LAB Experiment 1
FILTERS

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1 Aim

Design the lowpass ,highpass ,bandpass filters with the given cutoff frequencies $f_{cH} = 30Hz$ and $f_{cL} = 25,000Hz$, using resistors and capacitors and examine them using NGspice

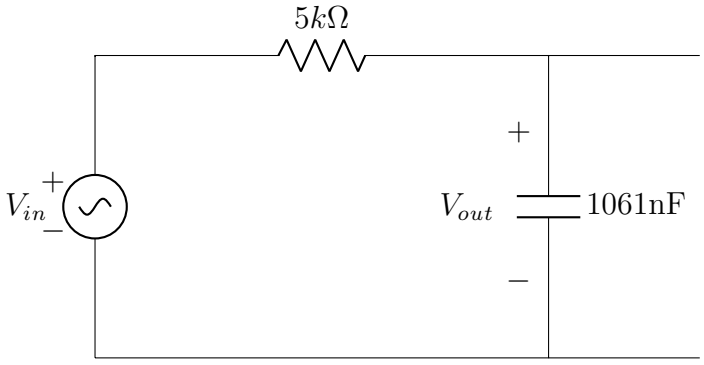
2 Procedure

2.1 Low pass filter

→ Given cutoff frequency , $f_{cH} = 30Hz$
→ Choosing the resistance as $5k\Omega$ and finding the capacitance by the formula

$$f_{cH} = \frac{1}{2\pi RC} = 30Hz$$

→ We get the value of C as 1061nF
→ Write a NGspice script using these values for the low pass filter and plot the output gain in dB

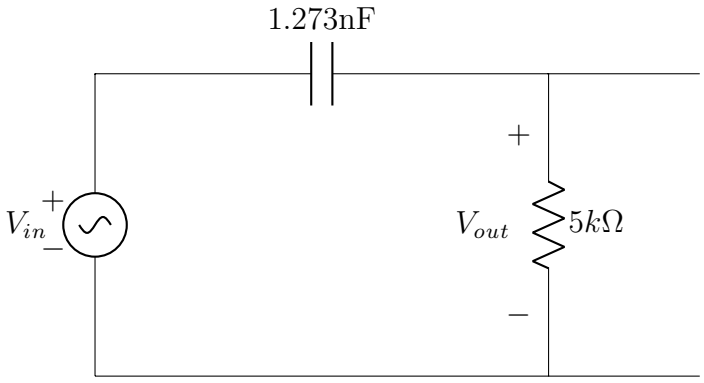


2.2 High pass filter

→ Given cutoff frequency , $f_{cL} = 25,000Hz$
→ Choosing the resistance as $5k\Omega$ and finding the capacitance by the formula

$$f_{cL} = \frac{1}{2\pi RC} = 25,000Hz$$

→ We get the value of C as 1.273nF
→ Write a NGspice script using these values for the high pass filter and plot the output gain in dB

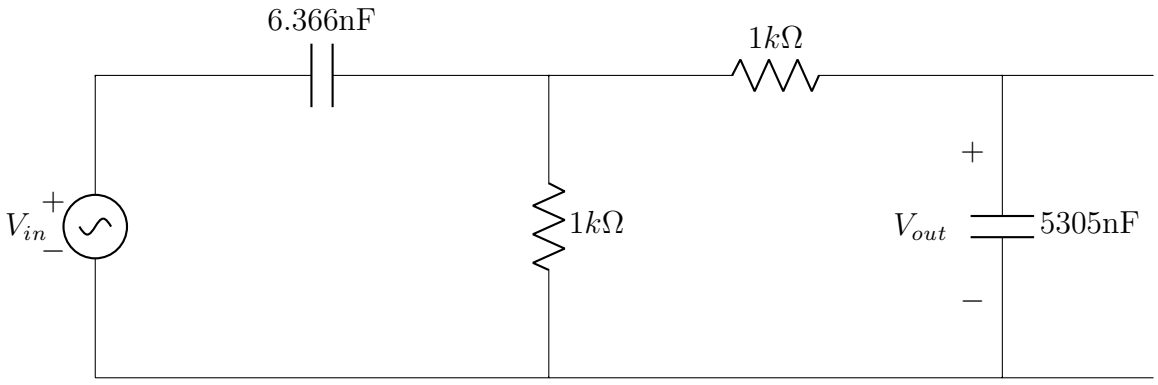


2.3 band pass filter

→ Given cutoff frequencies , f_{cL} = 25,000Hz and f_{cH} = 30Hz
→ Choosing the resistances as $R_1 = R_2 = 1k\Omega$ and finding the capacitances by the formulae

$$f_{cL} = \frac{1}{2\pi R_1 C_1} = 25,000Hz \text{ and } f_{cH} = \frac{1}{2\pi R_2 C_2} = 30Hz$$

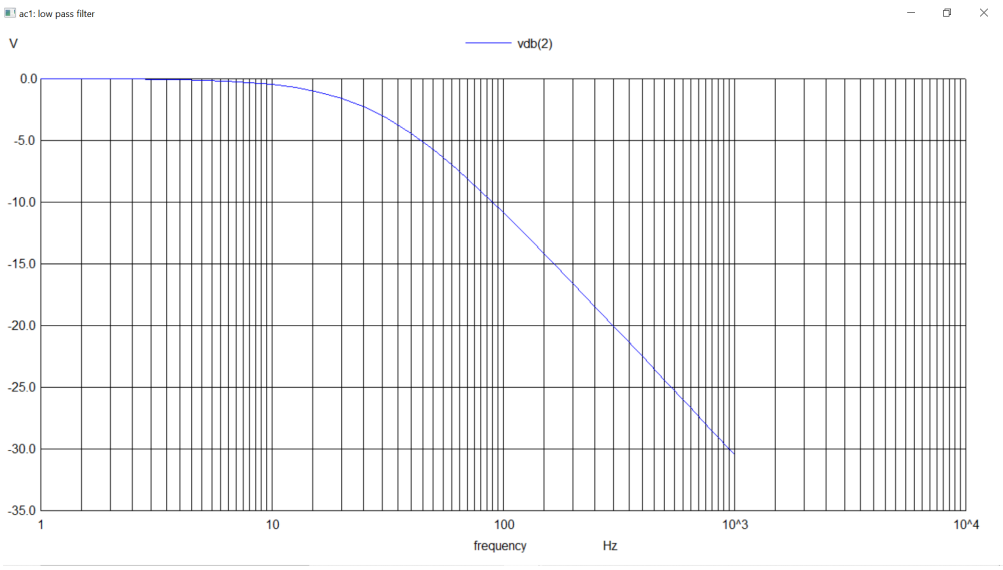
→ We get the values as C_1 = 6.366nF and C_2 = 5305nF
→ Write a NGspice script using these values for the band pass filter and plot the output gain in dB



3 Results

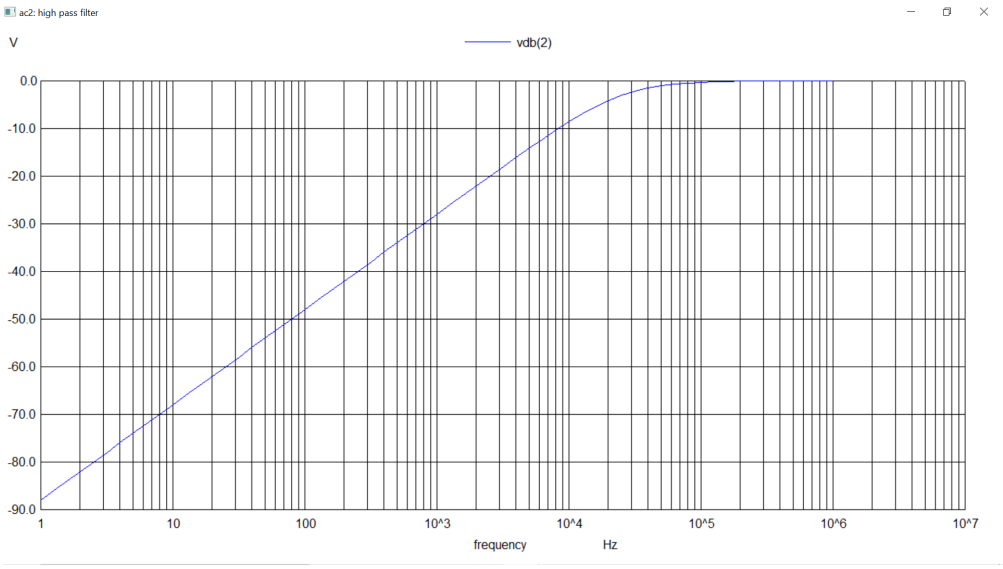
3.1 Low pass Filter

We can see in the below figure that all the frequencies greater than $f_{cH} = 30Hz$ are not allowed to pass



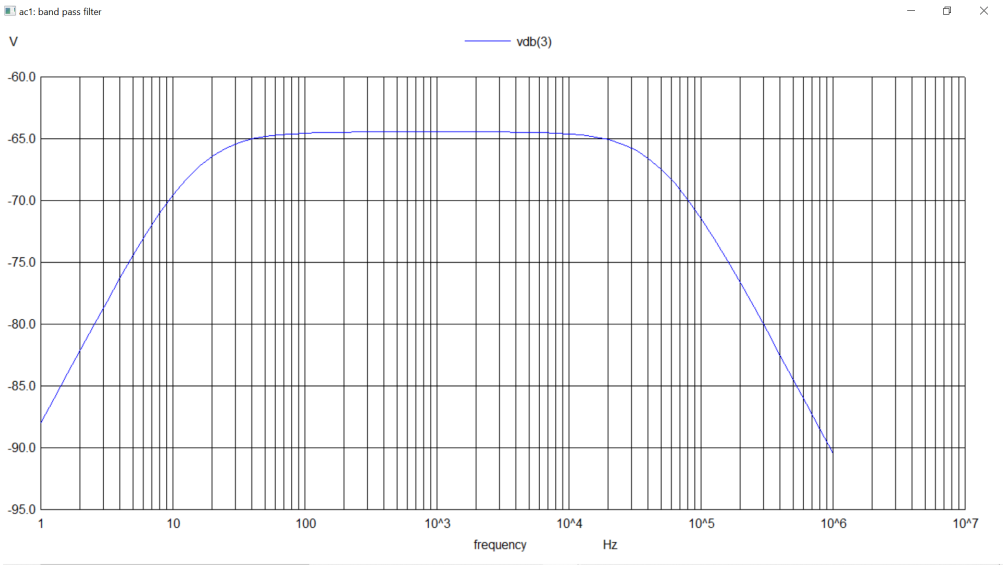
3.2 High pass Filter

We can see in the below figure that all the frequencies lower than $f_{cL} = 25,000Hz$ are not allowed to pass



3.3 Band pass Filter

Theoretically, a band pass filter only allows the frequencies between the given cutoff frquencies to pass.
But according to the given data, $f_{cH} = 30Hz$ and $f_{cL} = 25,000Hz$, since $f_{cH} < f_{cL}$ the gain is not zero but close to -64dB.
So this is not a band pass filter



4 Understanding

We know that the Voltage gain in dB is given by the formula

$$Gain = 20log\left(\frac{V_o}{V_{in}}\right)$$

For low pass filter, all the frequencies below the cutoff frequency have $V_o = V_{in}$, Hence the the gain is zero.
As the frequency increases, the V_o tends to zero and the gain decreases to $-\infty$ and they are not allowed to pass
We can also see that at cutoff frequency the gain is -3dB.
Similarly we can analyze for the other filters.

5 Conclusion

- Low pass filter only allows the frequencies below the cutoff frequency
- High pass filter only allows the frequencies above the cutoff frequency
- Band pass filter only allows the frequencies between the cutoff frequencies

Since these are not ideal filters the frequencies are gradually not allowed, so the the plot is not a perfect rectangle.