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INFORMATION TECHNOLOGY
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Department
of
Electronics & Communication Engineering

Circuit Theory and Devices

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Lab_2: LPF and BPF design in LTSpice

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Objective:

1. Design first, and second order Low Pass and Band Pass filters using RC circuits on the software Ltspice.

2. Plot the magnitude and phase response of the filters in a Bode plot and compare their performances.

Theoretical Calculations:

Date......................

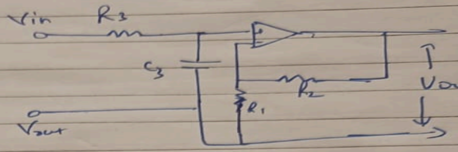
First order LPF.

$f_L = 40 \text{ KHz} = \dfrac{1}{2\pi R_3 C_3}$

for $R_3 = 40\Omega$;

$\longrightarrow C_3 = \dfrac{4 \mu\Omega F}{40}$

$= 0.1 \mu F.$



Second order LPF

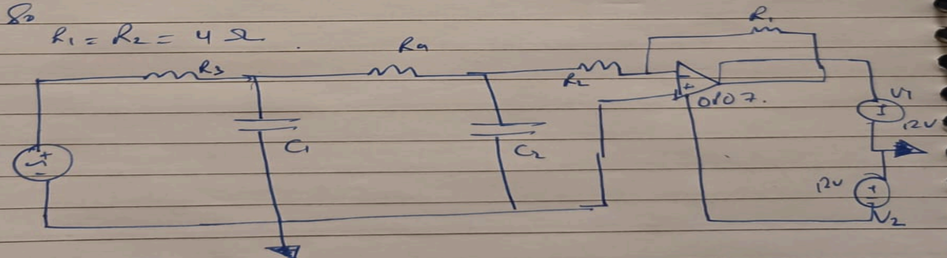
$f_L = 40 \text{ KHz} = \dfrac{1}{2\pi\sqrt{R_1 C_1 R_2 C_2}}$

for $C_1 = C_2 = 1 \mu F$

$R_1 R_2 = \dfrac{1}{2\pi \sqrt{10^{-6} \times 10^{-6}}} \times \dfrac{1}{40 \times 10^{-3}} \Rightarrow 16$

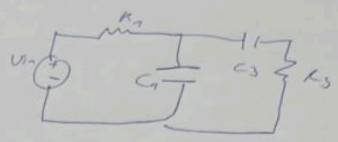
So

$R_1 = R_2 = 4\ \Omega$.



Spiral

First order BPF



$f_L = 35\,kHz$

$= \frac{1}{2\pi R_4 C_4}$

$; R_4 C_4 = \frac{1}{2\pi\, 35000} = 4.54 \times 10^{-6}$

$C_4 = 0.1\,\mu F$

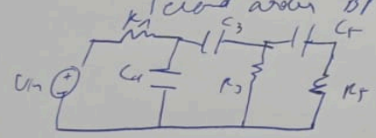
then $R_4 = 45.4\,k\Omega$

Similarly;

$f_H = 45\,kHz \Rightarrow R_3 C_3 = 3.53 \times 10^{-6} \left(\frac{1}{2\pi R_3 C_3} \right)$

$\therefore R_3 = 35.3\,k\Omega$ for $C_3 = 0.1\,\mu F$

Second order BPF



f_L : same as first order

$f_H = 45\,kHz = \frac{1}{2\pi\sqrt{R_3 C_3 R_5 C_5}}$

$\therefore$ for $C_3 = C_5 = 0.1\,\mu F$

$R_3 = R_5 = 3.53 \times 10^{-6}$.

Observations:

1) LOW PASS FILTER -:

- All signals over a certain frequency are muted in a low pass filter. The signals are attenuated after they reach the cutoff frequency (fH), and after a specific higher frequency, they are entirely suppressed.
- The roll-off rate for the first order LPF is -20 dB/decade, as would be expected for a single-order filter.
- Except for the fact that the gain will be twice as steep at 40dB/decade as the first order filter, the second order low pass filter's frequency response is identical to that of the first order version.
- The roll-off rate for the second order LPF is -40 dB/decade, as would be expected for a two-order filter. Compared to the first order filter, the change from the passband to the stopband is sharper.

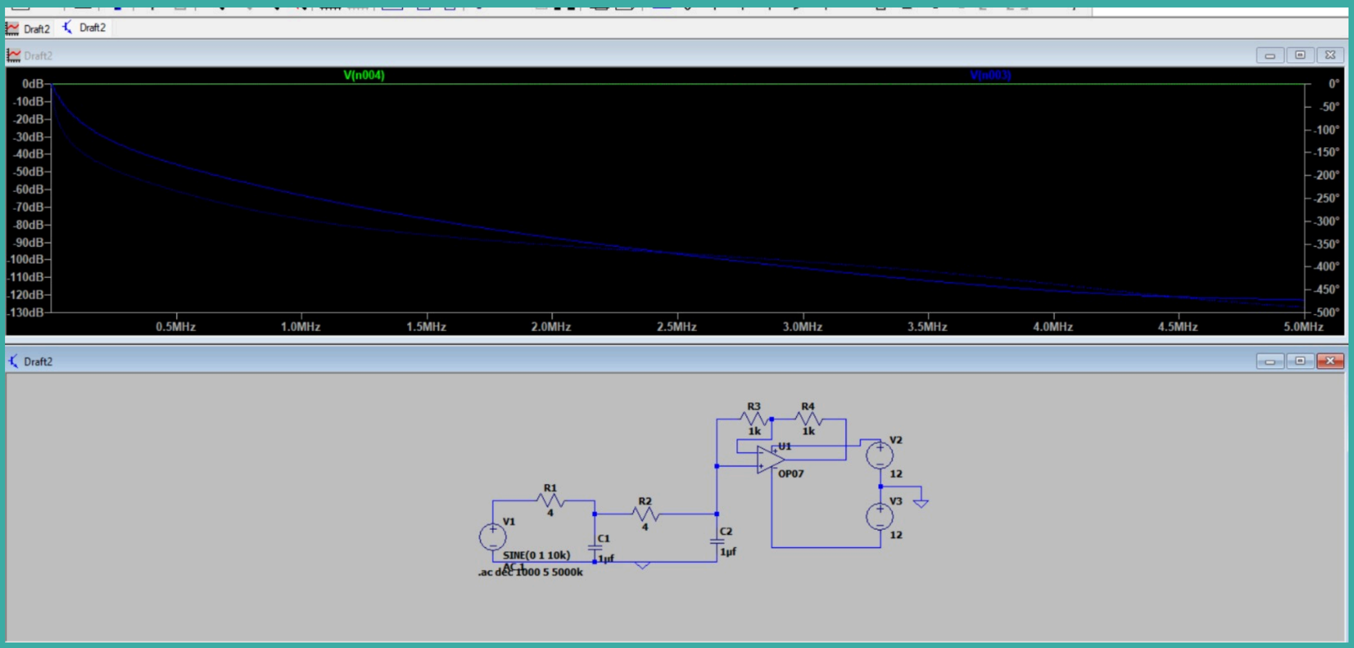
BAND PASS FILTER-:

- The bandwidth for the first order BPF is determined by the lower and upper cutoff frequencies.
- Only signals within the chosen frequency range are permitted to exit the band pass filter; all other signals are blocked.While signals from other frequencies are attenuated, transmissions in the frequency range of fL to fH are allowed to flow through the filter.

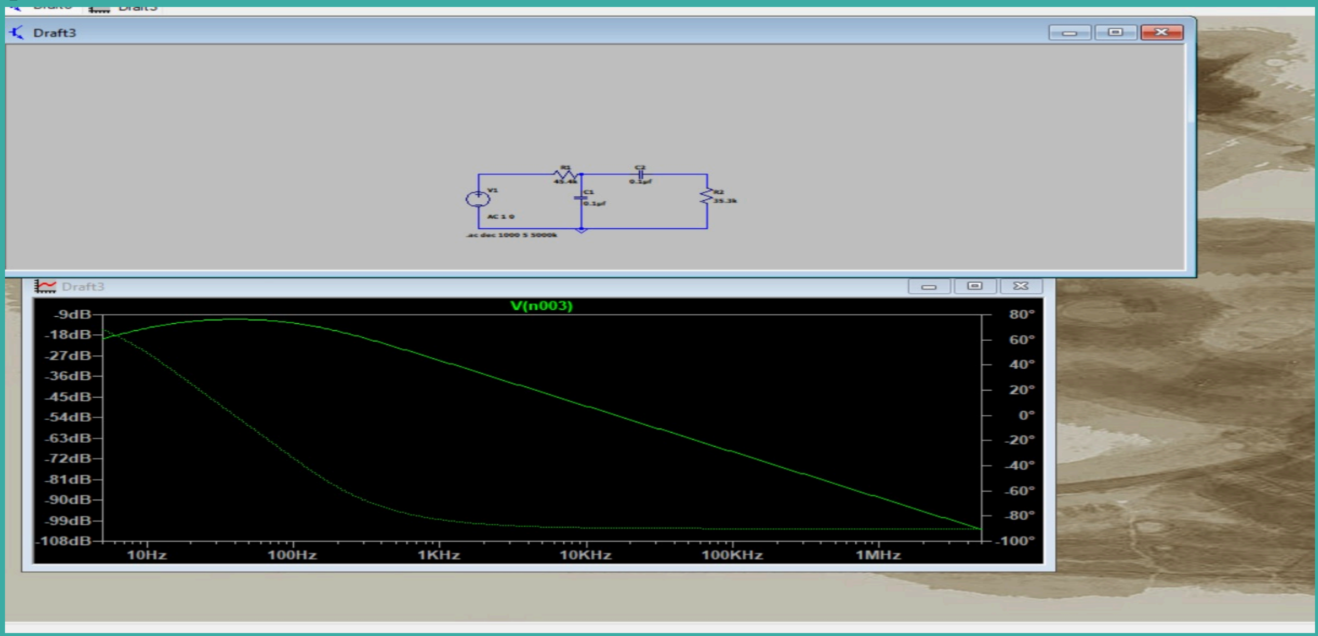
- The lower cutoff frequency for the second order BPF is the same as the first order. In comparison to 1st order, the higher cutoff frequency shifts based on the cascaded LPF sections, providing a sharper transition between the passband and stopband.
- A higher order filter offers sharper attenuations beyond the pass band compared to a lower order, with the peak frequency of the first order in a band pass filter being higher than the peak frequency of the second order (the order of a filter is defined by the number of storage elements (capacitors and inductors)).

Plots:

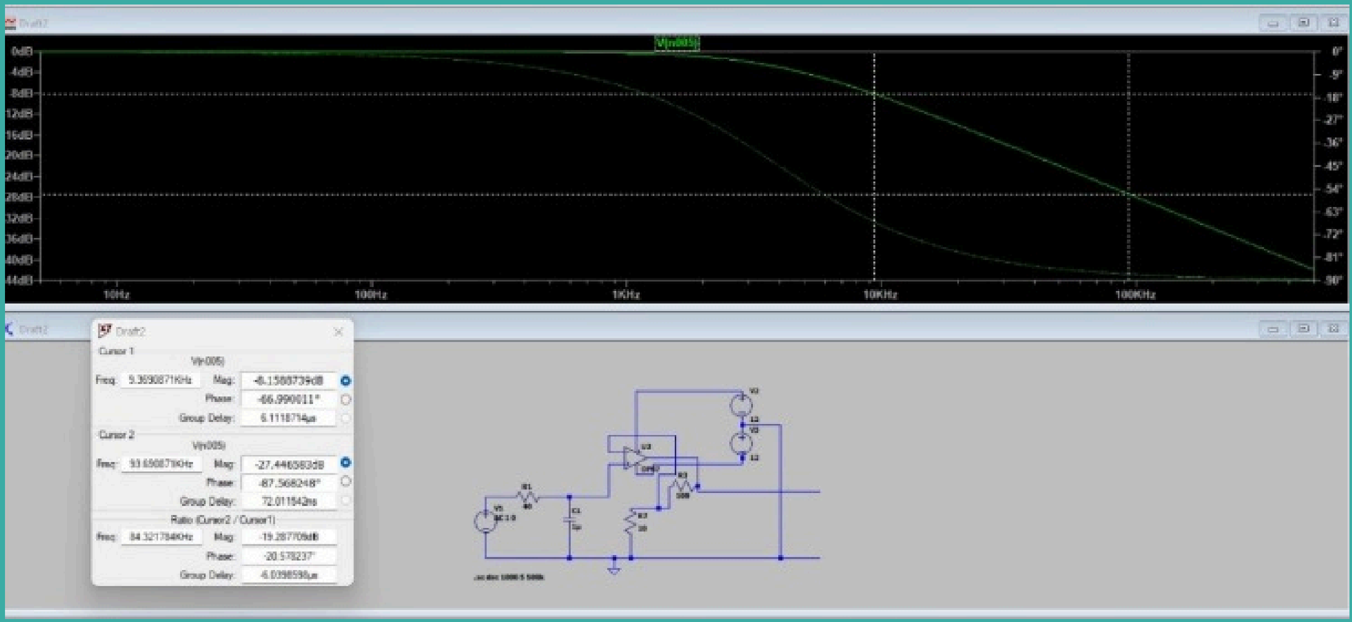
1st order lpf



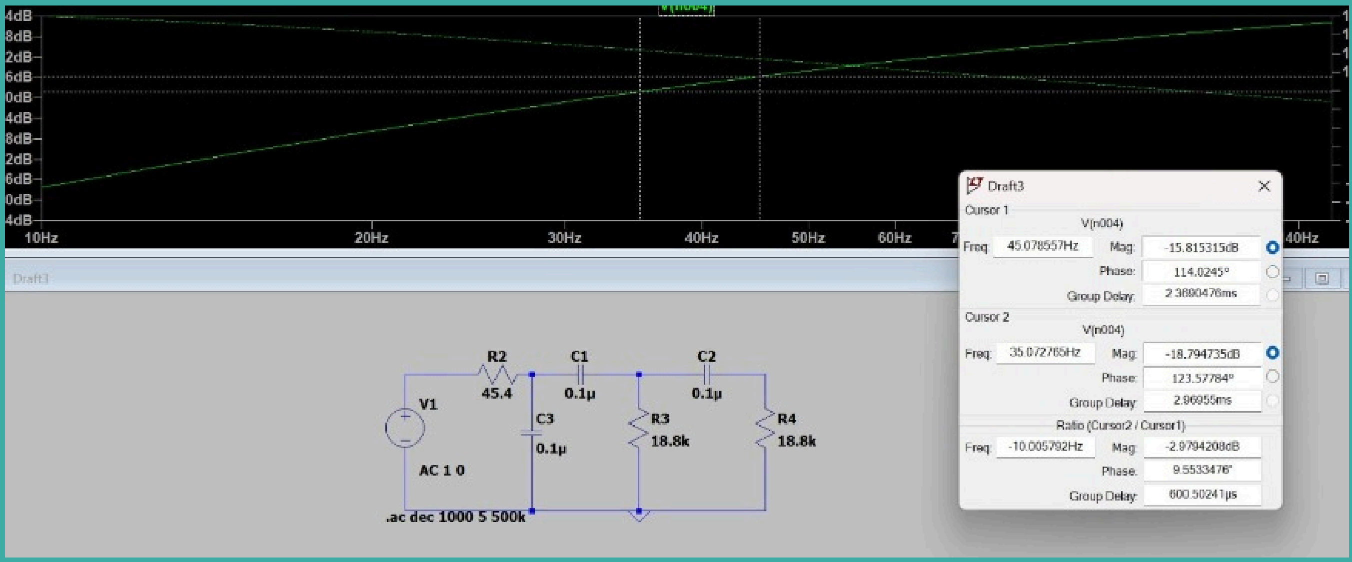
lpf 2nd order



bpf 1st order



bpf 2nd order



Conclusions:

An essential device in electronics is a low pass filter, which attenuates higher frequencies while allowing signals below a particular threshold to flow through. It is indispensable in a wide range of applications due to its capacity to filter out undesirable noise and high-frequency components. Low-pass filters are a key element in a world where precise signal handling is necessary.

A frequency selective filter circuit called an active band pass filter is used in electronic systems to distinguish between signals at a single frequency or a range of frequencies that fall within a defined "band" from signals at all other frequencies.This band or frequency range is situated between two corner or cutoff frequencies known as the "lower