

Electric Circuits II Project

Report

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Theoretical background:

We chose the Band Pass filter circuit 5 (Sallen Key / Cascaded band pass filter).

Equations used:

1. Gain = $V_{\text{out}}/V_{\text{in}} = V_{\text{out}}$ as $V_{\text{in}} = 1\text{V}$

2.

Lower cutoff Frequency	$f_L = \frac{1}{2\pi\sqrt{2} R_1 C_1}$
Higher Cutoff Frequency	$f_H = \frac{1}{2\pi\sqrt{2} R_2 C_2}$
Center Frequency	$f_0 = \sqrt{\omega_L \omega_H}$

Filter design:

Values:

$R_1 = 1\text{k ohms}$, $R_2 = 100\text{k ohms}$

$C_1 = 10\text{nf}$, $C_2 = 22\text{pf}$

Therefore $f_L = 11253.9\text{ kHz}$, $f_H = 51154\text{ kHz}$, $f_0 = 23993.4\text{ kHz}$

We also obtained from the AC Sweep graph

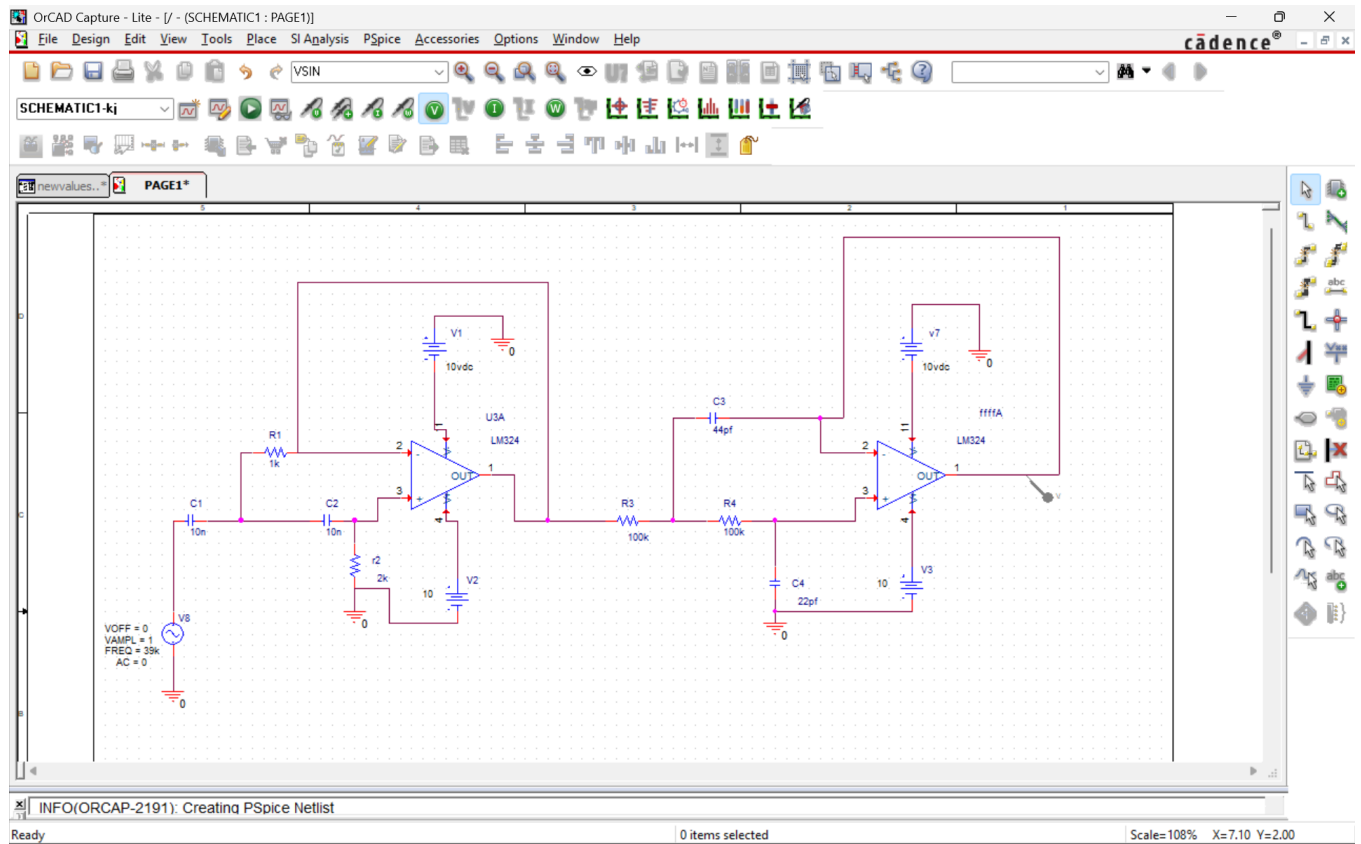
$f_1 = 11.9\text{ kHz}$ ($<f_0$)

$f_0 = 24\text{ kHz}$ (peak)

$f_2 = 39\text{ kHz}$ ($>f_0$)

Circuit simulation:

Circuit Design on Capture:



AC Sweep Simulation Profile:

Simulation Settings - afd

General
Analysis
Configuration Files
Options
Data Collection
Probe Window

Analysis Type:
AC Sweep/Noise

Options:

- ☒ General Settings
- ☐ Monte Carlo/Worst Case
- ☐ Parametric Sweep
- ☐ Temperature (Sweep)
- ☐ Save Bias Point
- ☐ Load Bias Point

AC Sweep Type

☐ Linear
☒ Logarithmic

Decade

Start Frequency: 100
End Frequency: 500k
Points/Decade: 10000

Noise Analysis

☐ Enabled
Output Voltage:
I/V Source:
Interval:

Output File Options

☐ Include detailed bias point information for nonlinear controlled sources and semiconductors (.OP)

OK Cancel Apply Reset Help

Time Transient Simulation Profile:

Simulation Settings - kj

General
Analysis
Configuration Files
Options
Data Collection
Probe Window

Analysis Type:
Time Domain (Transient)

Options:

- ☒ General Settings
- ☐ Monte Carlo/Worst Case
- ☐ Parametric Sweep
- ☐ Temperature (Sweep)
- ☐ Save Bias Point
- ☐ Load Bias Point
- ☐ Save Check Point
- ☐ Restart Simulation

Run To Time : 0.001 seconds (TSTOP)

Start saving data after : 0 seconds

Transient options:

Maximum Step Size 1us seconds

☐ Skip initial transient bias point calculation (SKIPBP)

☐ Run in resume mode

Output File Options...

OK Cancel Apply Reset Help

Simulation results:

Screenshots for the obtained simulation results and comments on the simulation results.

You need to run two simulation profiles:

i. AC sweep simulation:

Sketch of the gain versus the frequency, where V_{ac} is used as the input signal (One sketch is required).

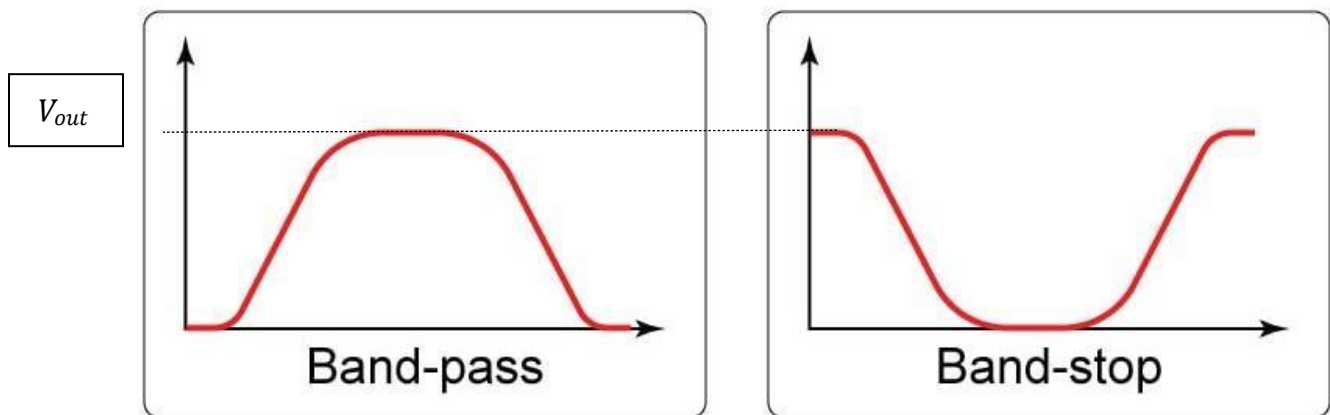
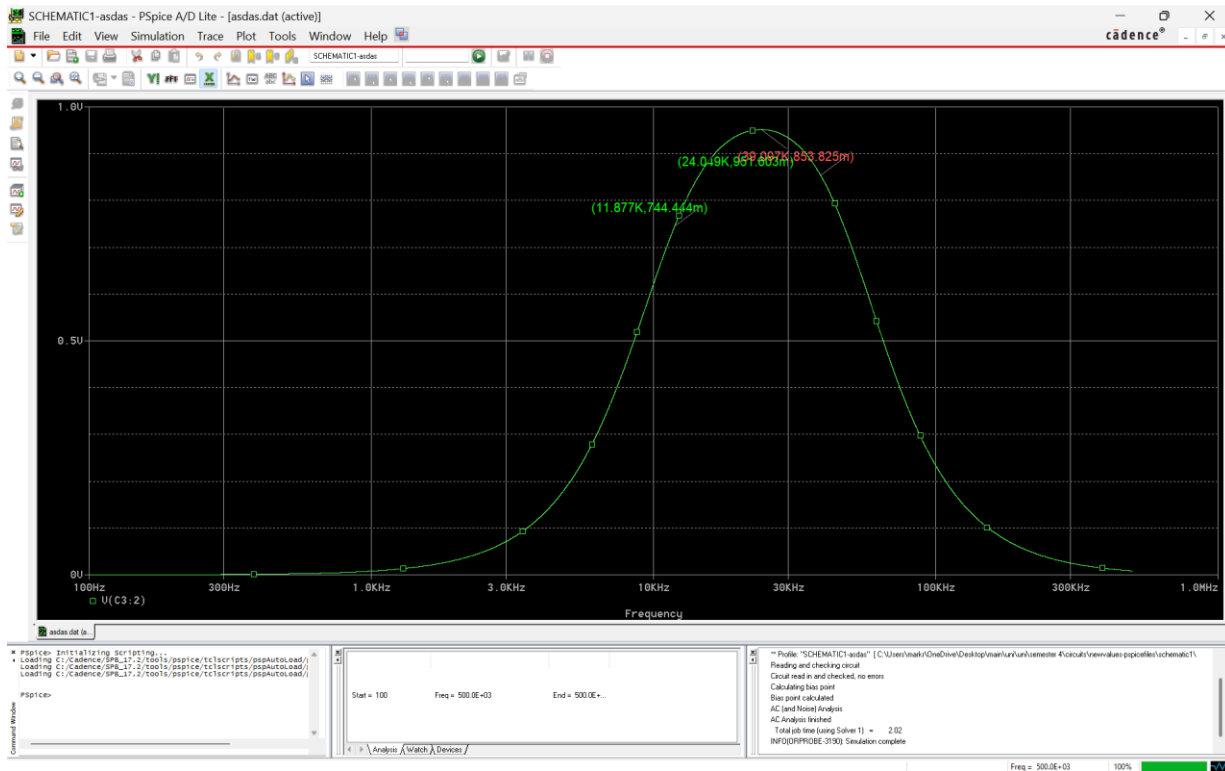


Figure 1 Expected outcome for the AC Sweep

AC Sweep Results:



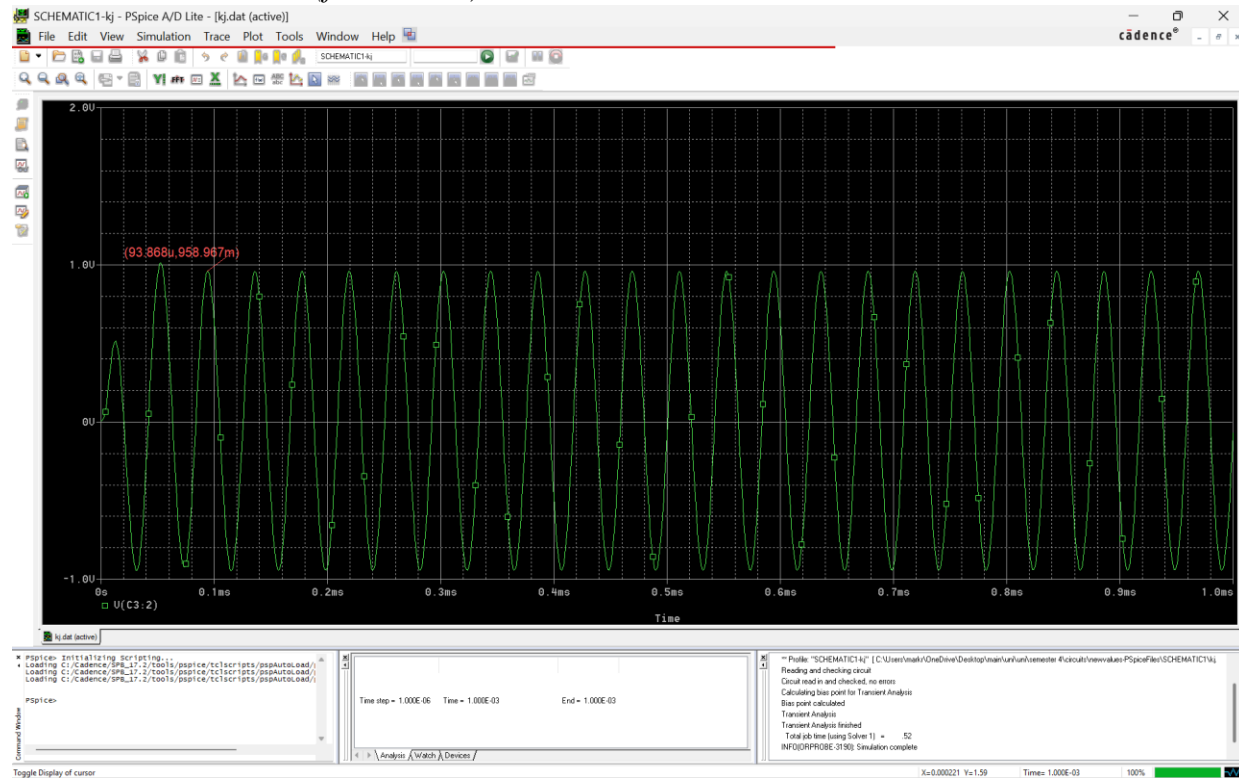
ii. Time domain simulation:

Sketch of voltage amplitude versus time, where V_{sin} is used as the input signal at three different frequencies ($f < f_0$, $f = f_0$ and $f > f_0$).

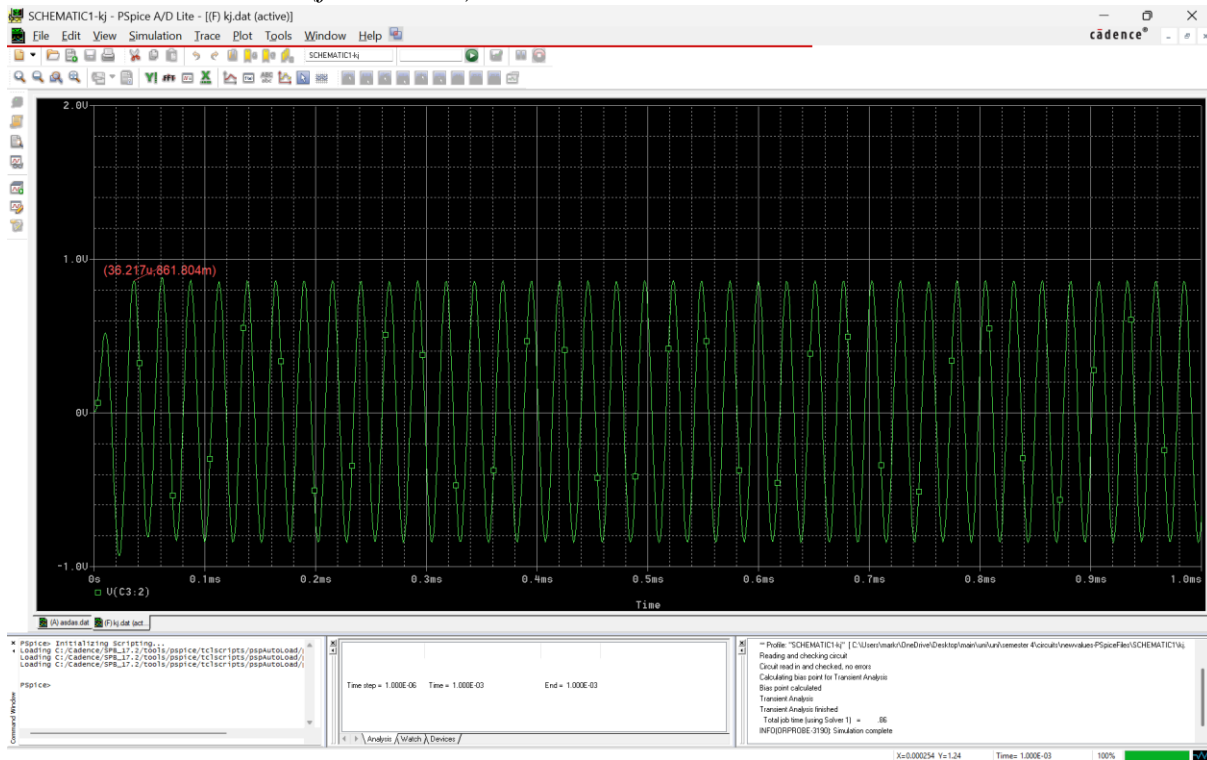
Time Transient Results ($f_1 = 11.9 \text{ kHz}$):



Time Transient Results ($f_0 = 24 \text{ kHz}$):



Time Transient Results ($f_2 = 39 \text{ kHz}$):

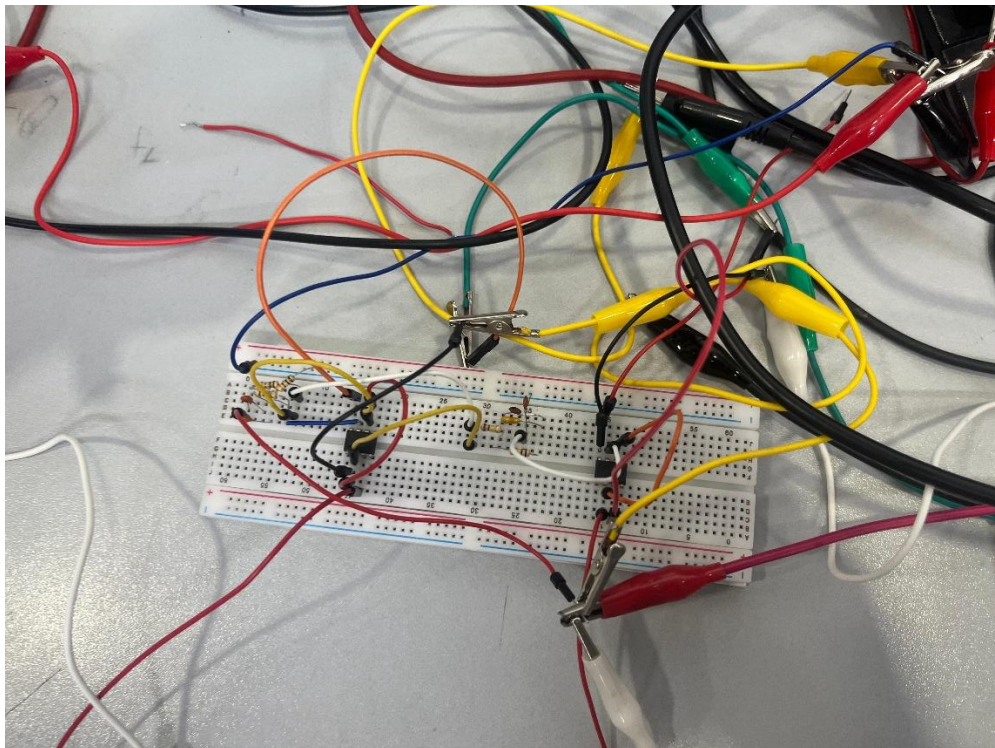
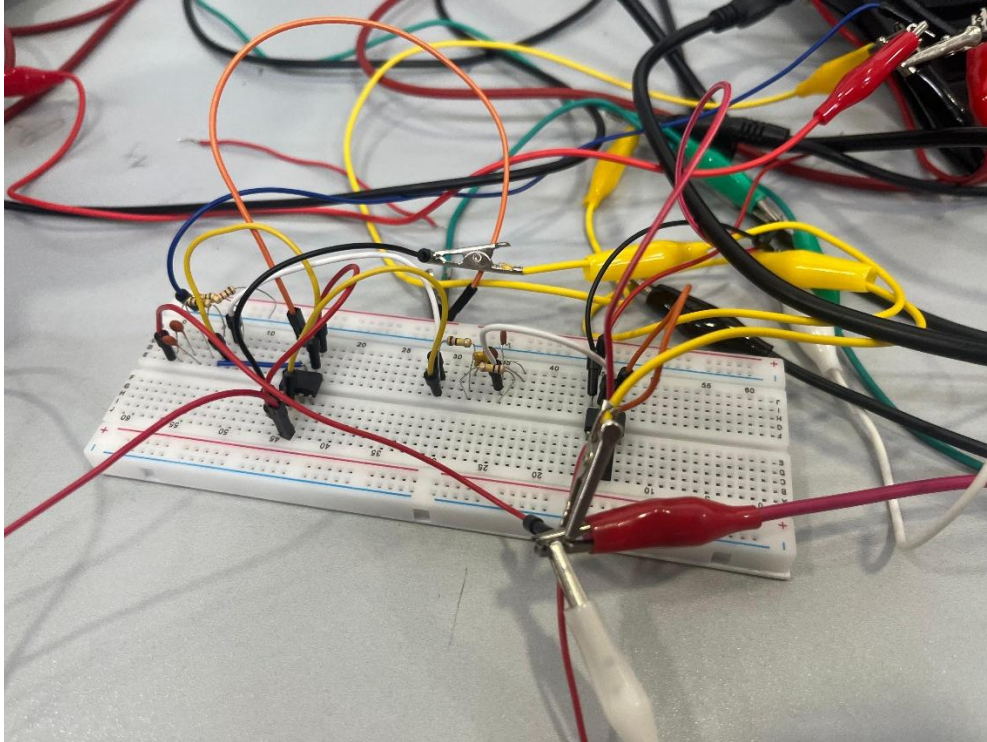


Hardware implementation:

Purchased components:

- 3 1k ohms resistors
- 2 100k ohms resistors
- 2 10 nf capacitors
- 3 22 pf capacitors
- 2 Lm741 op amps
- 1 breadboard
- Wires & crocodiles

Hardware Connections:

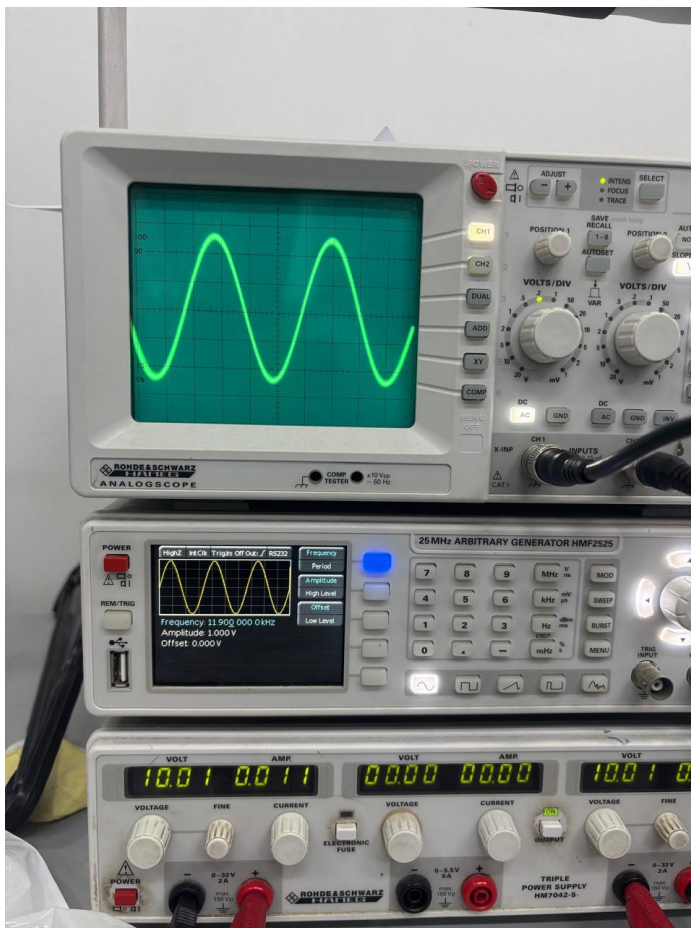


Hardware results:

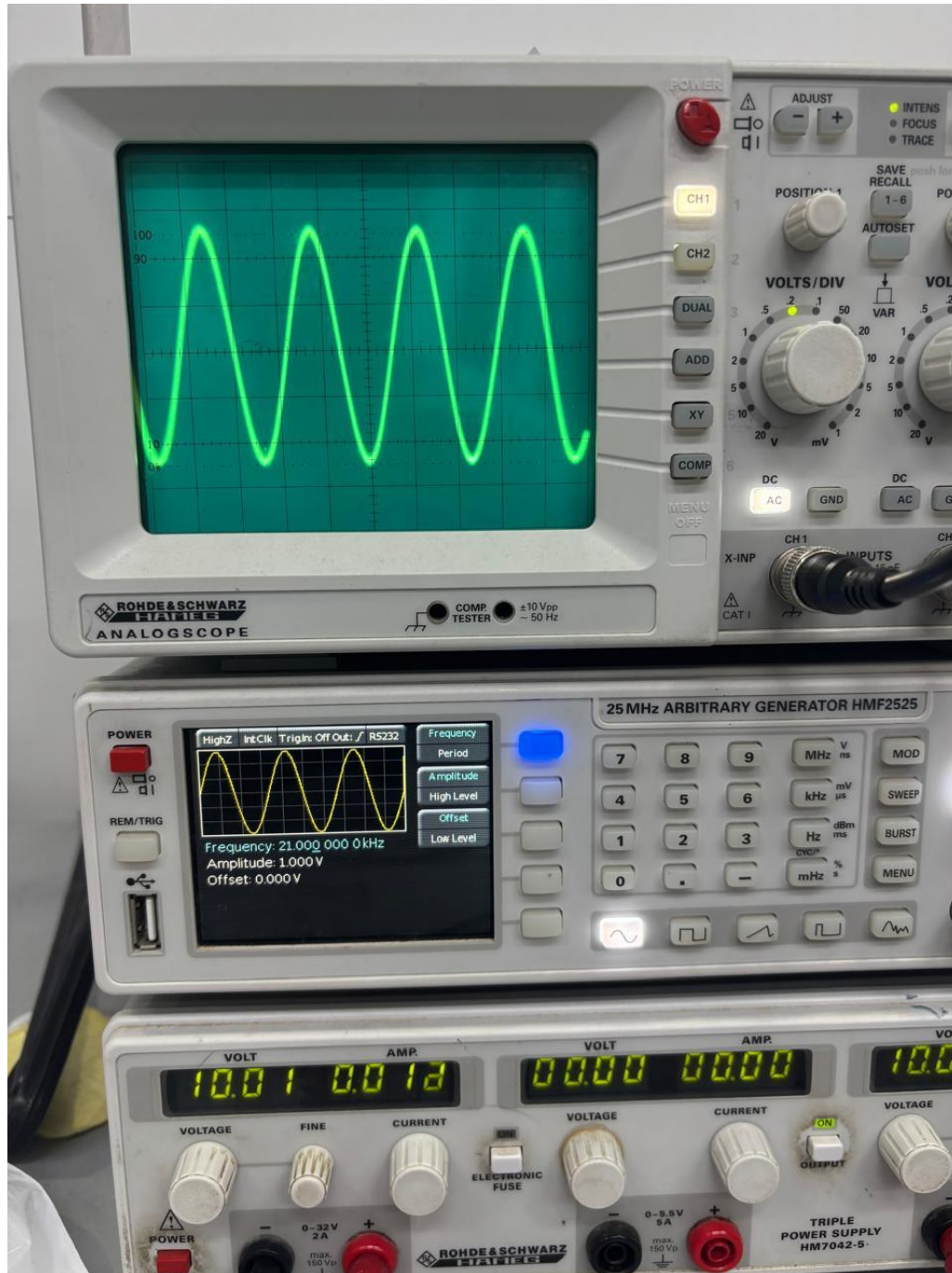
Includes pictures from the oscilloscope for the input voltage and the output voltage at three different frequencies (to show that the type of filter).

Includes also discussion of the results obtained from the hardware implementation.

i. $f < f_o$: (11.9 kHz)



ii. $f \approx f_0$: (24 kHz)



iii. $f > f_0$: (39 kHz)

