CND 101 - LAB [4]

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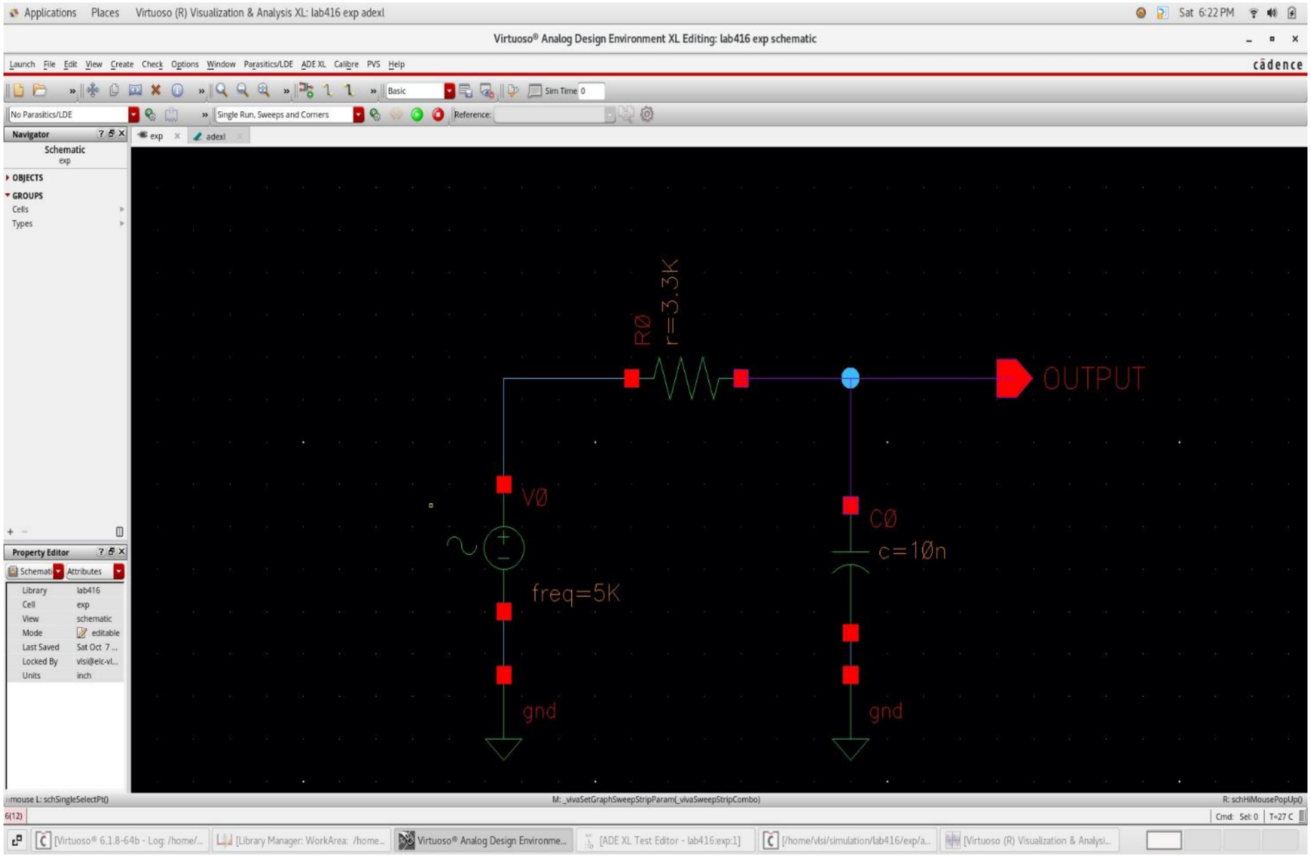
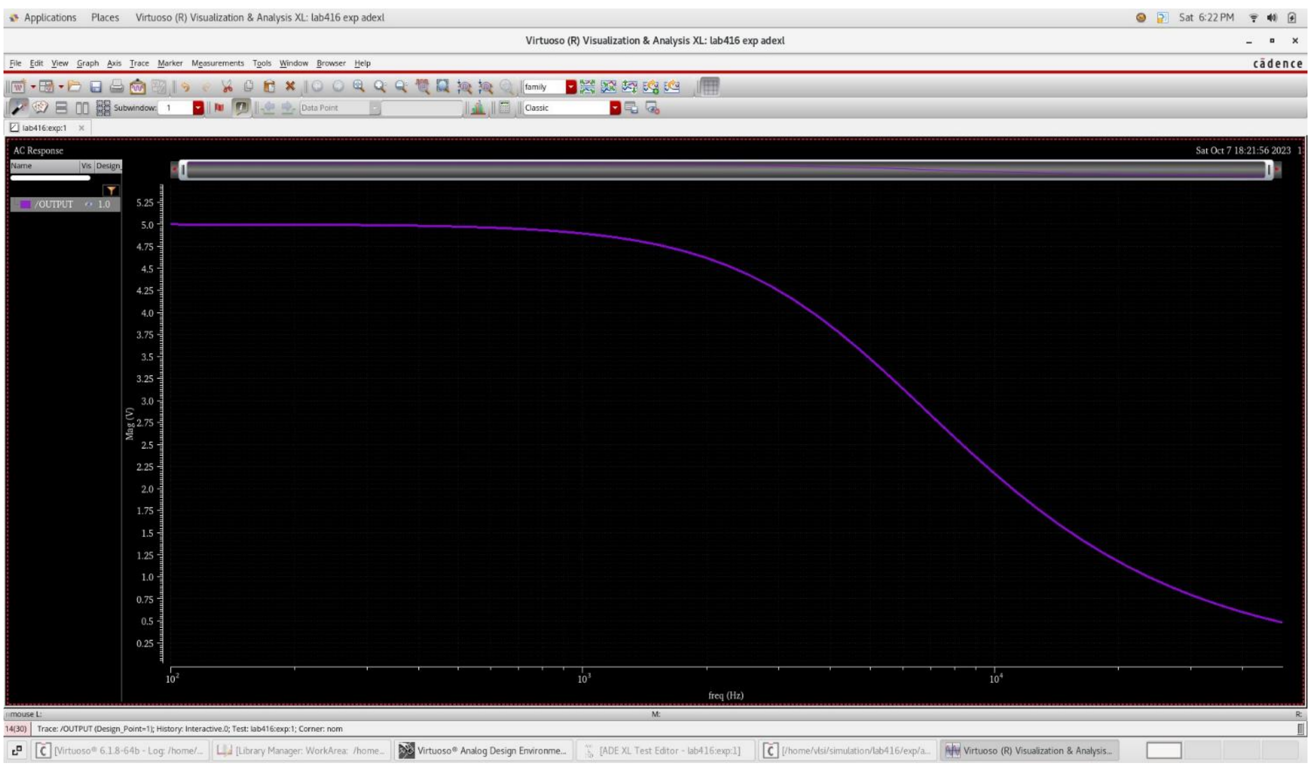
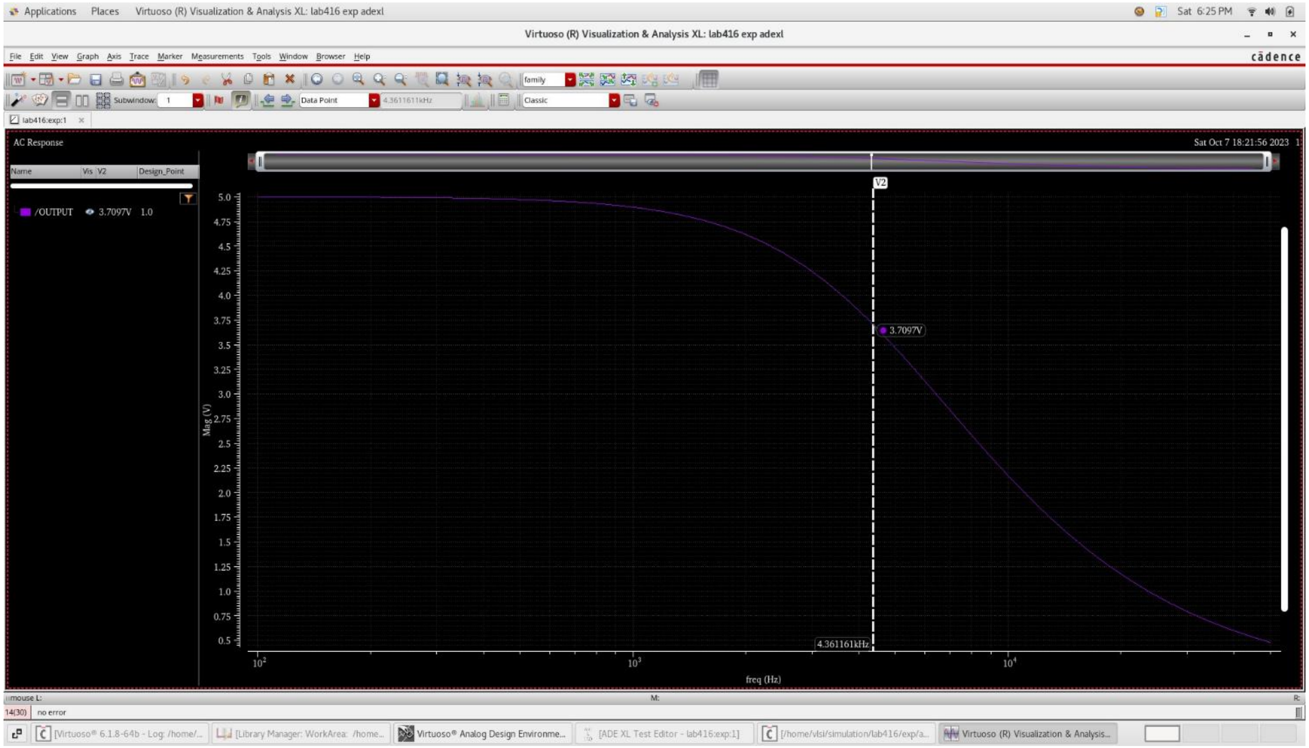
A. Low pass filter

1. RC circuit



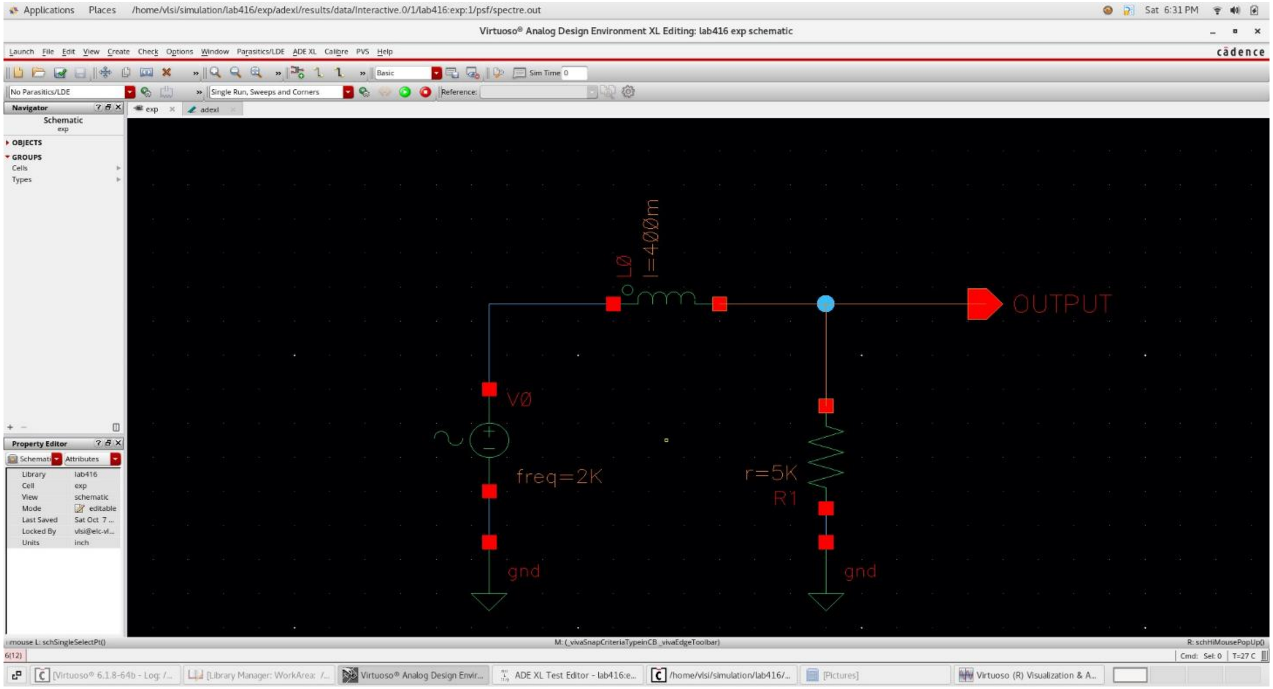




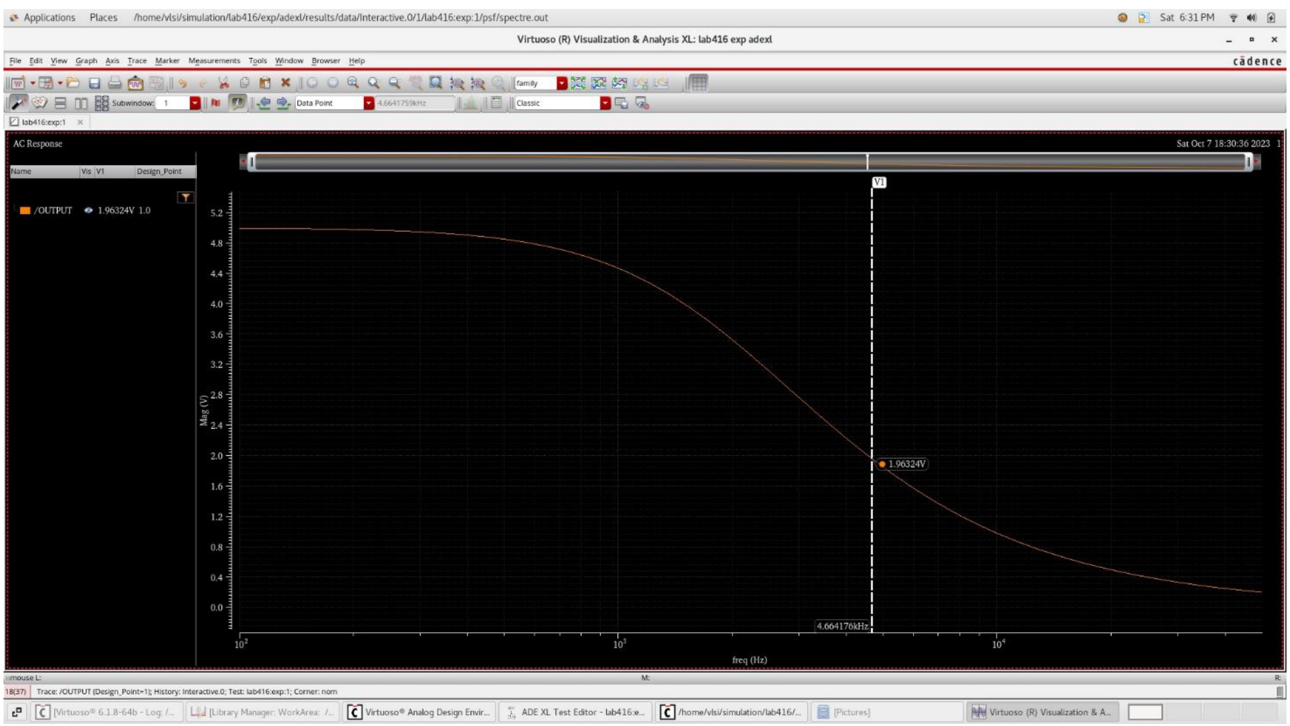
Input voltage=5V,5kHz			
F in Hz	O/p Voltage	Gain A = Vo/Vin	Af = 20 log Vo/Vi
4.36K	3.709v	0.7418	-2.59dB
5.39K	3.334v	0.6668	-3.52dB
6.50K	2.98v	0.596	-4.495dB
7.84K	2.62v	0.524	-5.61dB
10.32K	2.12v	0.424	-7.45dB
11.99K	1.87v	0.374	-8.54dB

Cutoff frequency = 4.82kHz

2. RL circuit



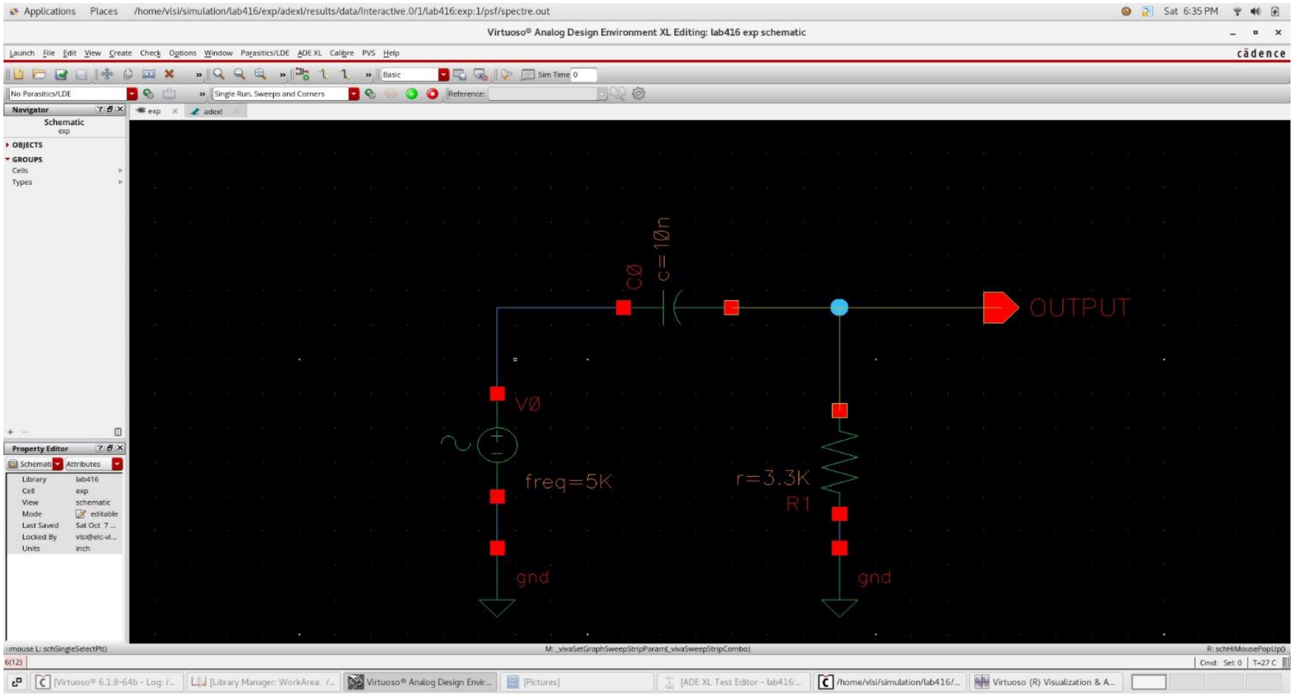
Virtuoso® Analog Design Environment XL Editing: lab416 exp schematic
L0
l=400m
OUTPUT
V0
freq=2K
r=5K
R1
gnd
gnd

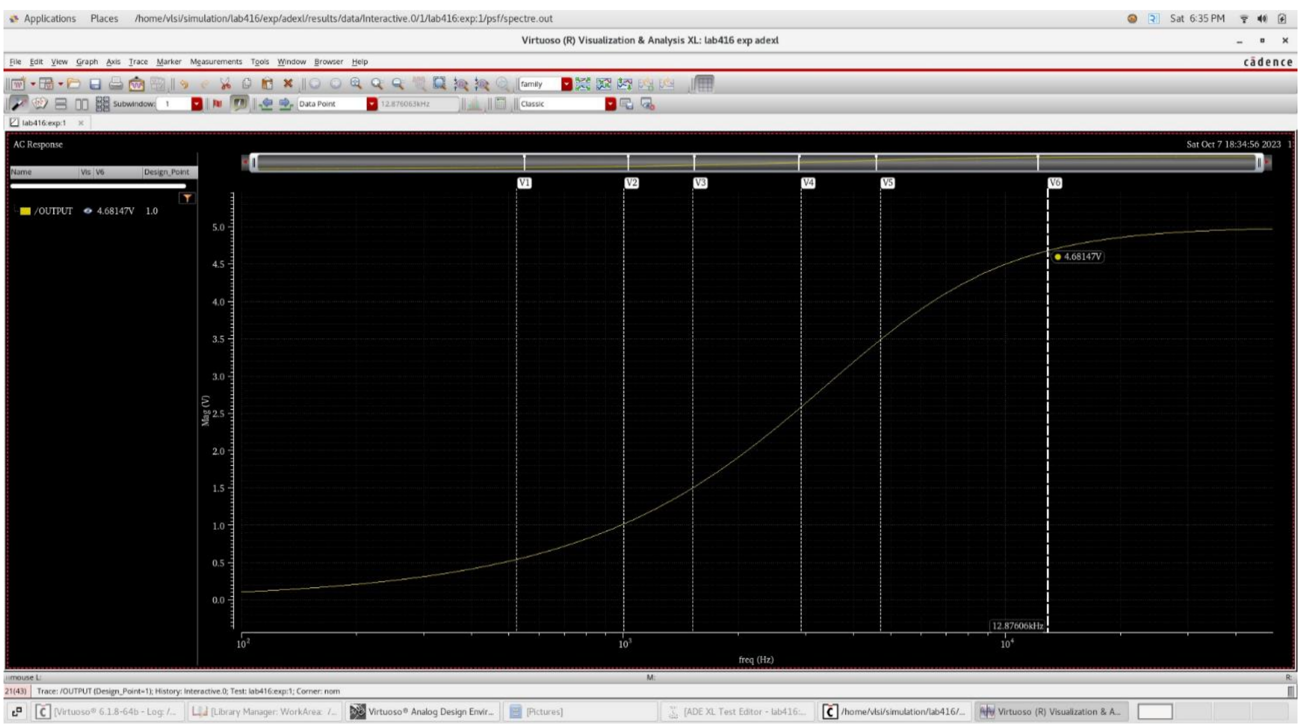


Virtuoso (R) Visualization & Analysis XL: lab416 exp adexl
AC Response
/OUTPUT 1.96324V 1.0
1.96324V
4.664176kHz
freq (Hz)
Mag (V)

B. High pass filter

1. RC circuit

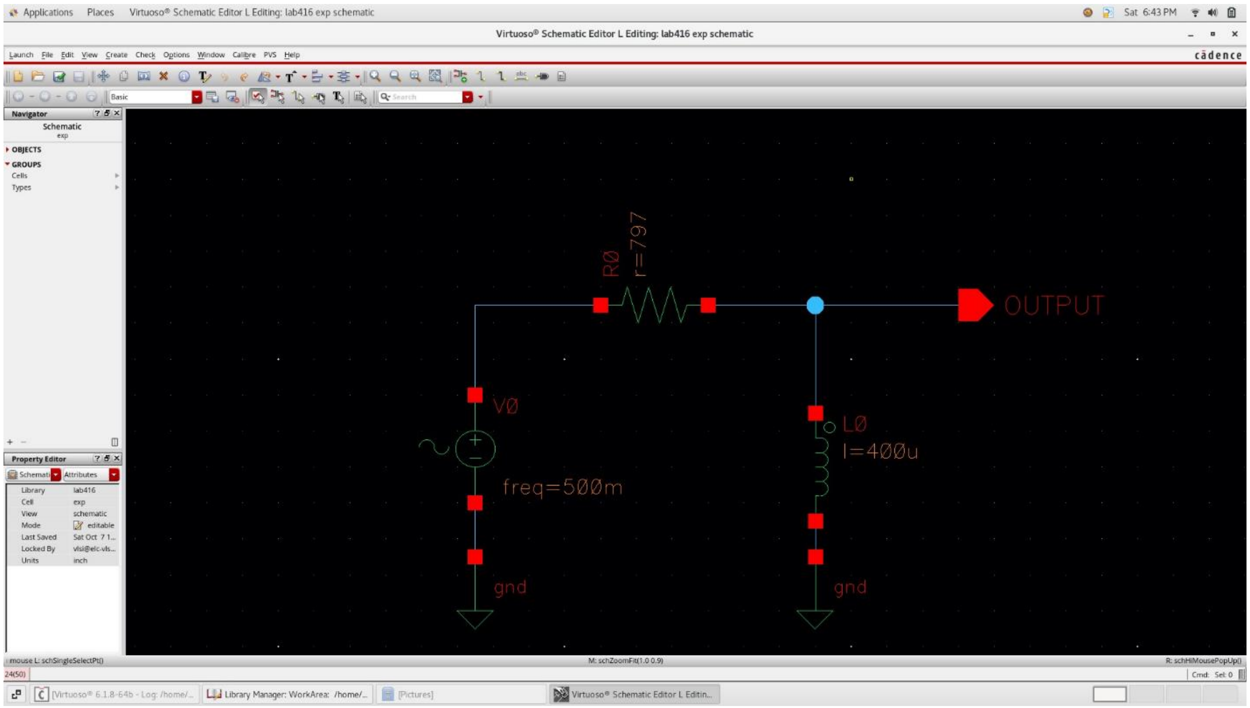


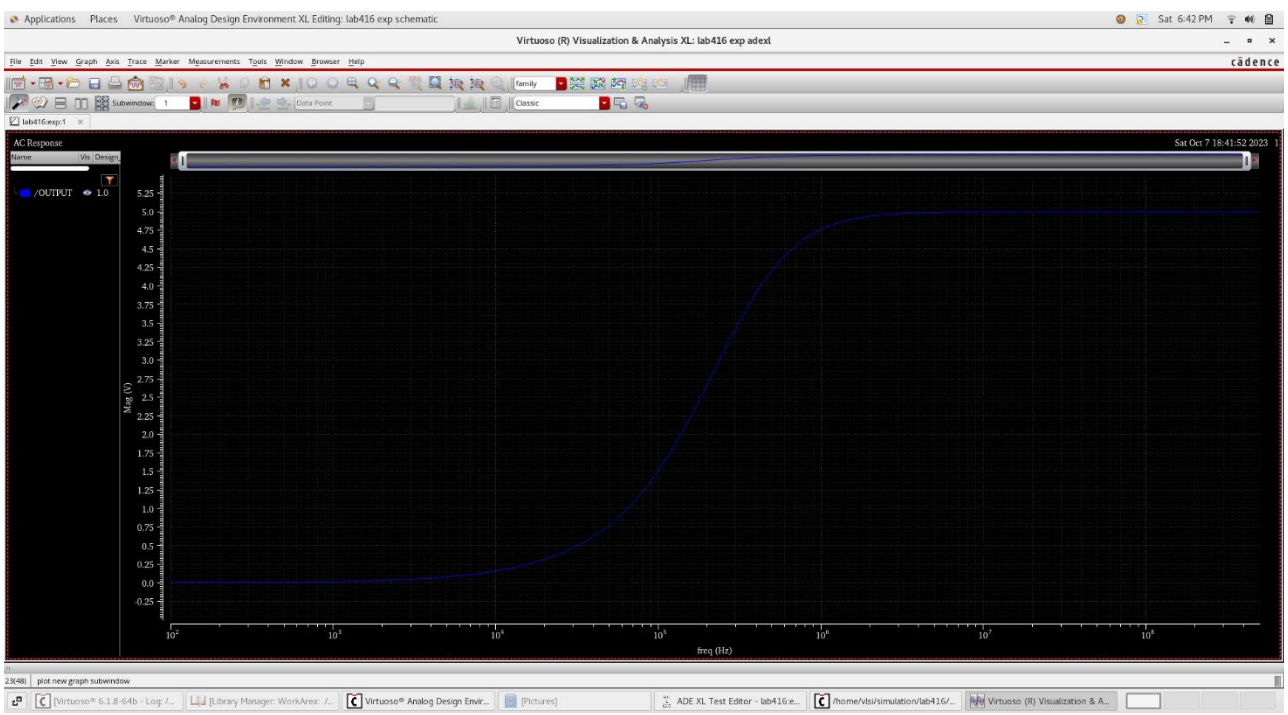


Input voltage=5V,5kHz			
F in Hz	O/p Voltage	Gain A = Vo/Vin	Af = 20 log Vo/Vi
12.876K	4.68v	0.936	-0.574
4.70K	3.49v	0.698	-3.12
2.91K	2.58v	0.516	-5.747
1.514K	1.497v	0.2994	-10.47
1.0045K	1.019v	0.2038	-13.816
526.16	542.69mv	0.1085	-19.288

Cutoff frequency = 4.82kHz

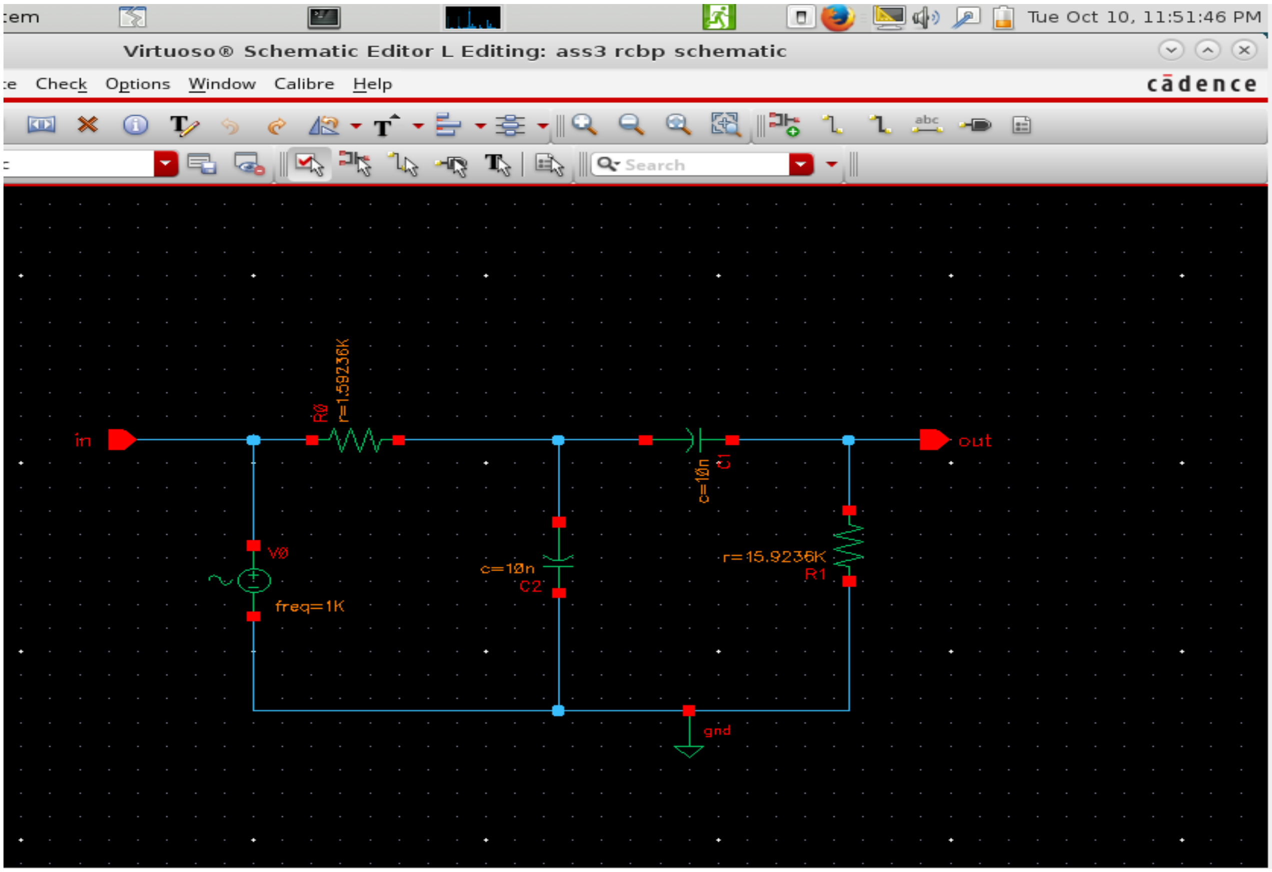
2. RL circuit

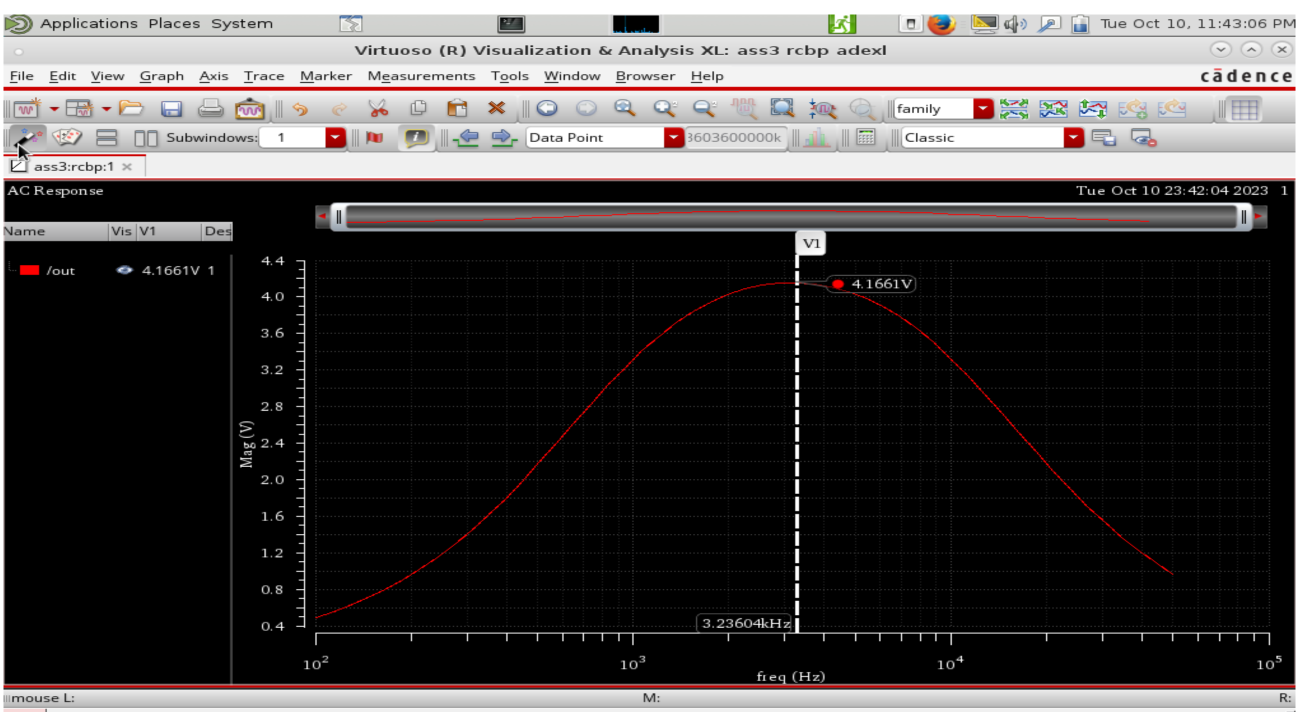

Virtuoso® Schematic Editor L Editing: lab416 exp schematic
R0
r=797
OUTPUT
V0
freq=500m
L0
l=400u
gnd
gnd


Virtuoso (R) Visualization & Analysis XL: lab416 exp adexl
AC Response
Sat Oct 7 18:41:52 2023
/OUTPUT
Mag (V)
freq (Hz)

C. Band pass filter

1. RC circuit

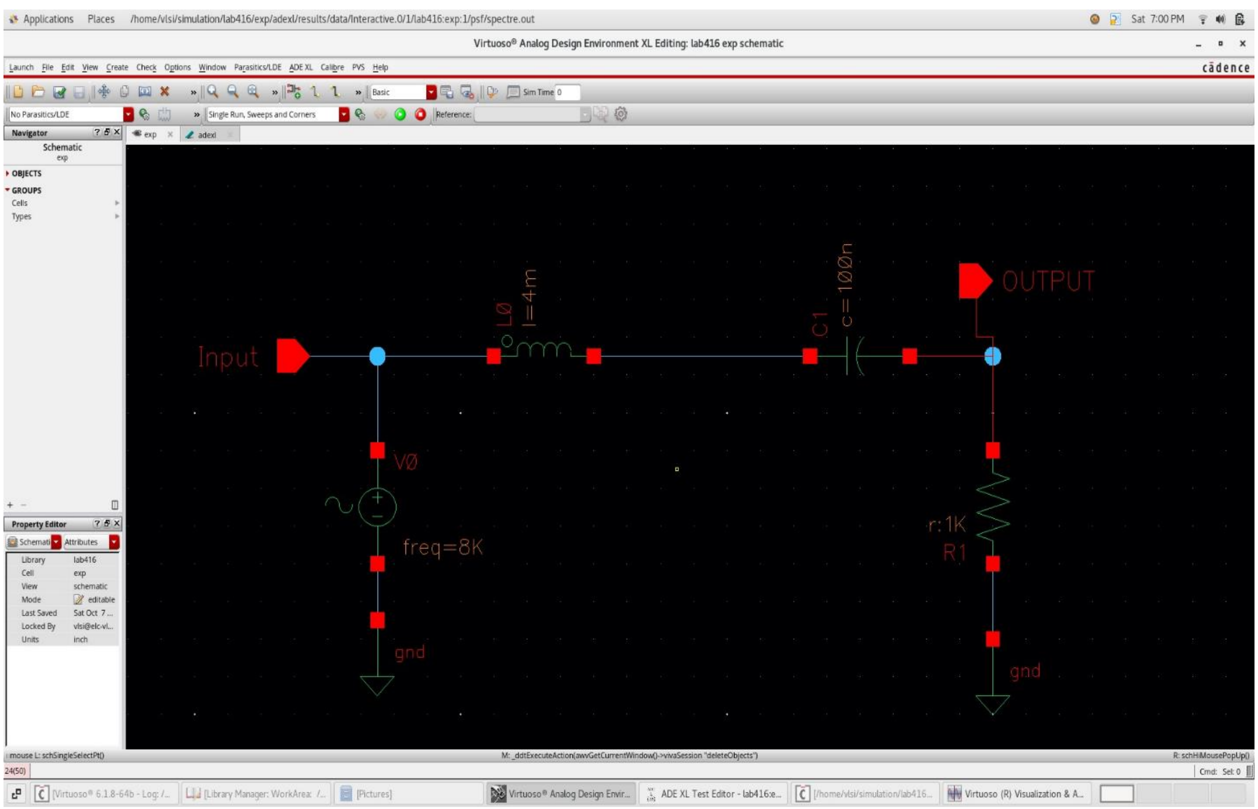


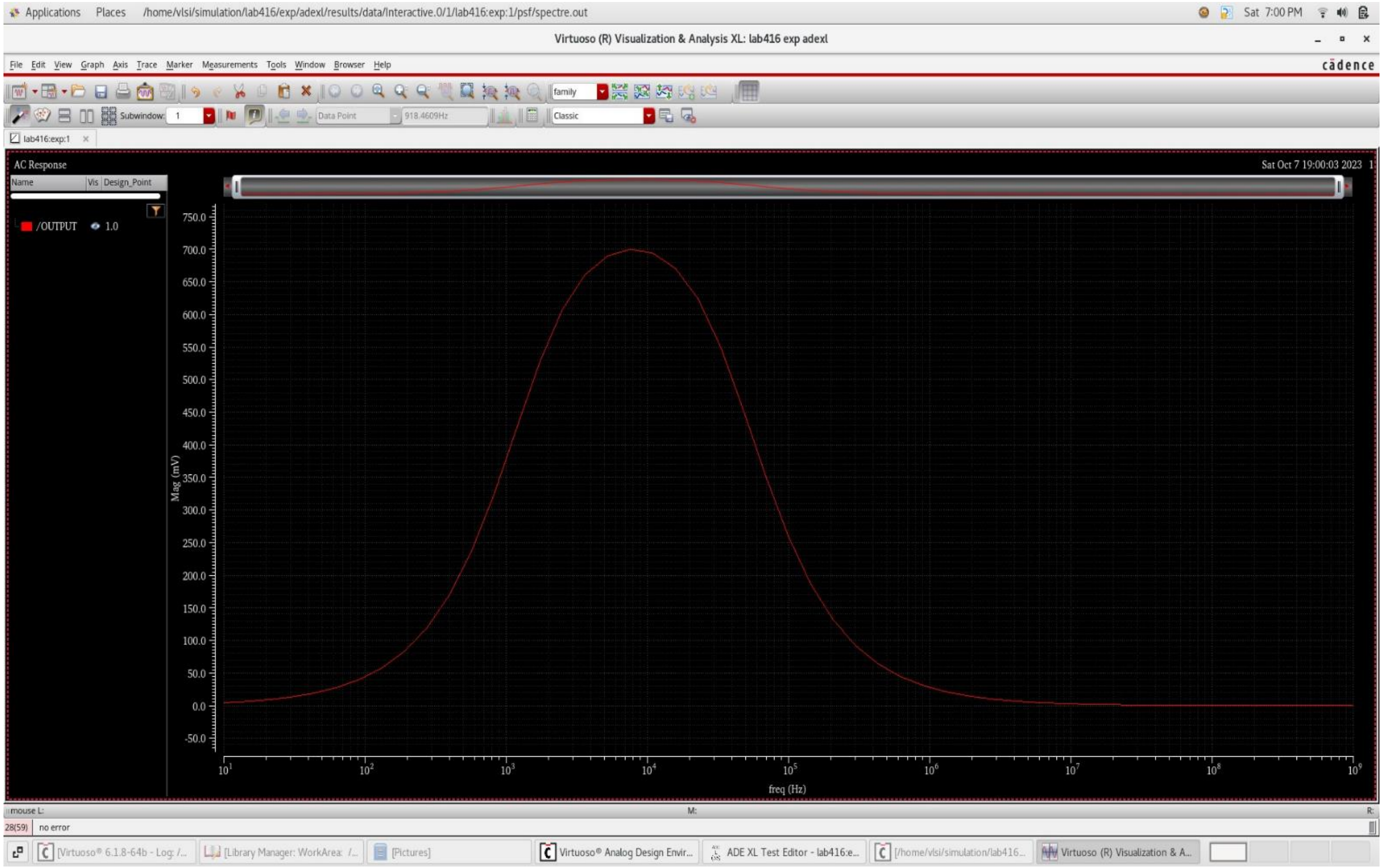


Input voltage=5V,5kHz			
F in Hz	O/p Voltage	Gain A = Vo/Vin	Af = 20 log Vo/Vi
9.41K	3.4196v	0.684	-3.2999
6.37K	3.876v	0.7752	-2.212
3.3K	4.1646v	0.8329	-1.588
877.9K	3.13v	0.626	-4.069
588.38	2.458v	0.4916	-6.168
409.65	1.86v	0.372	-8.59

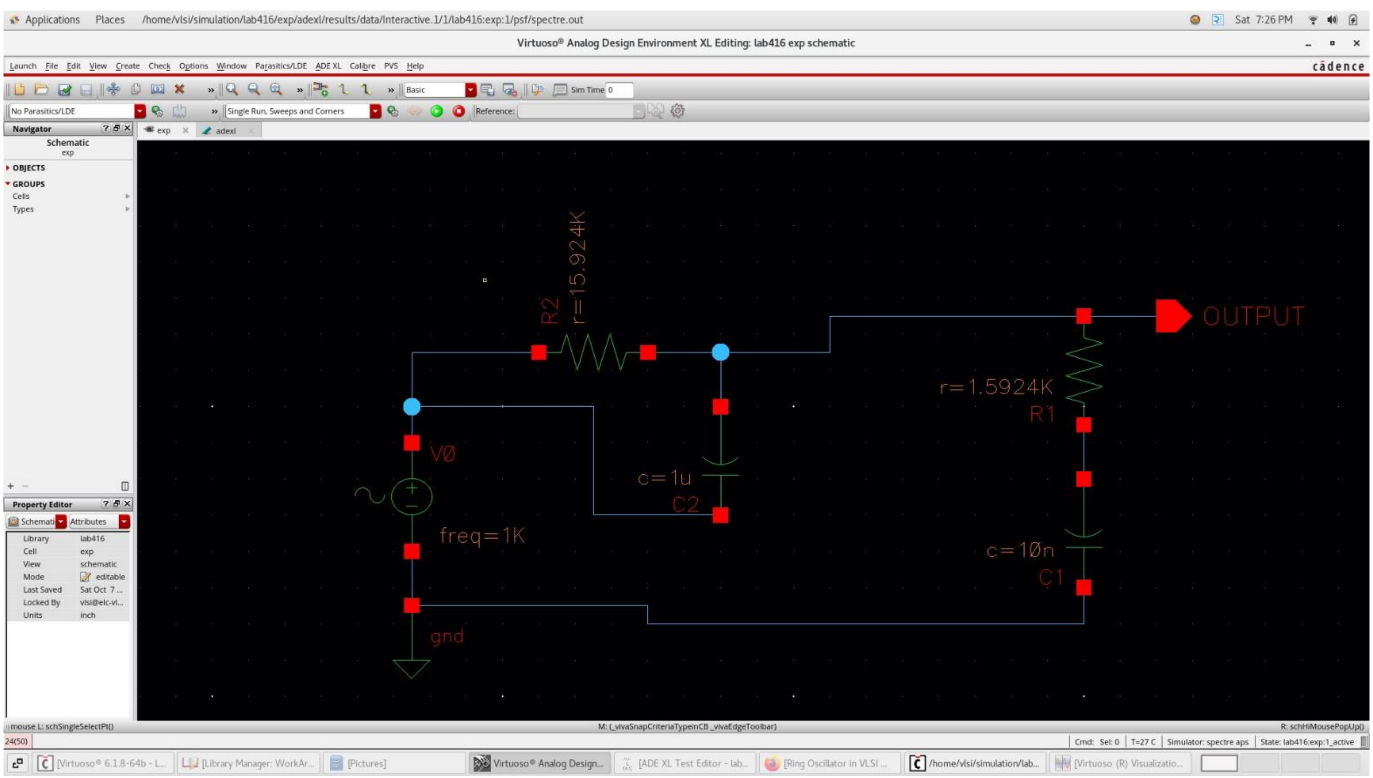
Cutoff frequencies FC=3.236kHz, F_L=781.97Hz, F_H= 12.79kHz.

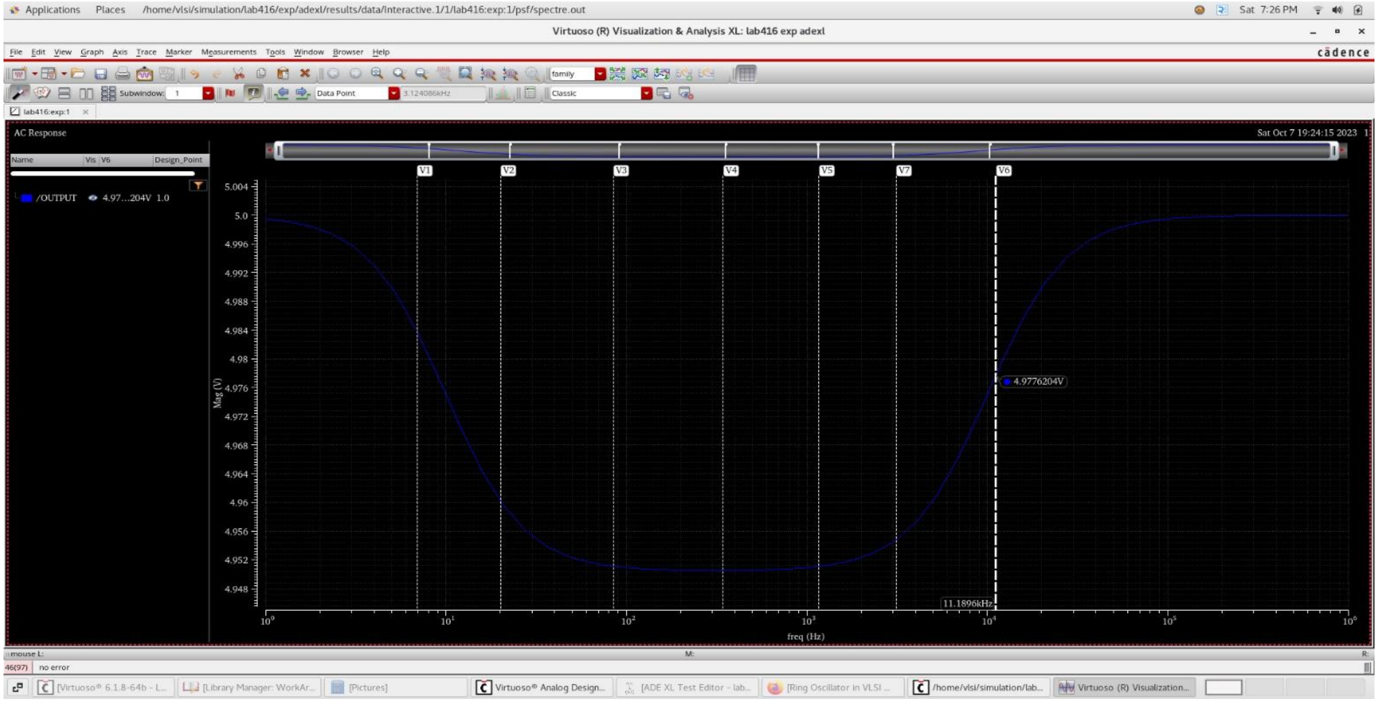
2. RLC circuit





D. Band stop filter

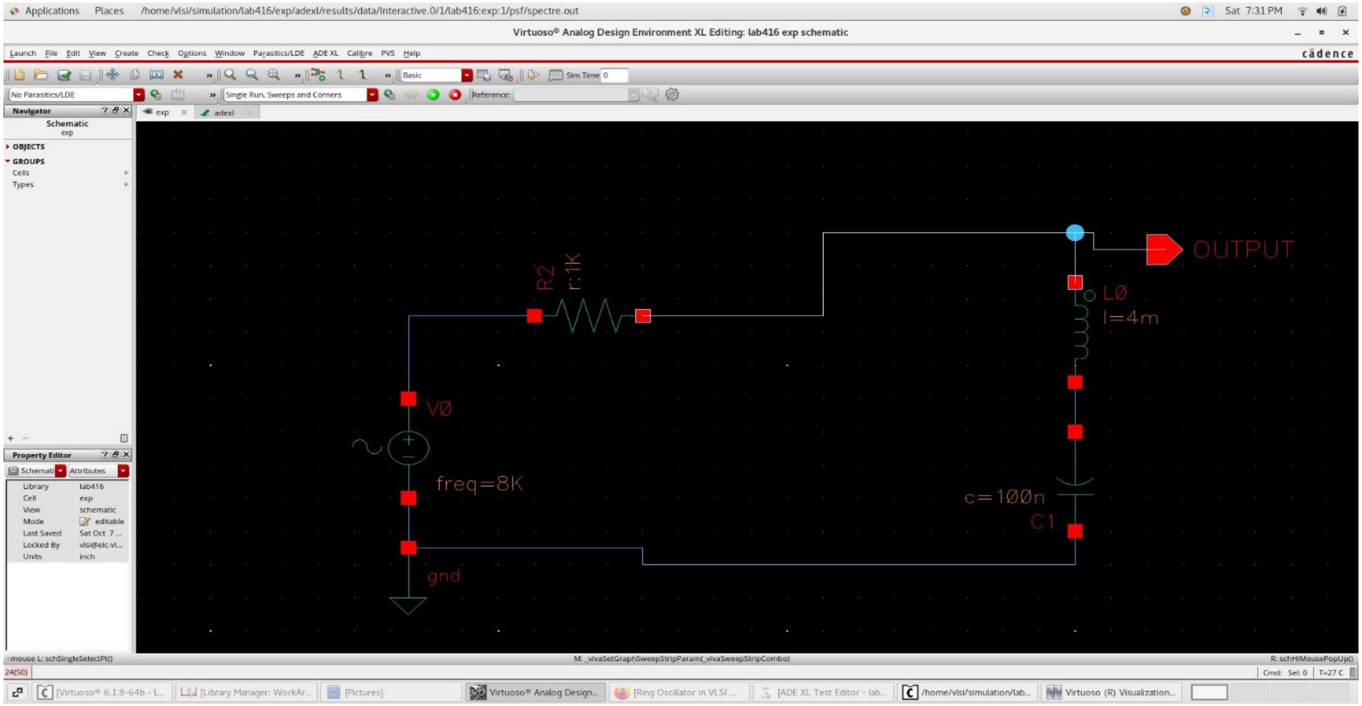


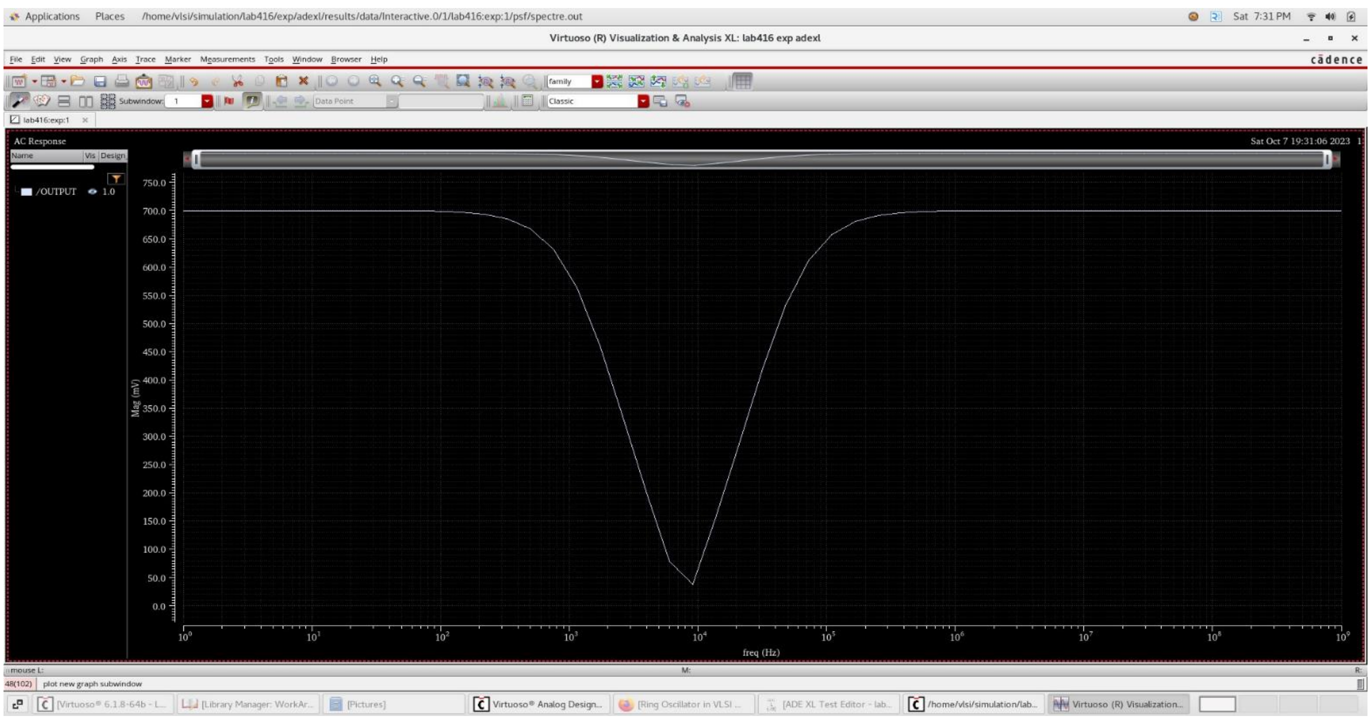


Input voltage=5V,5kHz			
F in Hz	O/p Voltage	Gain A = Vo/Vin	Af = 20 log Vo/Vi
11.896K	4.977v	0.9954	-0.04
3.12K	4.955v	0.991	-0.0786
1.168K	4.951v	0.9902	-0.0855
344.3	4.95v	0.99	-0.087
84.614	4.951v	0.9902	-0.0855
20.049	4.96v	0.992	-0.0698

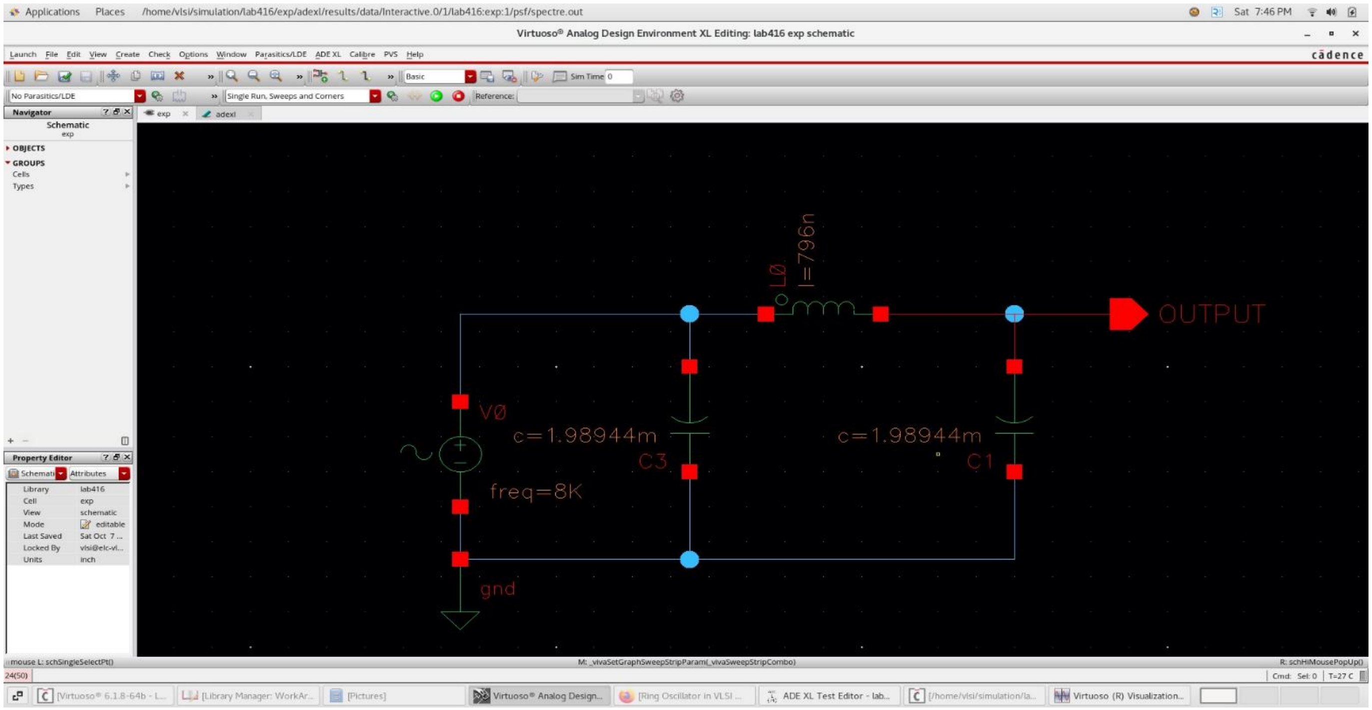
Cutoff frequencies F_C =3.24KHz, F_H =17.02KHz, F_L=587.52Hz

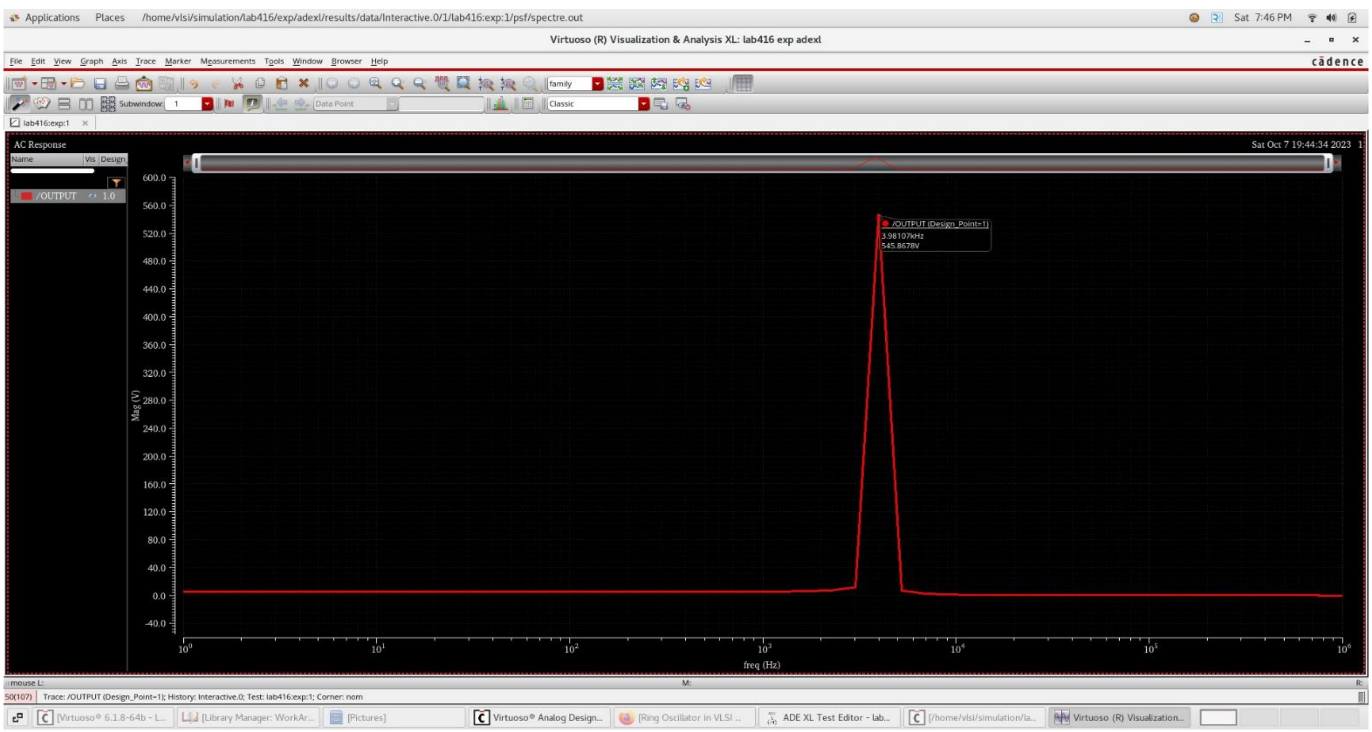
2. RLC band stop filter





Assignment 4 circuit





Comments

1- What is Pi Filter and How it works?

A Pi filter is an electronic filter used in electronic circuits to filter or condition signals.

It gets its name because its schematic diagram resembles the "π".

Pi filters are commonly used for various applications, including power supply filtering and signal filtering in radio frequency (RF) and audio circuits.

A Pi filter consists of three components: two capacitors and one inductor arranged in the shape of a Pi symbol (π).

The Pi filter is typically used as a low-pass filter, which means it allows lower-frequency signals to pass through while attenuating higher-frequency signals.

<u>Here's how it works:</u>

Input Capacitor (C1):is connected to the signal source or the power supply voltage. It serves two primary purposes:

1- Blocks DC or low-frequency signals from entering the filter, allowing only AC or high-frequency signals to pass.
2- Forms a voltage divider with the impedance of the inductor, allowing it to filter out high-frequency components.

Inductor (L): The inductor is placed between the input and output capacitors. Its primary role is to provide high impedance to high-frequency signals while allowing low-frequency signals to pass with relatively low impedance. It effectively short-circuits high-frequency noise or interference.

Output Capacitor (C2): is connected to the load or the circuit that requires the filtered signal. It serves to:

1- Block any residual high-frequency components that may have passed through the inductor.
2- Smoothen the output voltage or signal by charging and discharging to maintain a steady DC voltage or a clean signal.

The Pi filter's effectiveness in filtering out specific frequencies depends on the values of the components (capacitance and inductance) and the signal frequency.

The cutoff frequency at which the filter starts attenuating signals depends on the values of the components and can be calculated using the following formula:

$$f_c = \frac{1}{2\pi\sqrt{LC}}$$

Pi filters are commonly used in power supply circuits to filter out noise and ripple from the DC voltage source, resulting in a clean and stable DC output.

They are also used in RF circuits and audio circuits to block unwanted higher-frequency signals and interference, ensuring that only the desired signals pass through.

2- My comments about output curve:

Here are some key comments about the output curve of a Pi filter:

1- Low-Pass Filter Response: A Pi filter primarily acts as a low-pass filter. This means it allows low-frequency signals to pass through to the output while attenuating higher-frequency signals. The output curve typically exhibits a smooth decline in gain as the frequency increases.
2- Cutoff Frequency: is a crucial point on the output curve. It is the frequency at which the filter starts to attenuate the signal. The cutoff frequency is determined by the values of the inductance (L) and capacitance (C) in the filter.
3- Passband Characteristics: In the passband, the output curve shows minimal attenuation. This is where the filter allows signals to pass through with little loss.
4- Stopband Characteristics: In the stopband, the output curve exhibits increasing attenuation. The filter becomes more effective at blocking higher-frequency noise or interference.
5- Resonance: At resonance, the impedance of the inductor and capacitor cancel each other out, leading to a peak in the output voltage.
6- Trade-Offs: Designing a Pi filter involves trade-offs between the cutoff frequency, filter order, and the desired amount of attenuation in the stopband.
7- Application-Specific: The design of a Pi filter should be tailored to the specific application and the frequency range of interest. For power supply filtering, the focus is on removing ripple and noise, while in RF applications, it's about isolating signals from interference.