Lab 4
Frequency Selective Circuits

Introduction:

Passive RC filters "filter out" undesired signals by separating and allowing AC signals based on frequency to pass. Passive filters are built out of passive components like resistors, capacitors, and inductors, and because they lack amplifying devices (transistors, op-amps, etc.), their output level is always smaller than the input.

Filters are named after the frequency range of signals that can travel through them while blocking or "attenuating" the remainder. The following are the most typical filter designs:

- The Low Pass Filter - The low pass filter allows only low-frequency transmissions from 0Hz to its cut-off frequency, c point, to pass while blocking any higher frequency signals.
- The High Pass Filter - The high pass filter only enables high-frequency signals above its cut-off frequency, c point, to pass through while blocking those below.
- The Band Pass Filter allows signals falling within a specific frequency band defined between two sites to pass through while blocking both lower and higher frequencies on either side of this frequency band.

A- Low pass filter:

1. RC circuit

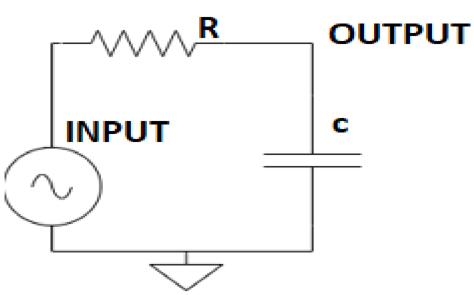


Figure 1 Low Pass Filter Circuit

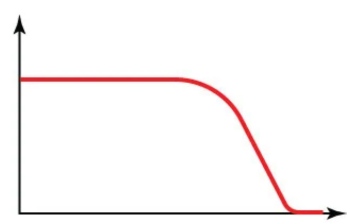


Figure 2 Characteristic Curve of Low pass filter

I. Design:

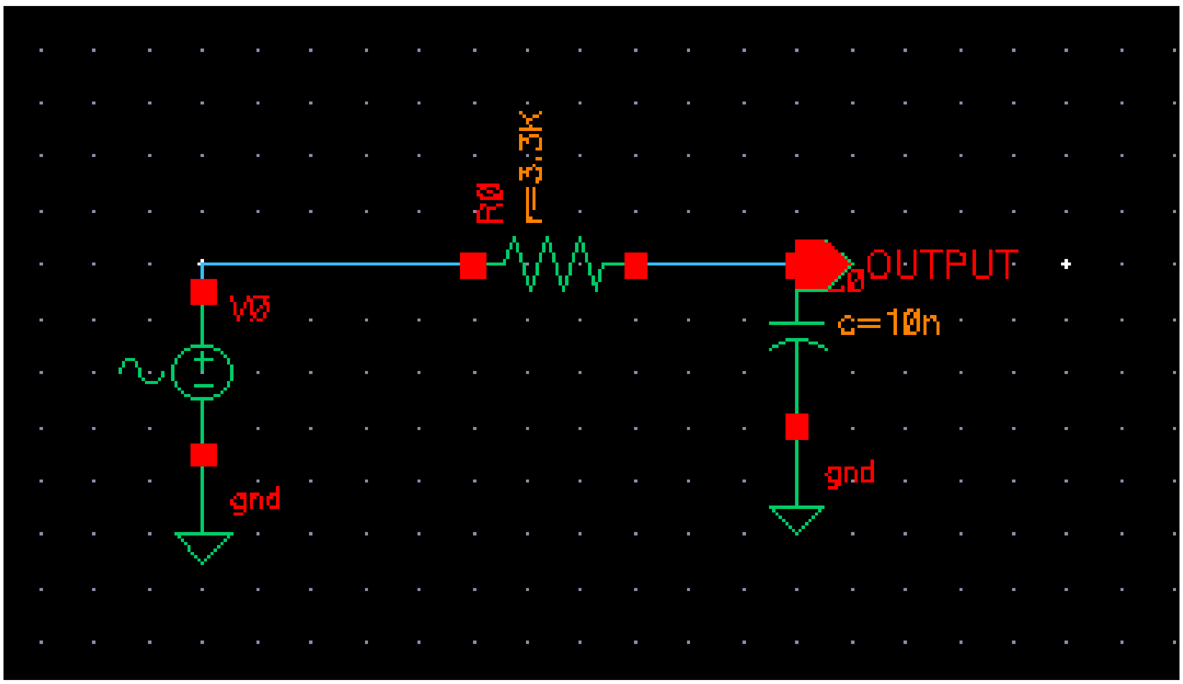
- Let fc = 5 KHz
- Assume c = 9.65 nF
- Fc = 1 / 2ΠRC
- $R = 1 / (2\Pi \times 5 \times 10^{3} \times 0.01 \times 10^{-6}) = 3.3\ K\Omega$

II. Procedures:

- Connections are made as shown in Fig.1
- The input voltage remains constant at 5V
- The input frequency is changed from 100 Hz to 50 KHz
- At each step corresponding output is measured.
- The gain in dB is calculated by using the formula Af = 20 log Vo/Vi
- The graph of gain V/freq is plotted.

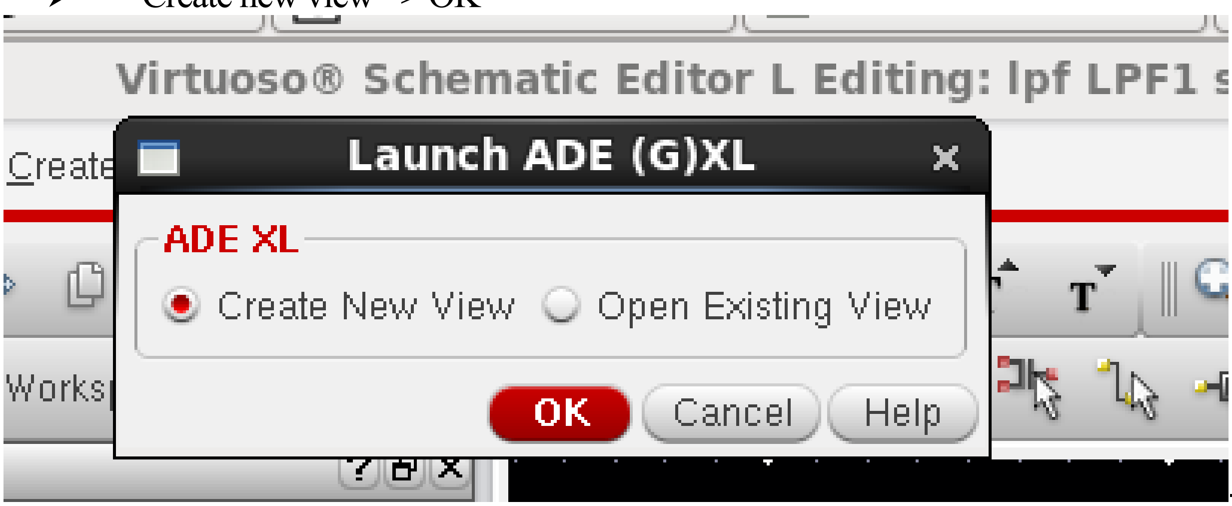
III. Simulation Procedures:

- Draw schematic:

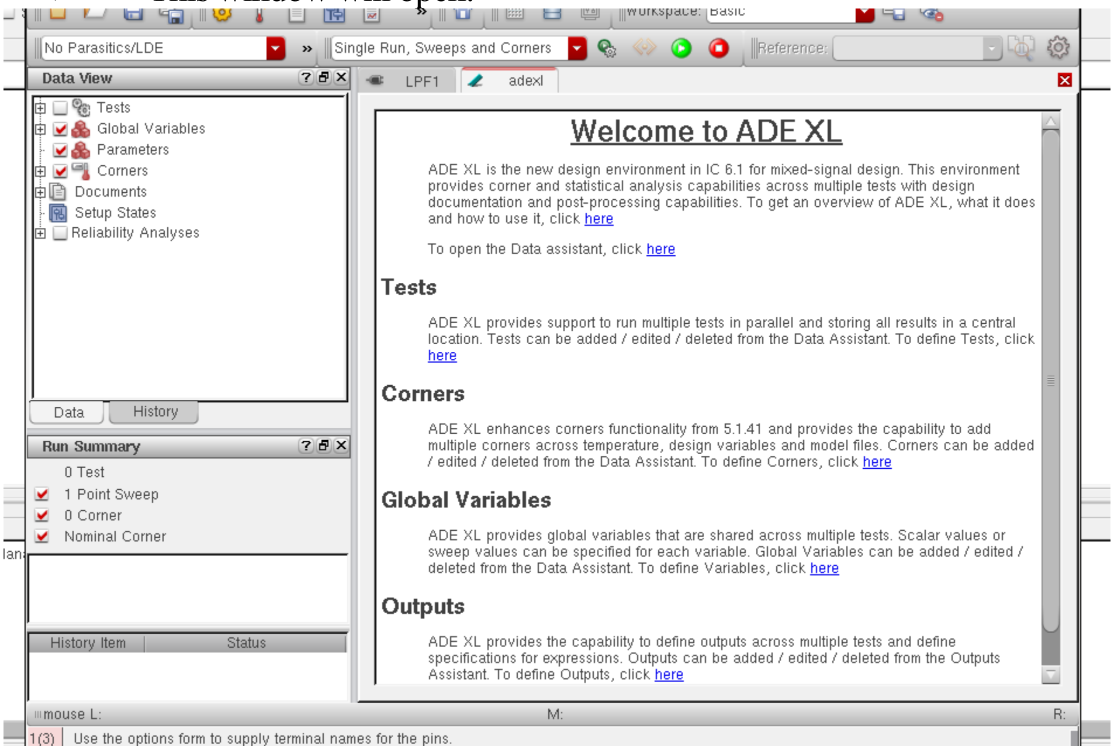


- to can obtain AC analysis:
- Launch => ADE XL

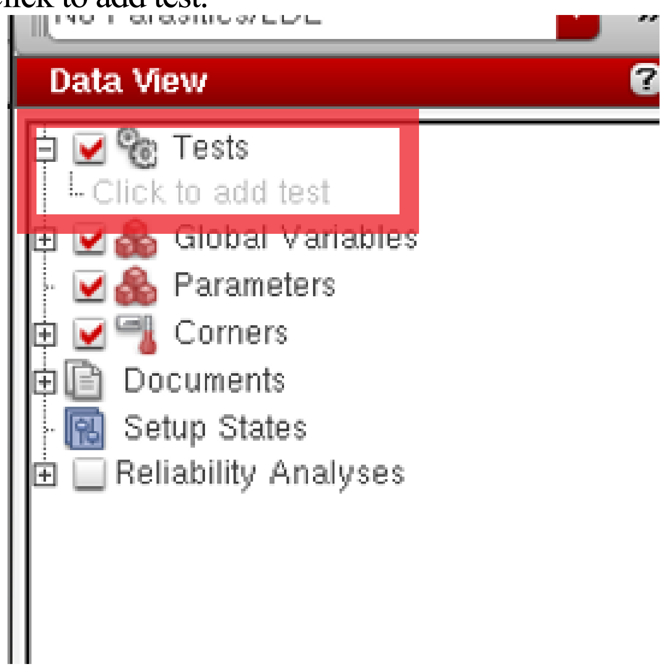
- Create new view => OK



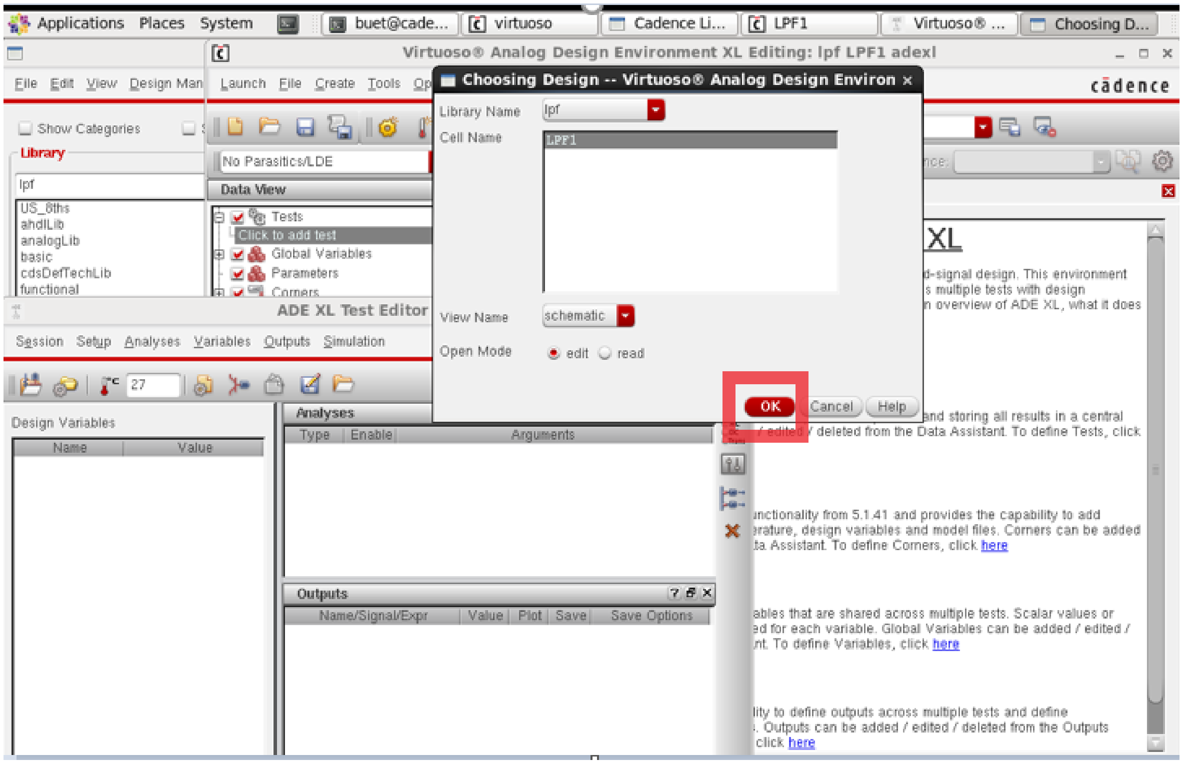
- This window will open:



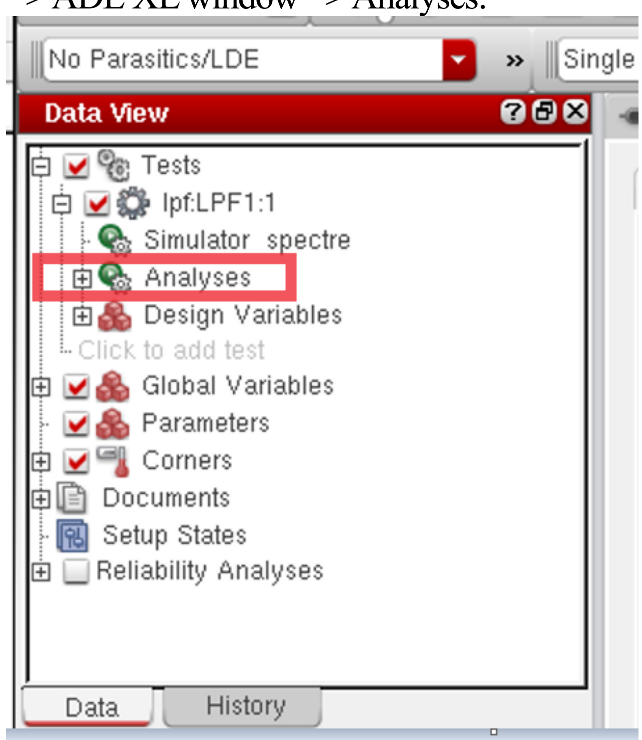
- select the “Tests” icon which is in the right part list to choose system analysis.
- Tests => Click to add test.



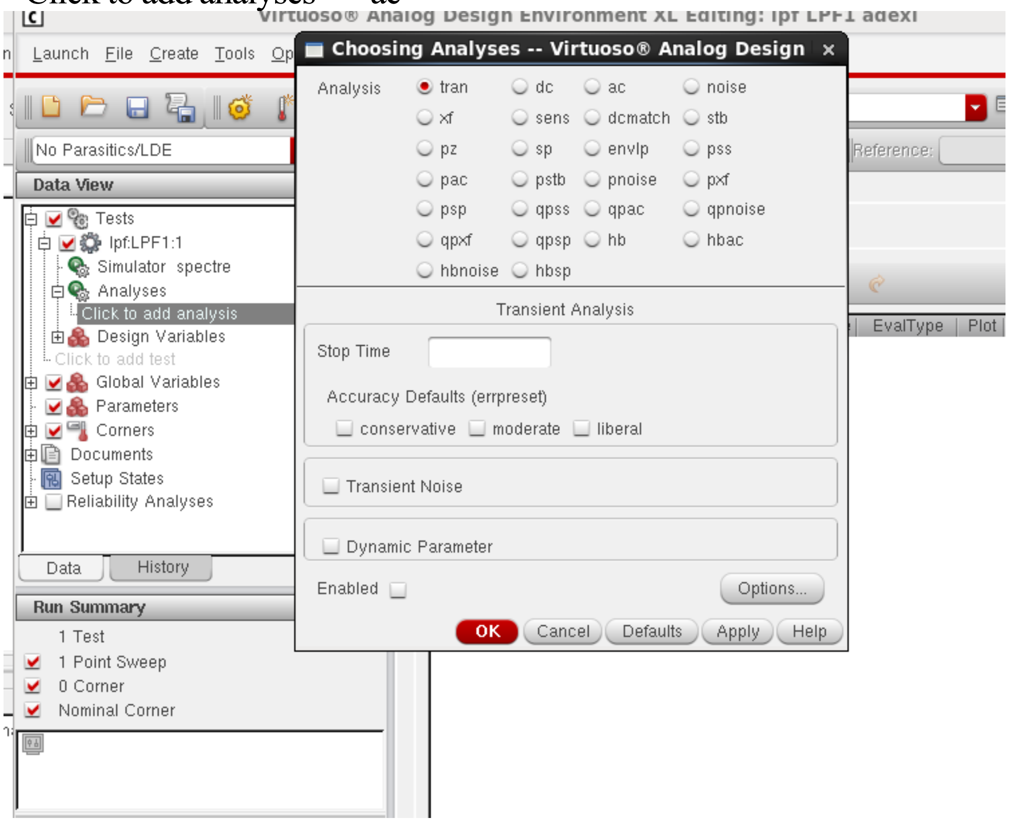
➢ after clicking “click to add test” this window will show:



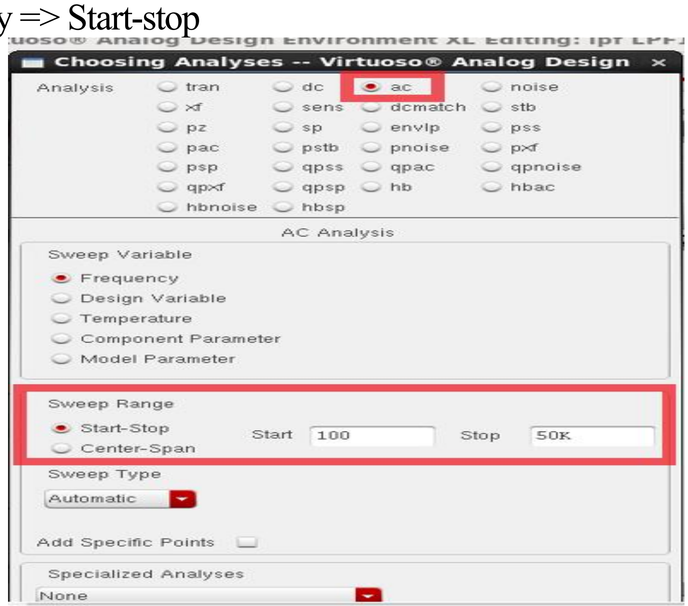
➢ click “OK” => ADE XL window => Analyses:



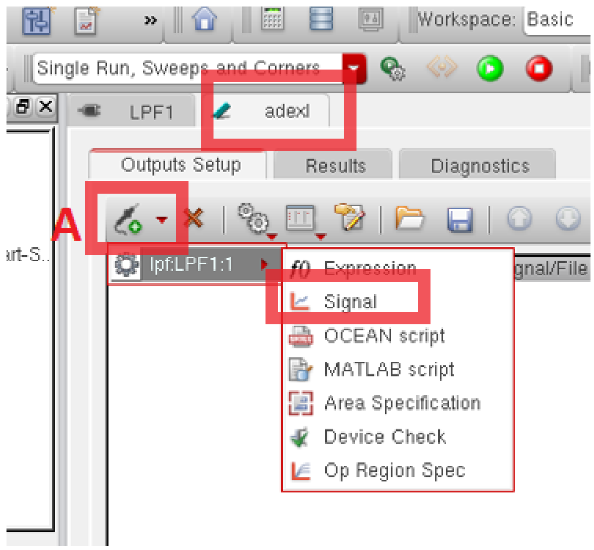
➢ Click to add analyses => ac



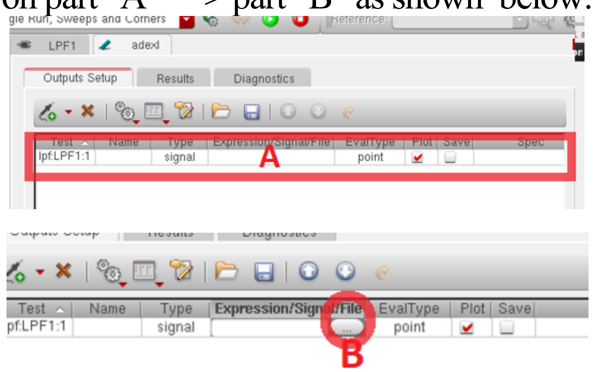
➢ Frequency => Start-stop



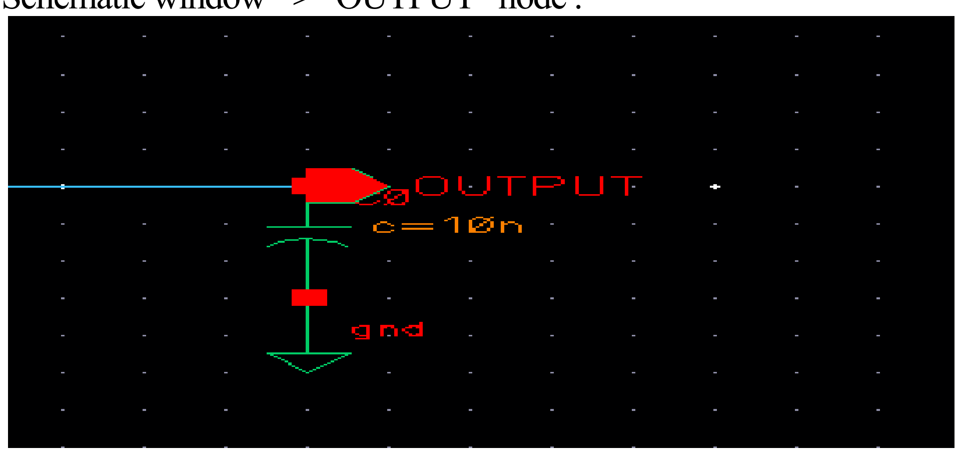
- "OK" => adexl window =>part "A" => Signal



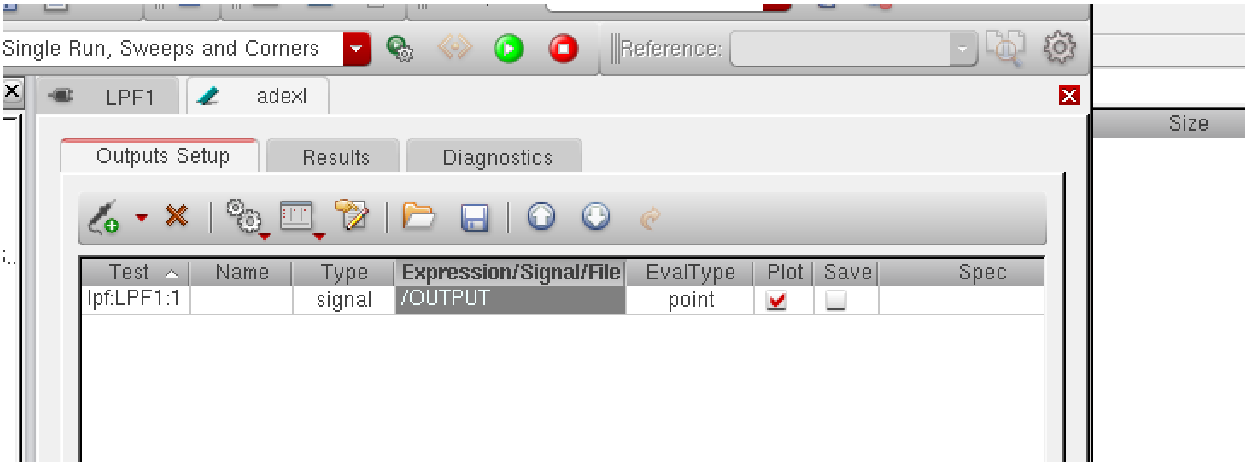
- Double click on part "A" => part "B" as shown below:



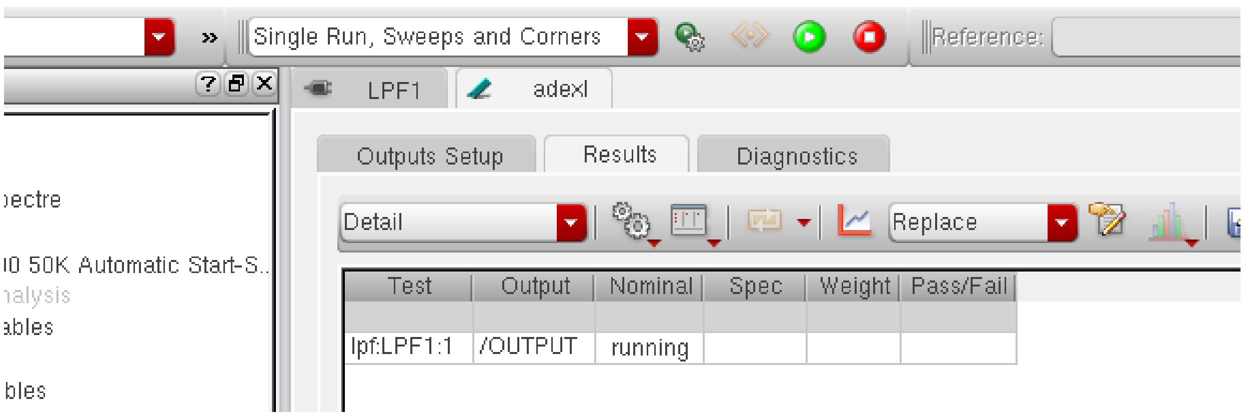
- Schematic window => "OUTPUT" node .



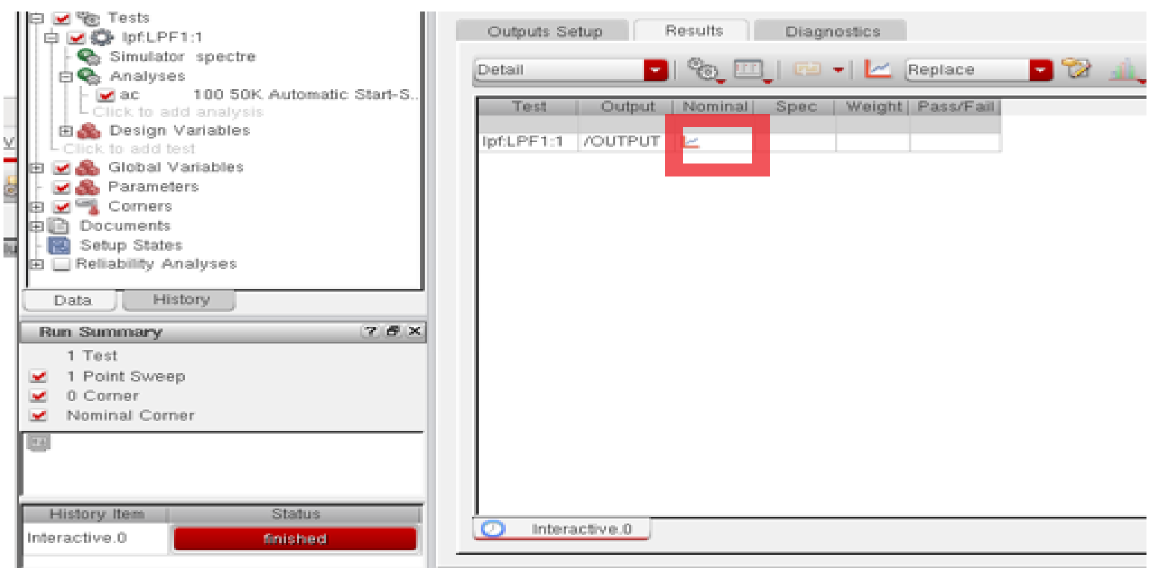
- It will be selected as below:-



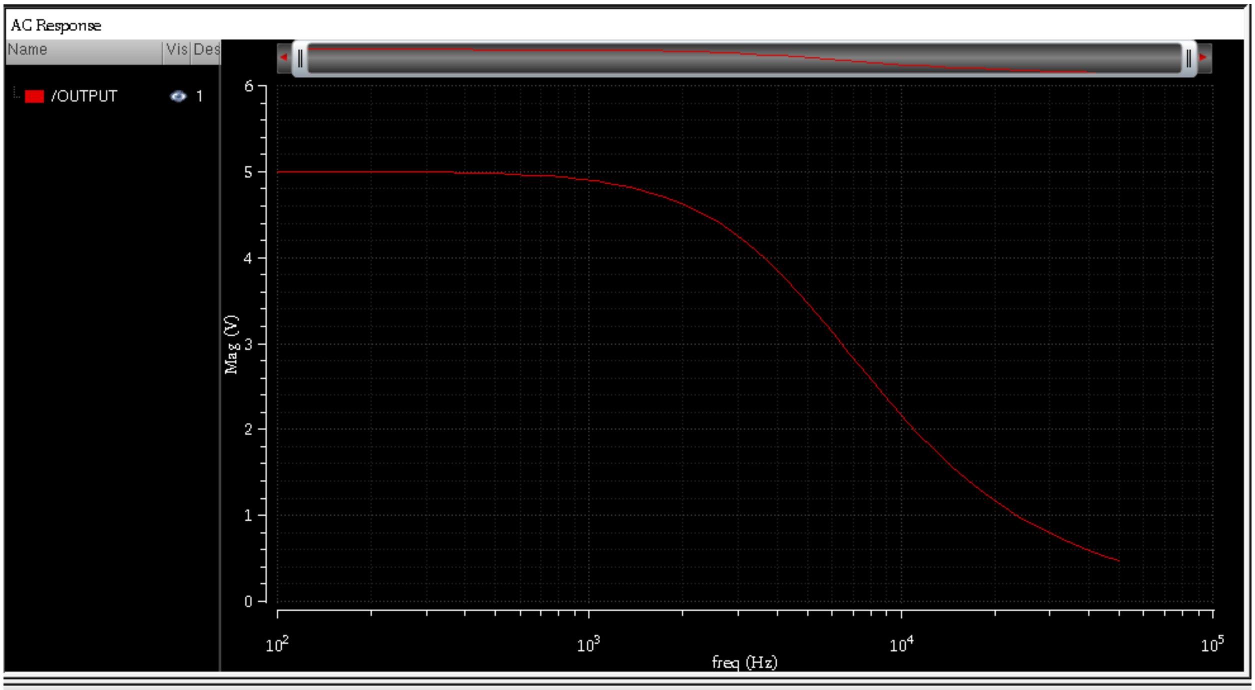
- Save and Run



- Double-click on curve to see the curve:



- Final results



IV. Tabular Column:

Input Voltage = ………………………………………..			
F in Hz	O/p Voltage	Gain A = Vo/Vin	Af = 20 log Vo/Vi

Cutoff frequency = ………………………………………….

2. RL circuit:

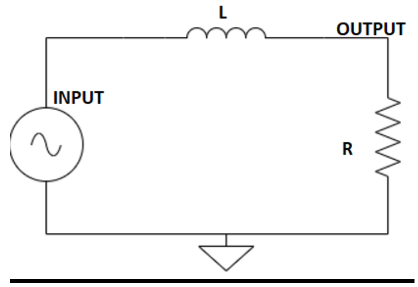


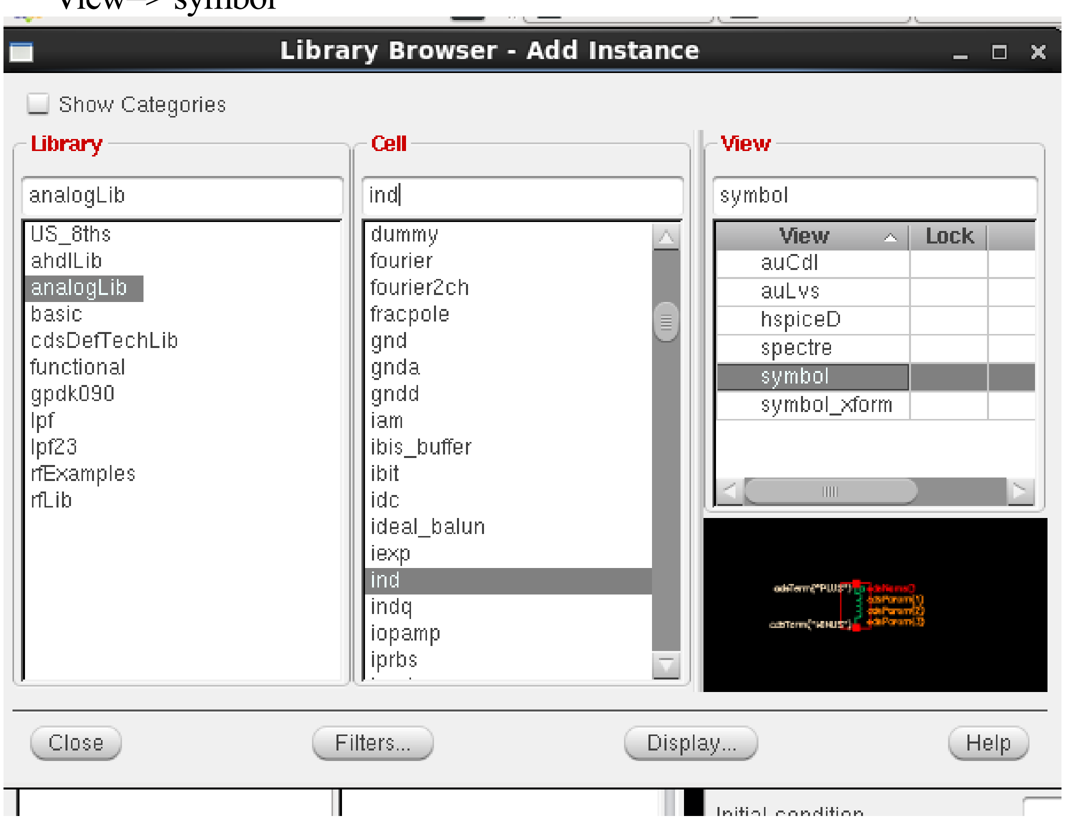
Figure 3 RL Circuit For Low pass filter

I. Design:

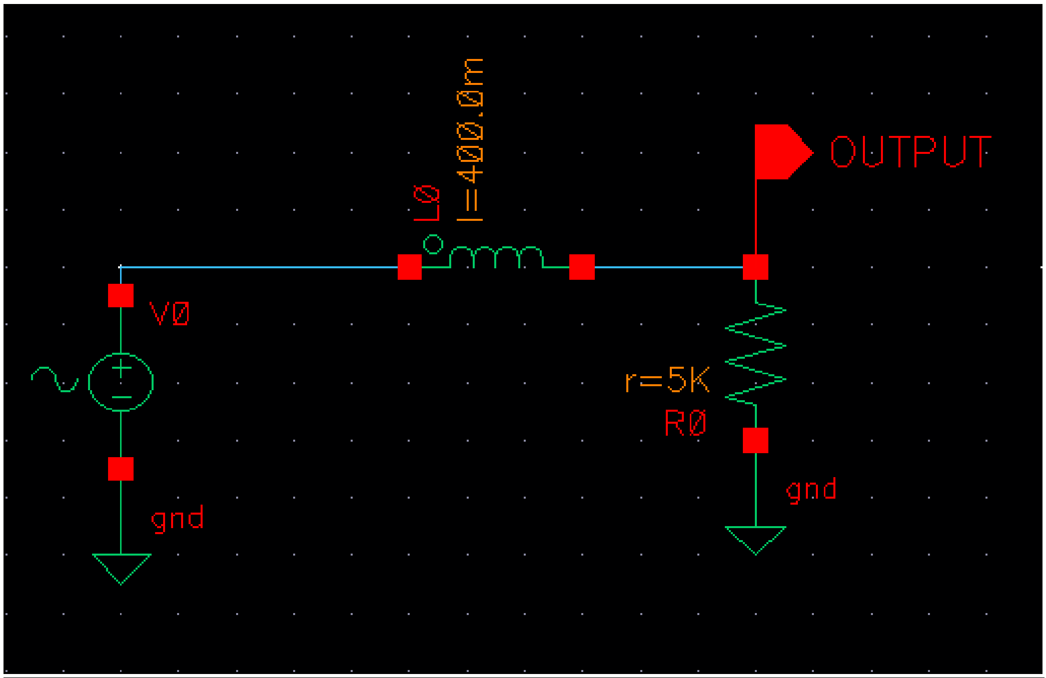
- Let $f_c = 2\ KHz$
- Assume R = 5 kΩ.
- $f_c = \frac{1}{2\ \pi RC}$
- L = 0.4 H.

II. Simulation Procedures:

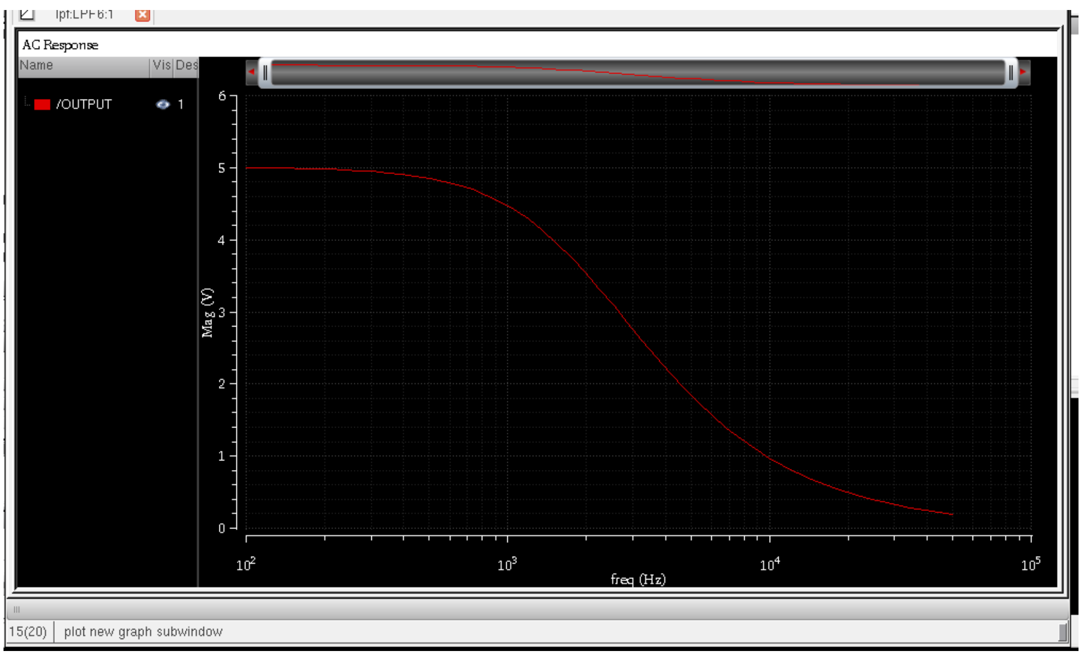
- Library=> analogLib
- Cell=> ind
- View=> symbol



➢ Draw schematic:



➢ Final results



B- <u>High pass filter:</u>

1. RC circuit

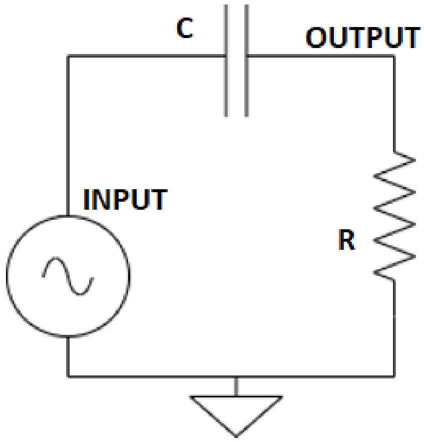


Figure 4 High Pass Filter circuit

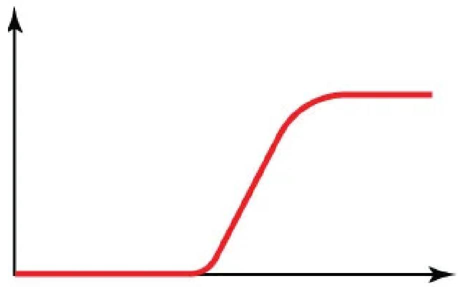


Figure 5 Characteristic Curve of High pass filter

I. Design:

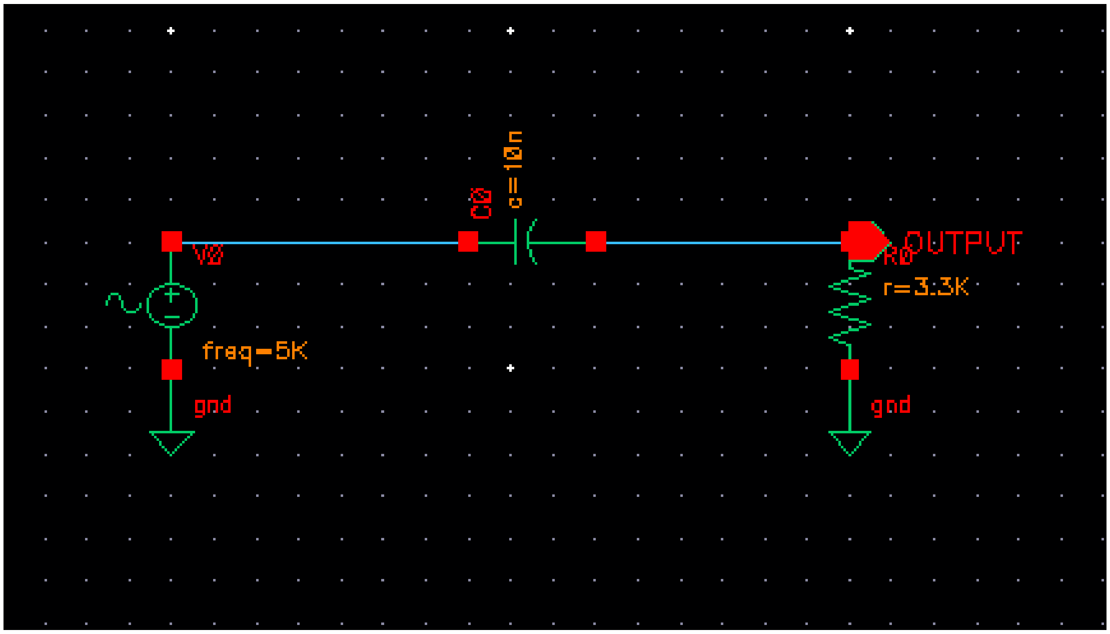
- Let fc = 5 KHz
- Assume c = 9.65 nF
- Fc = 1 / 2ΠRC
- R = 1 / (2Π x 5 x 10^3 x 0.01 x 10^{-6}) = 3.3 KΩ

II. Experiment:

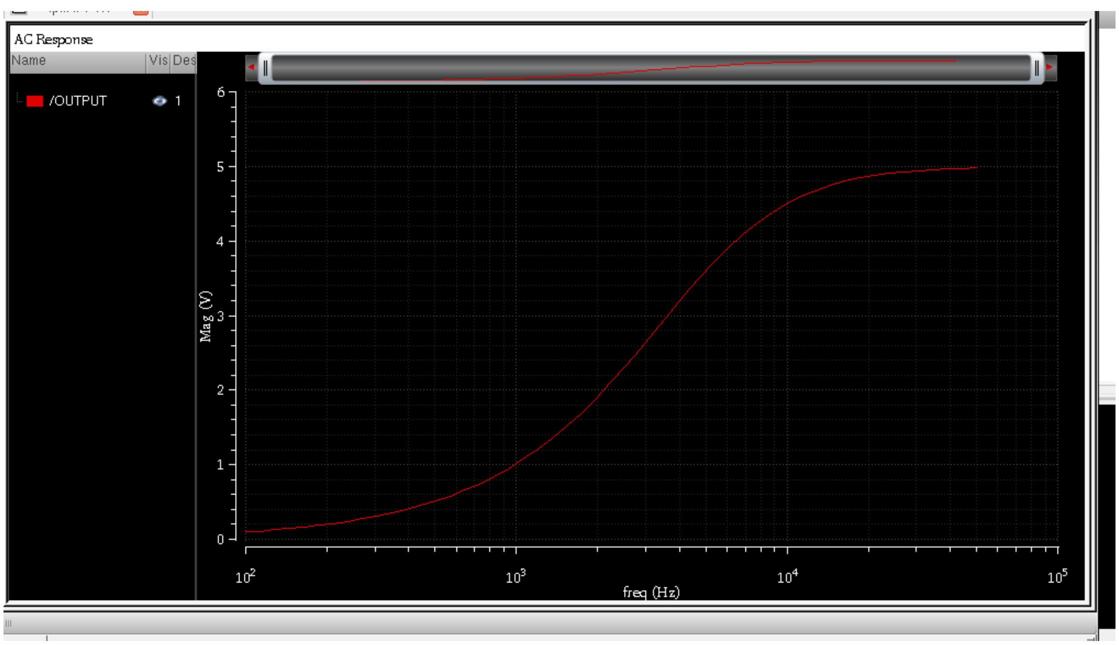
1. Connections are made as shown in Fig.4
2. The input voltage remains constant at 5V
3. The input frequency is changed from 100 Hz to 50 KHz
4. At each step corresponding output is measured.
5. The gain in dB is calculated by using the formula Af = 20 log Vo/Vi
6. The graph of gain V/freq is plotted.

III. Simulation procedures:

- Draw schematic:



- Final Results



IV. Tabular Column:

Input Voltage = ……………………………………..			
F in Hz	O/p Voltage	Gain A = Vo/Vin	Af = 20 log Vo/Vi

Cutoff frequency = ………………………………………..

2. RL circuit:

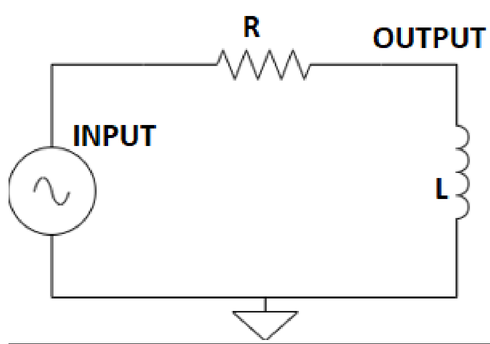


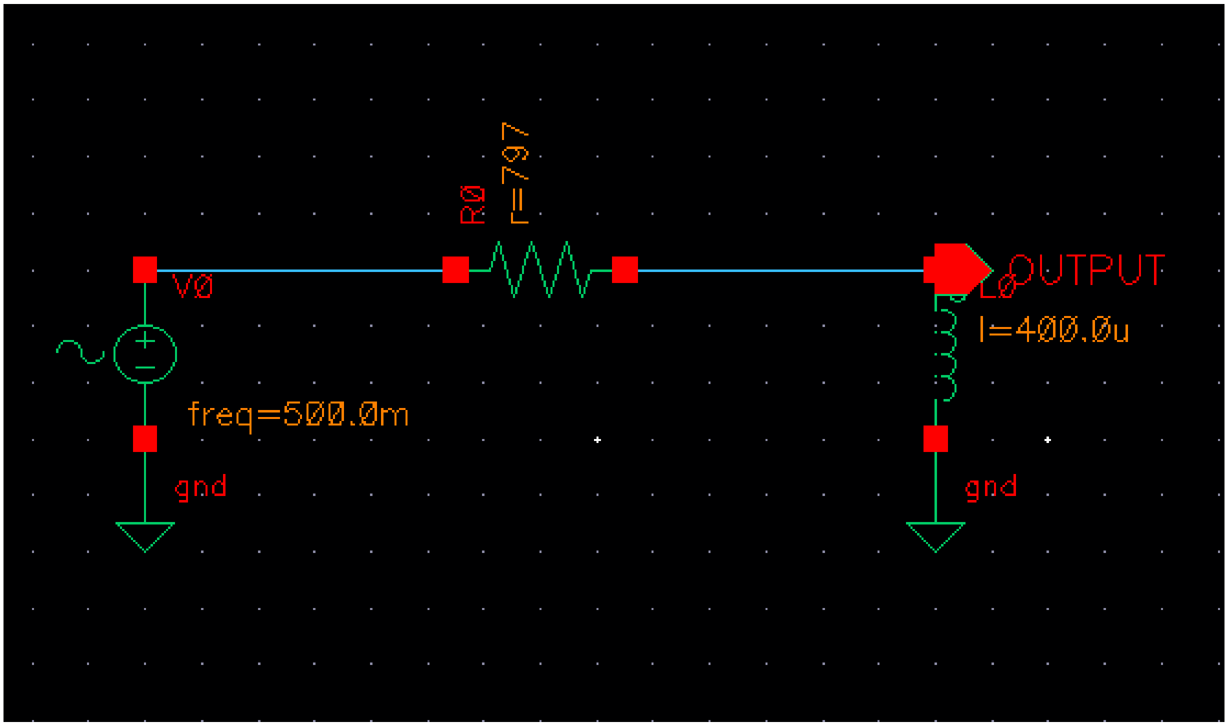
Figure 6 RL Circuit For High pass filter

I. Design:

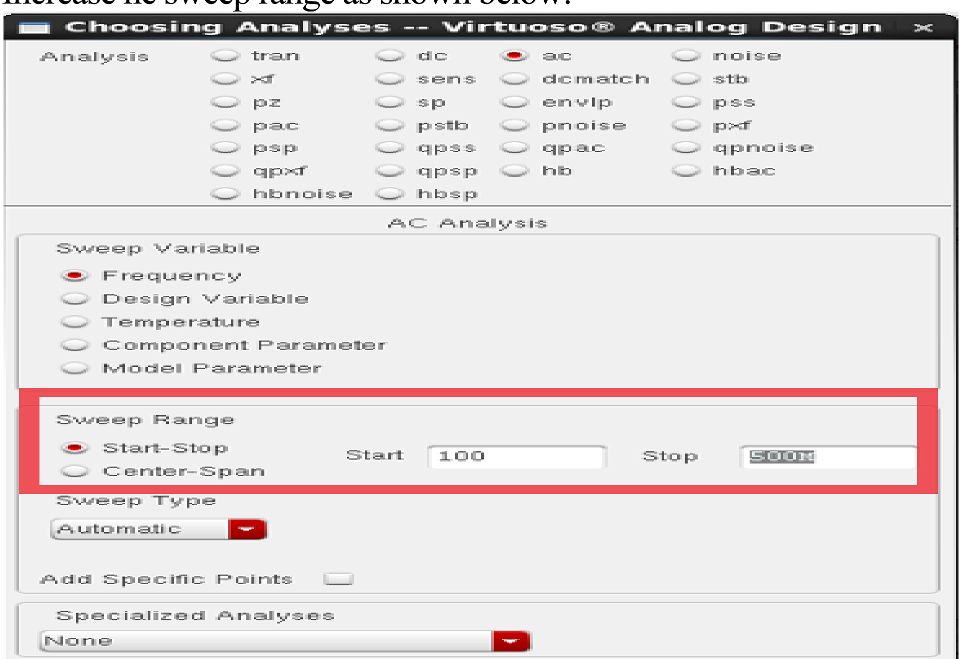
- Let $f_c = 0.5\ Hz$
- Assume R = 797 Ω.
- $f_c = \frac{1}{2\ \pi RC}$
- L = 0.4 mH.

II. Simulation procedures:

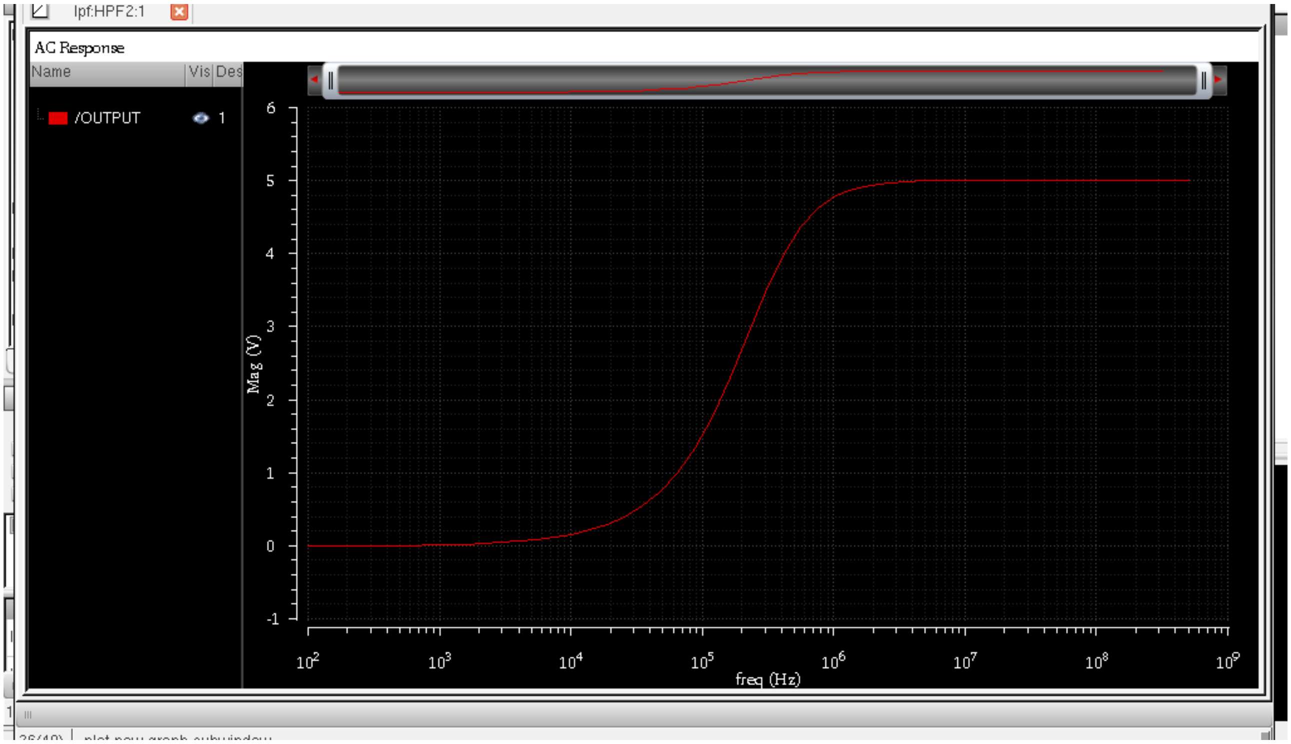
- **Draw schematic:**



- Try to wide the range of sweep to see all curve response well.
- Increase he sweep range as shown below:-



- Final Results



C- <u>Band pass filter:</u>

1. RC circuit

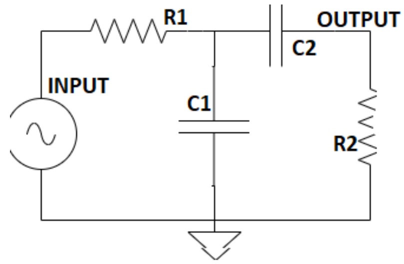


Figure 7 Band Pass Filter circuit

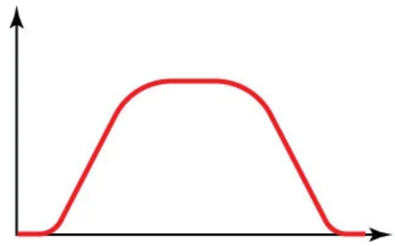


Figure 8 Characteristic Curve of Band pass filter

I. Design:

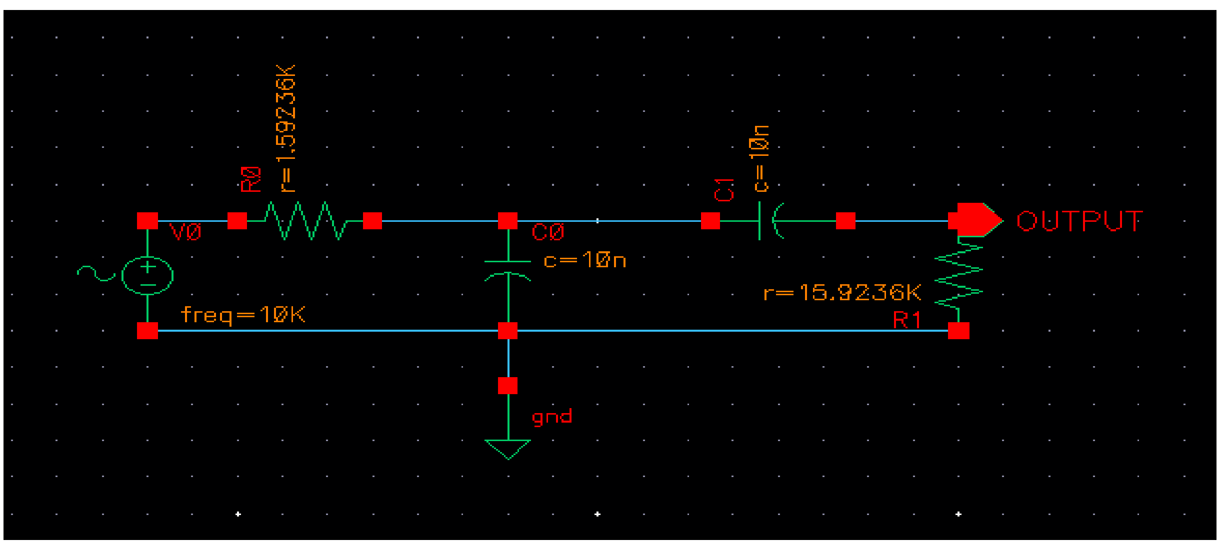
- Let fb = 1 KHz – 10 KHz
- Assume C1 = C2 = 10 nF
- Fc = 1 / 2ΠRC
- R1 (high) = 1592 Ω at 1 KHz
- R2 (low) = 15924 Ω at 10 KHz

II. Experiment:

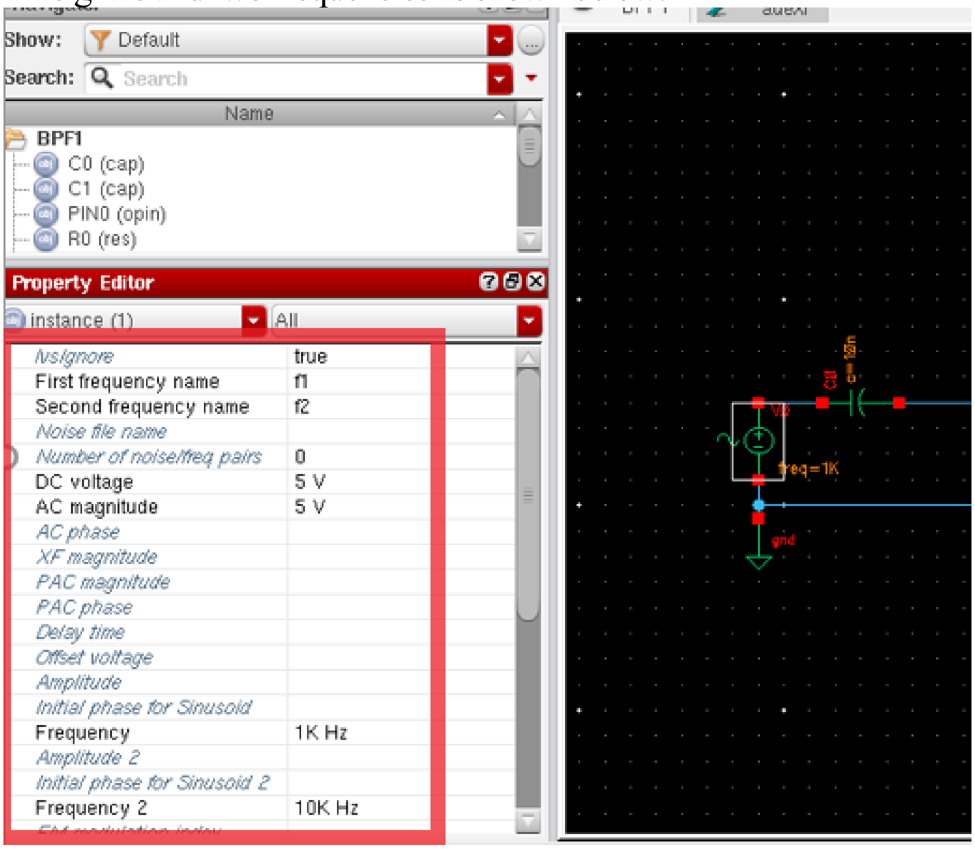
1. 1-Connections are made as shown in Fig.7
2. The input voltage remains constant at 5V
3. The input frequency is changed from 100 Hz to 50 KHz
4. At each step corresponding output is measured.
5. The gain in dB is calculated by using the formula Af = 20 log Vo/Vi
6. The graph of gain V/freq is plotted.

III. Simulation Procedures:

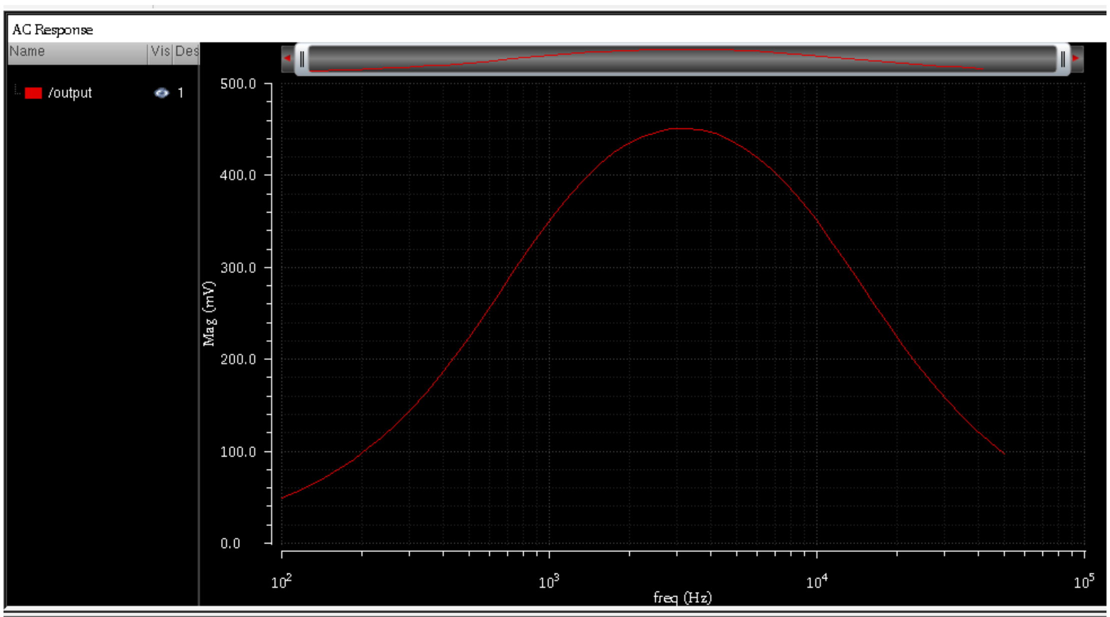
- Draw schematic:



➢ starting in normal way as above steps but edit parameters of Vsin source with two signals and two frequencies as shown below:-



➢ Final Results



IV. Tabular Column:

Input Voltage = ……………………………………..			
F in Hz	O/p Voltage	Gain A = Vo/Vin	Af = 20 log Vo/Vi

Cutoff frequencies = ………………………………………

2. RLC circuit:

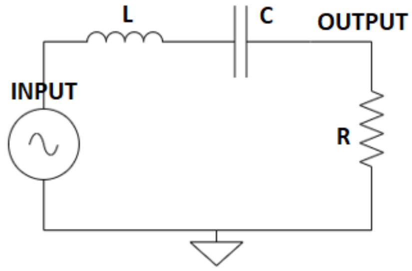


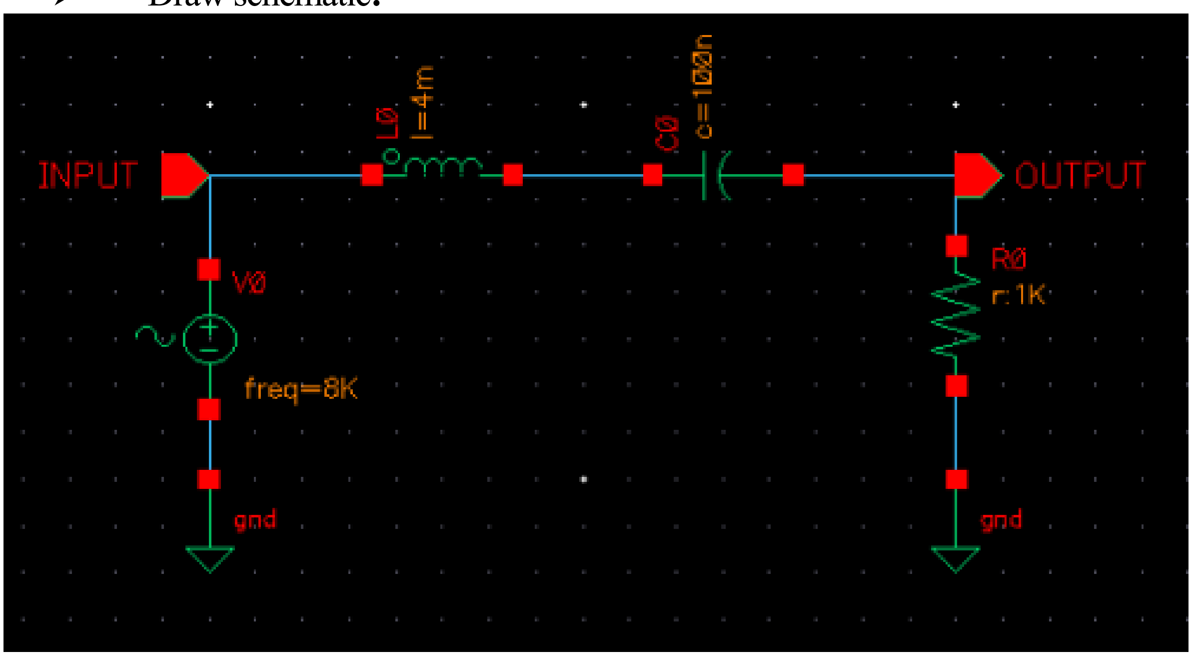
Figure 9 RLC Circuit For Band pass filter

I. Design:

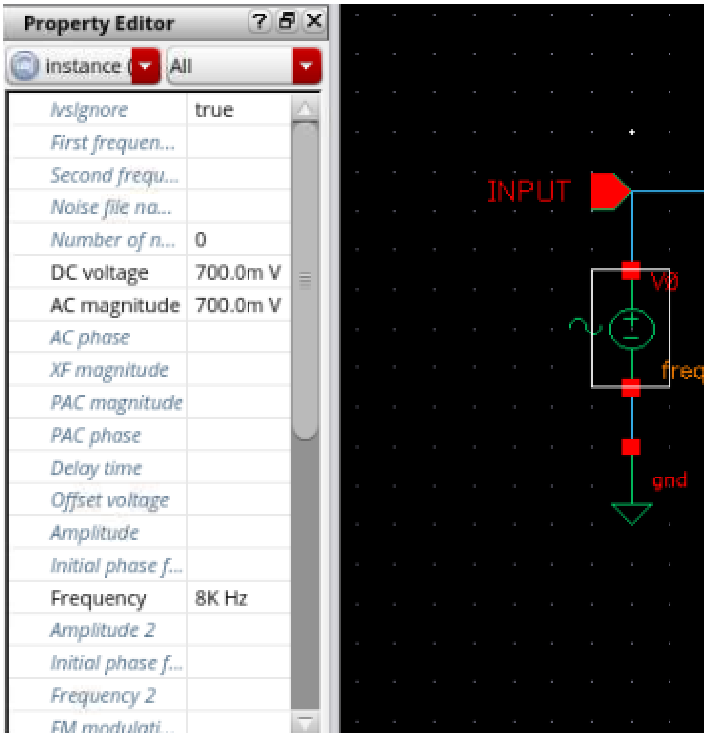
- Let $f_o = 8\ KHz\ , Q = 5$
- Assume C = 100 nF.
- $f_o = \frac{1}{2\ \pi\sqrt{LC}}\ , \Delta f = \frac{1}{2\pi RC}\ , \mathrm{Q} = \frac{f_o}{\Delta f} = R\sqrt{C/L}$
- L = 4 mH, R = 1kΩ.
- Vsource=700mv
- Range sweep between 1-1GHz

II. Simulation procedures:

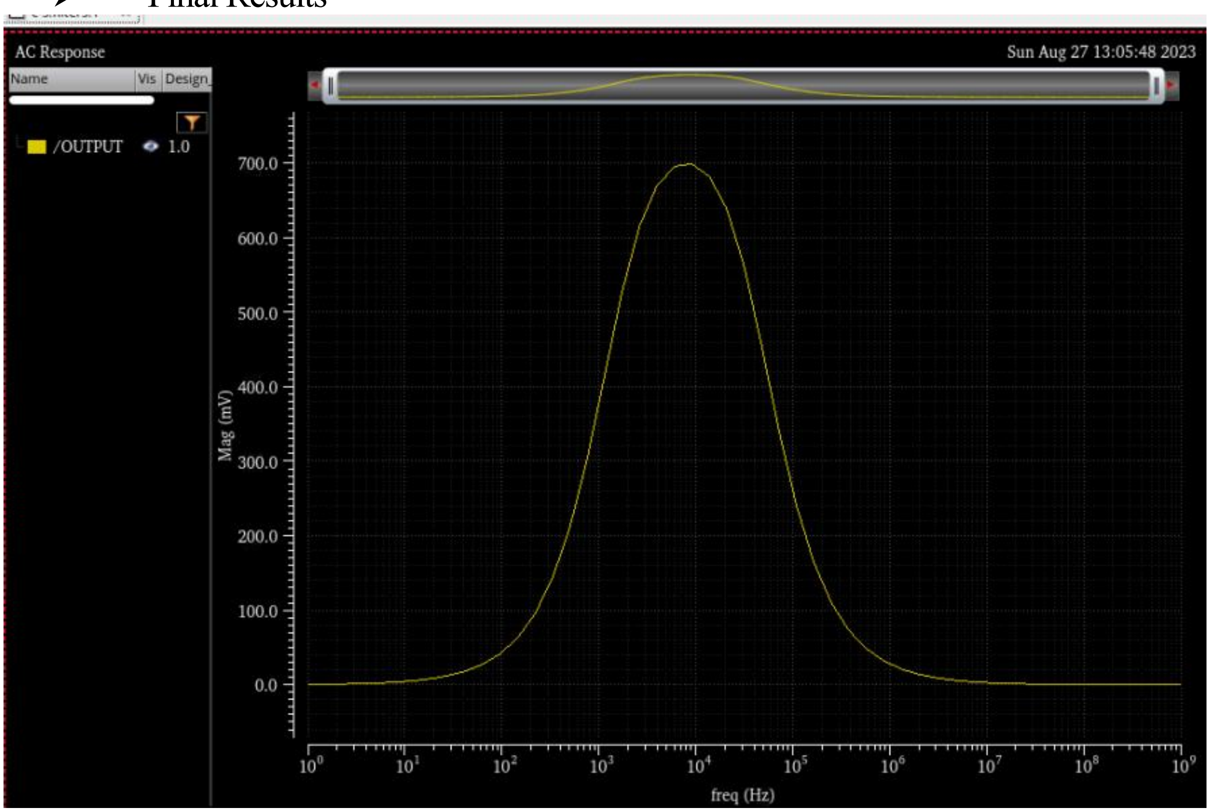
- Draw schematic:



- vsin=>700mv



- Final Results



D- <u>Band stop filter:</u>

1. RC circuit

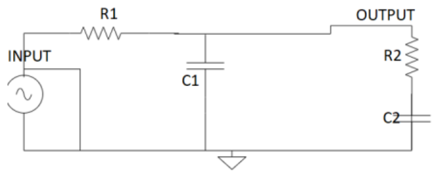


Figure 10 Band Stop Filter circuit

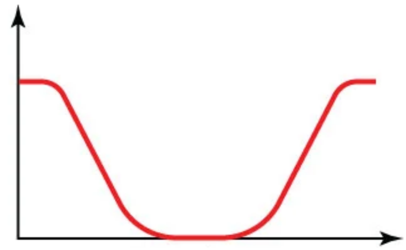


Figure 11 Characteristic Curve of Band stop filter

I. Design:

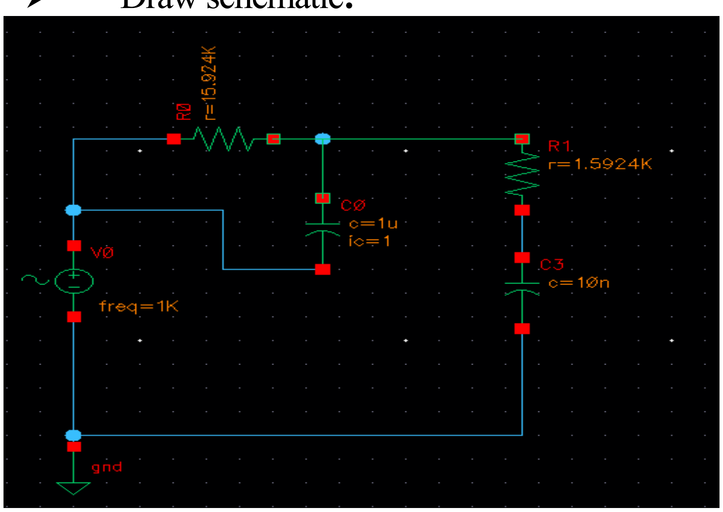
- Let fb = 1 KHz – 10 KHz
- Assume C1 = 100nF , C2 = 1 nF
- Fc = 1 / 2ΠRC
- R1 (high) = 1592 Ω at 1 KHz
- R2 (low) = 15924 Ω at 10 KHz

II. Experiment:

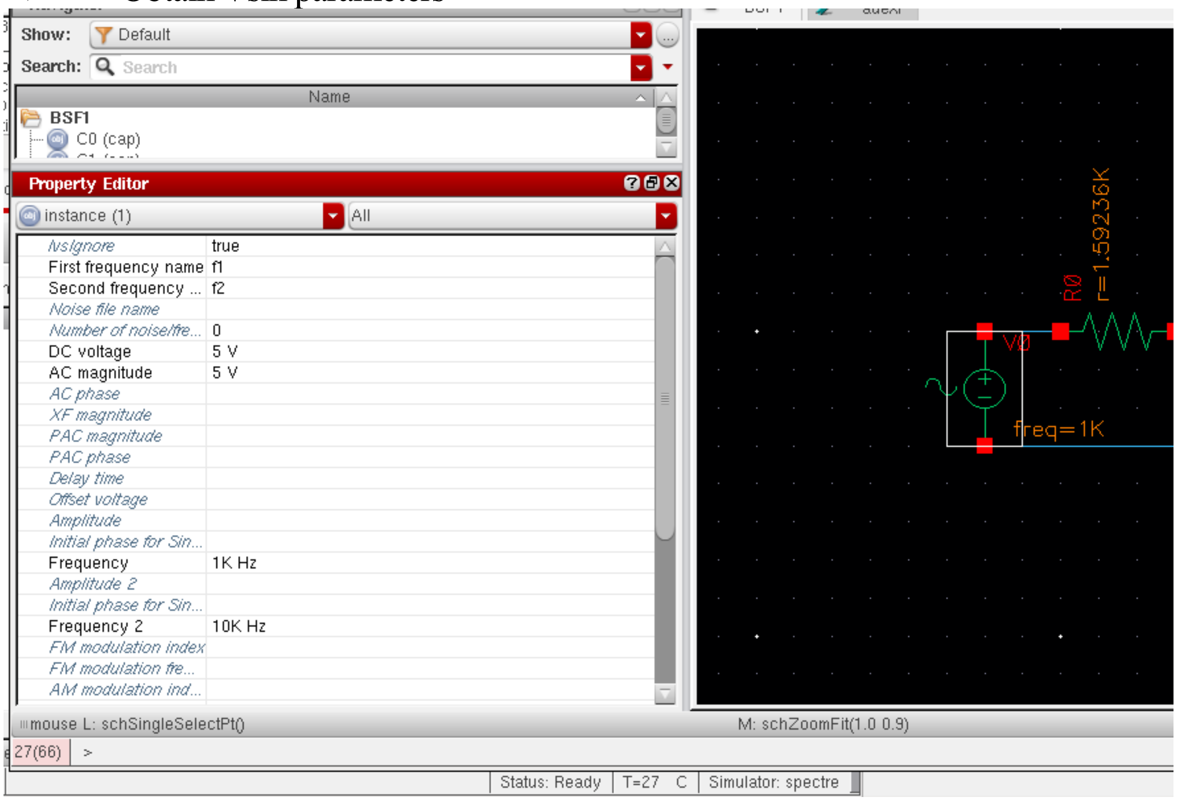
- Connections are made as shown in Fig.10
- The input voltage remains constant at 5V
- The input frequency is changed from 100 Hz to 50 KHz
- At each step corresponding output is measured.
- The gain in dB is calculated by using the formula Af = 20 log Vo/Vi
- The graph of gain V/freq is plotted.

III. Simulation Procedures:

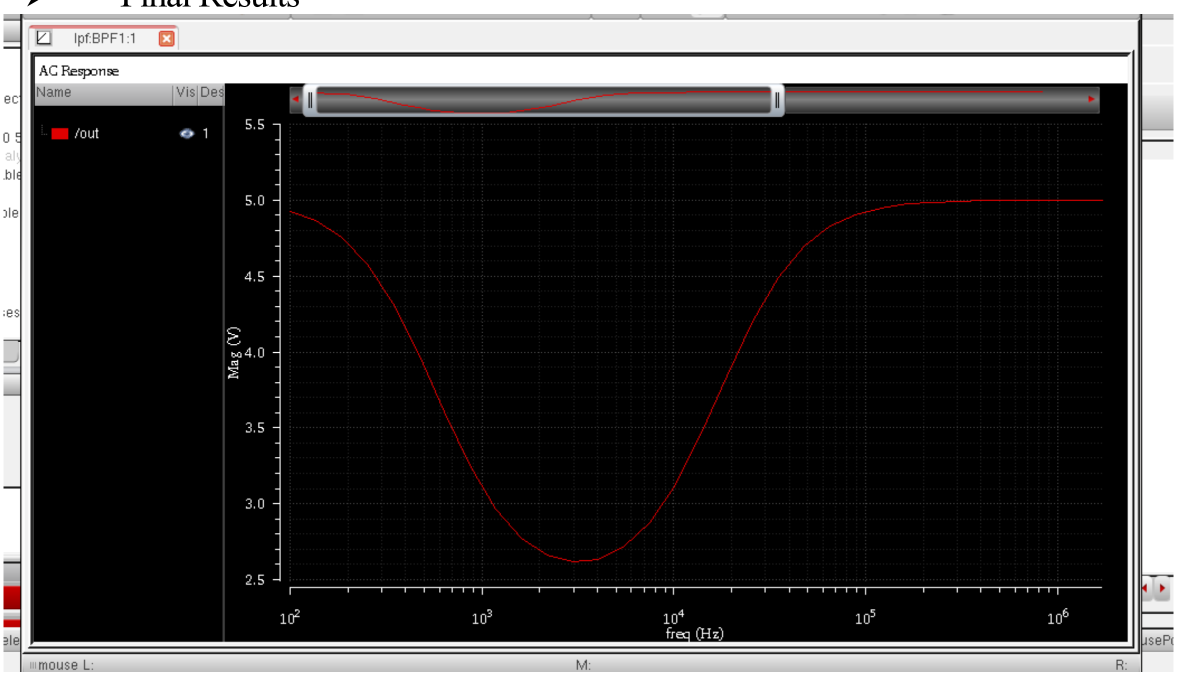
- Draw schematic:



➢ Obtain Vsin parameters



➢ Final Results



IV. Tabular Column:

Input Voltage = ………………………………………..			
F in Hz	O/p Voltage	Gain A = Vo/Vin	Af = 20 log Vo/Vi

Cutoff frequencies = ……………………………………………

2. RLC circuit:

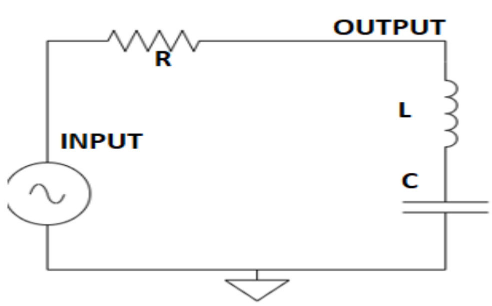


Figure 12 RLC Circuit For Band stop filter

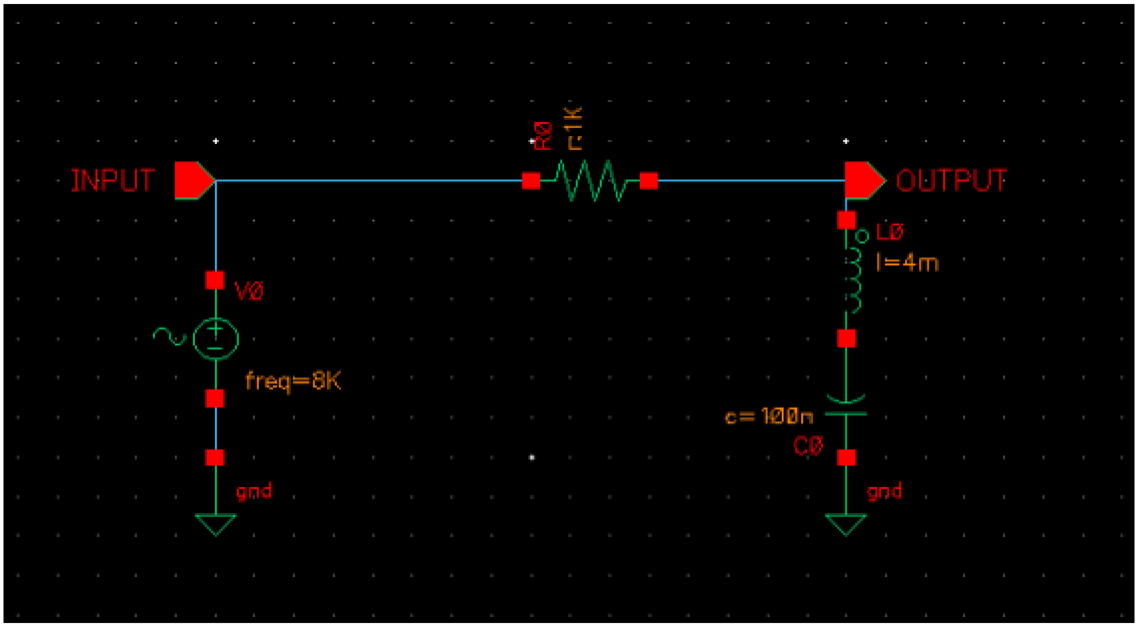
I. Design:

- Let $f_o = 2\ KHz\ , Q = 6$
- Assume C = 100 nF.
- $f_o = \frac{1}{2\ \pi\sqrt{LC}}$, $\Delta f = \frac{1}{2\pi RC}$, Q = $\frac{f_o}{\Delta f} = R\sqrt{C/L}$
- L = 0.063 H, R = 4.8kΩ.
- Vsource=700mv

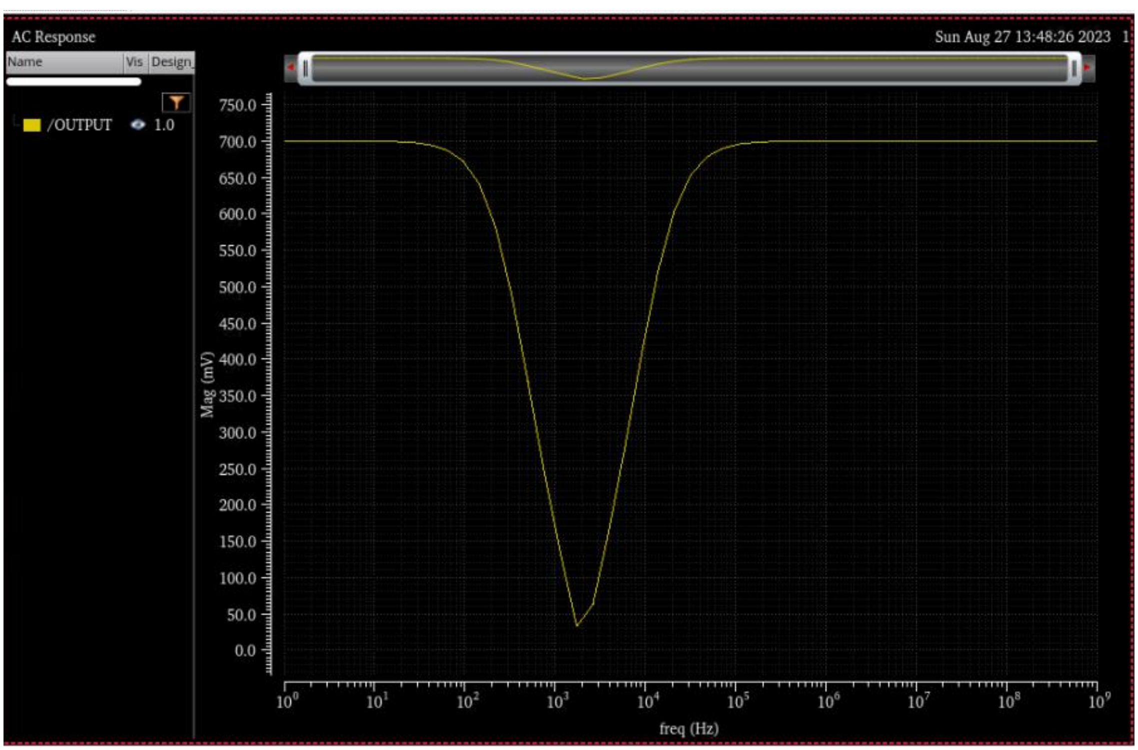
- Range sweep between 1-1GHz

II. Simulation Procedures:

- Draw schematic:



- Final Results



Assignment 4

- What is Pi Filter and How it works?
- **Design a Pi-Filter as shown in figure 1** , let :

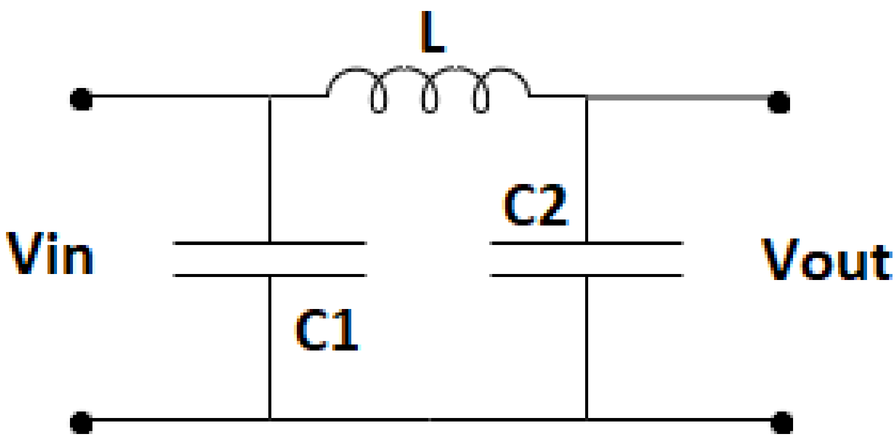
  Fc=8 kHz ,and use this equations :

  $Fc=\frac{1}{\pi\sqrt{LC}}$,

  $L=\frac{1}{\pi * fc * z0}$

  $C1=C2=\frac{z0}{\pi\ fc}$

- Assume that the input impedance (Z0)=50 ohm
- Mention your own comments about output curve.



Pi-Circuit

Bonus 4

- What is Harmonic (Shunt) filters?
- Design C-type Damped filter using cadence, let:-
  -all capacitors =100nf.
  -inductance=40mH
  -resistive load=4.5Kohm
- Apply transient & AC analysis, and mention your comments.