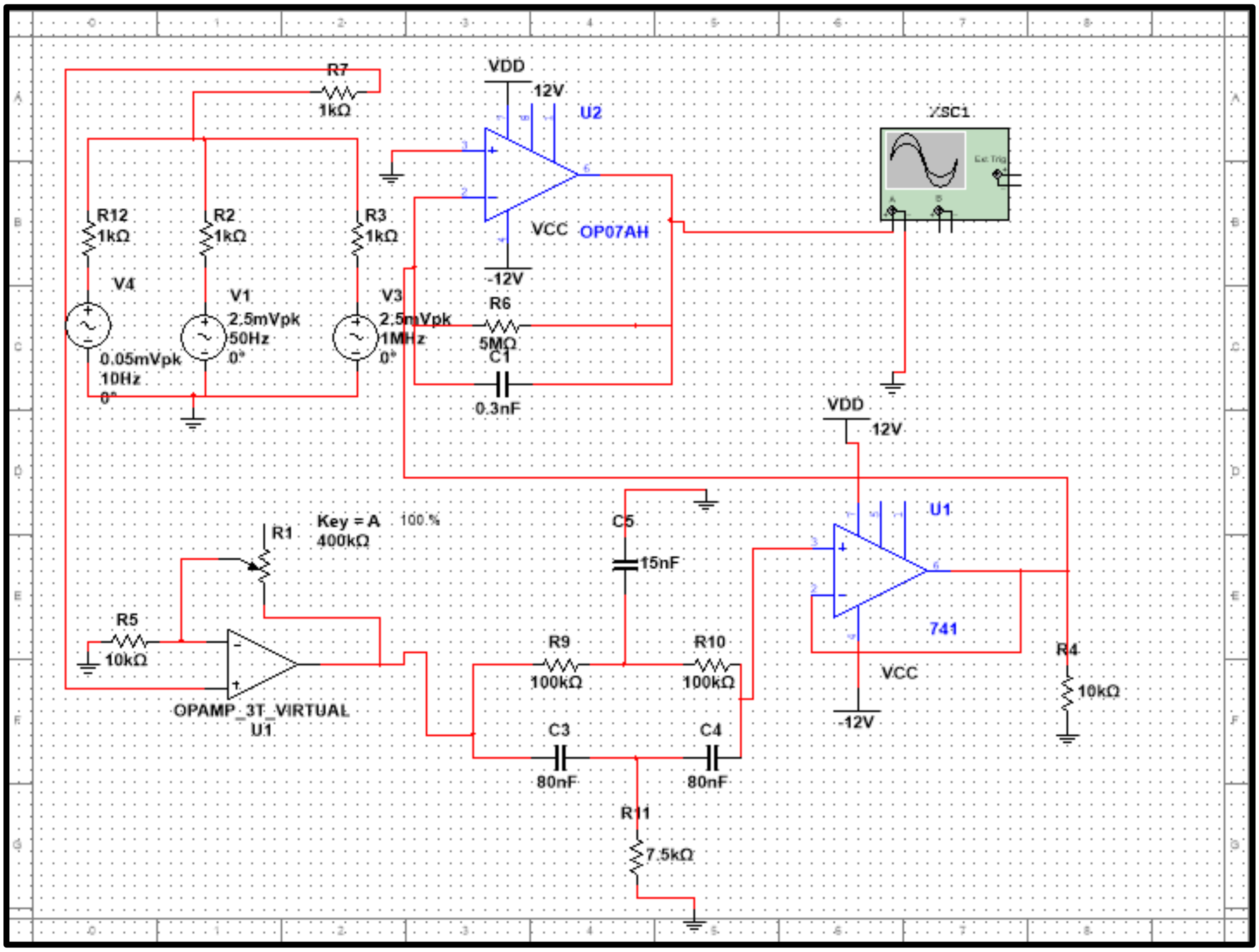
Now, we display the combined signal resulting from these three signals:



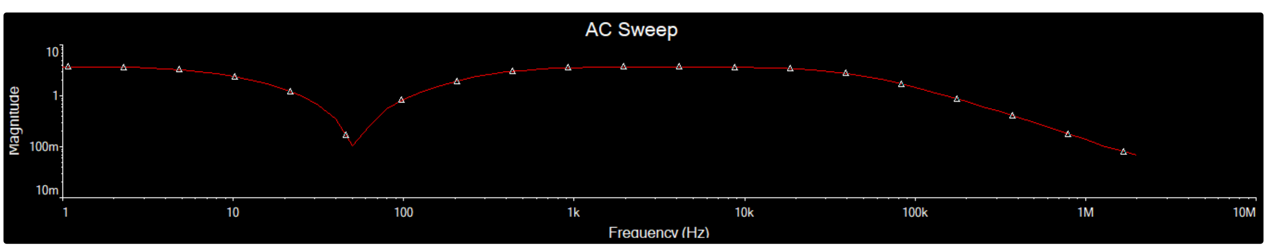
Now, similar to the previous section, if we reduce the time scale in this figure, we can observe the period of the sinusoidal signal.



As we reasoned in the previous section, this signal gradually increases and is a sinusoidal signal.
In fact, the sum of sinusoidal signals results in another sinusoidal signal, but if we zoom in, we can also observe the 1 MHz signal.
Now, let's move on to the designed circuit diagram:



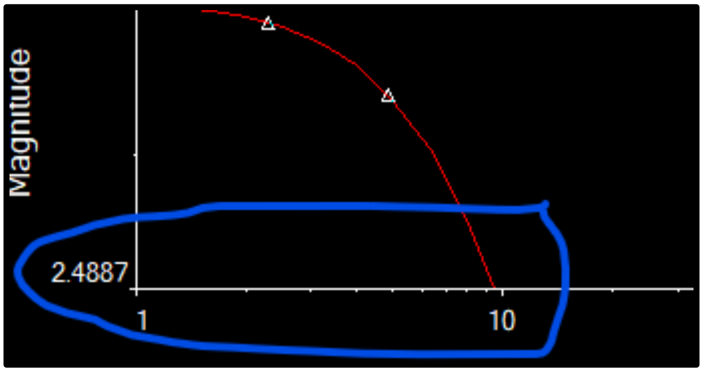
The components of the circuit were explained in the previous section.
Now, let's move on to the final figure and analyze it at different frequencies:



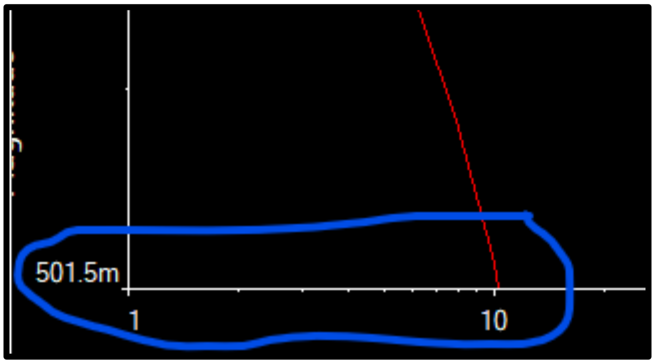
As we can see, at the frequency of 50 Hz, the notch filter has been applied. Additionally, at 1 MHz, the voltage is significantly lower compared to the initial voltage, indicating that the signal has been filtered and attenuated.

Now, by using a potentiometer, we can adjust the gain.

If we zoom in on the frequency of 10 Hz in the figure above, the following shape is displayed:



As expected, we now have a gain of approximately 50,000 at a frequency of 10 Hz. Now, if we decrease the potentiometer setting, we can achieve a lower gain as well:



Here, we observe a gain of approximately 10,000.

In conclusion, in this project, we were able to attenuate unwanted signals such as city noise and 1 MHz noise, allowing us to obtain the desired signal, which is the ECG or EEG.