BIRZEIT UNIVERSITY

Faculty of Engineering & Technology Electrical & Computer Engineering Department

ENEE2103

CIRCUITS AND ELECTRONICS LABORATORY

Prelab II

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Section : 2

Instructor : Dr. Mohammad Al Ju'beh

Teacher Assistant : Eng. Bilal Ismail

Date :8.5.2023

Part 1: Passive filters:

I. First order circuits:

1. To Use Ac Sweep Analysis:

Frow Analysis Setup —> AC Sweep —> AC Sweep Type(Decade) —>Sweep Parameters(Start Freq:1Hz,End Freq:1MHz)

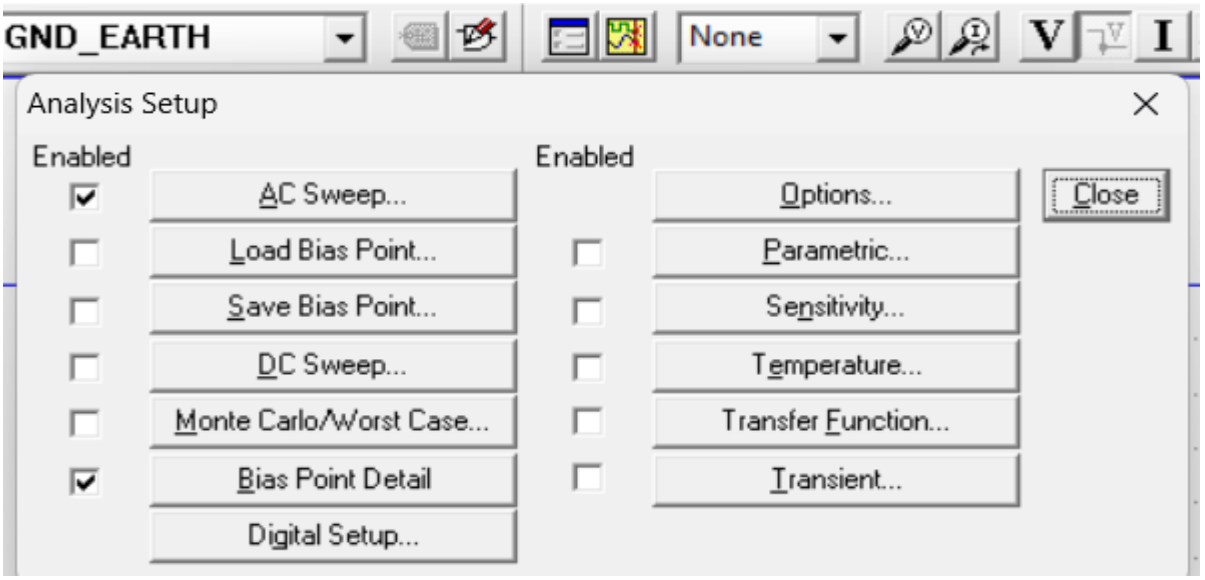


Figure 1-1:AC Sweep

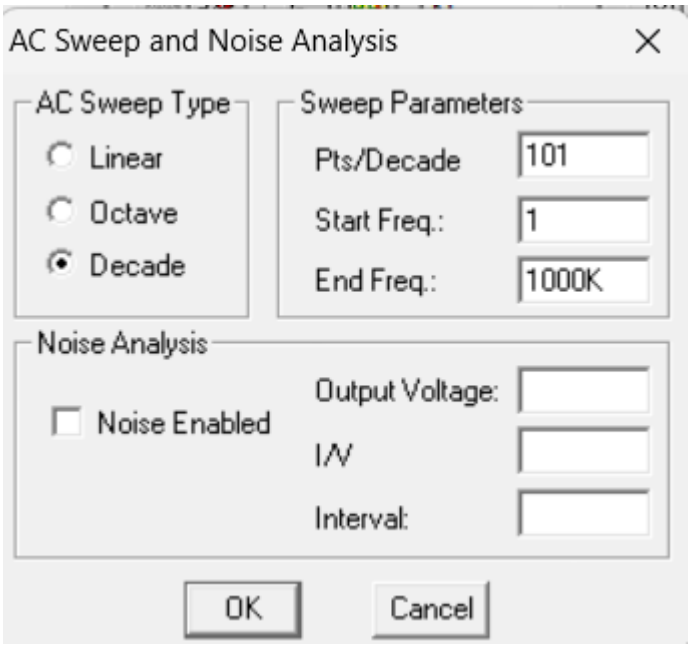


Figure 1-2: Sweep Parameters

2. The decibel values for the magnitudes of VR1 and VC1 are:

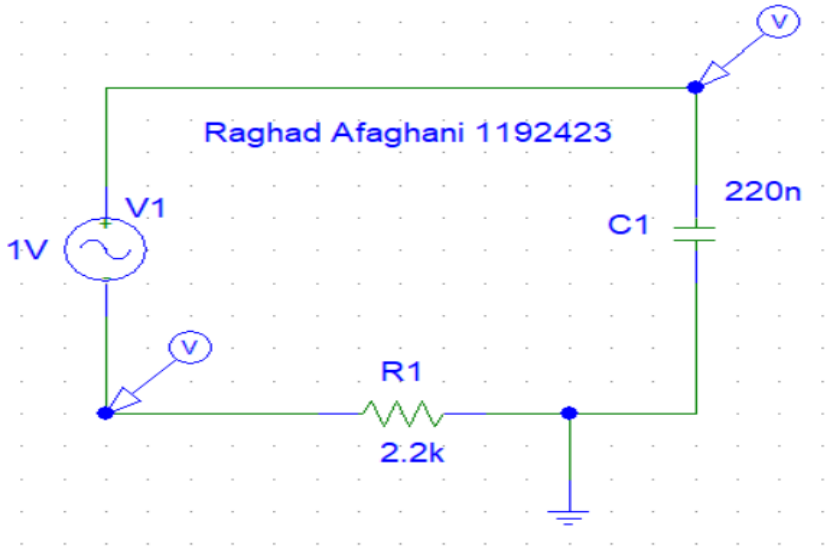
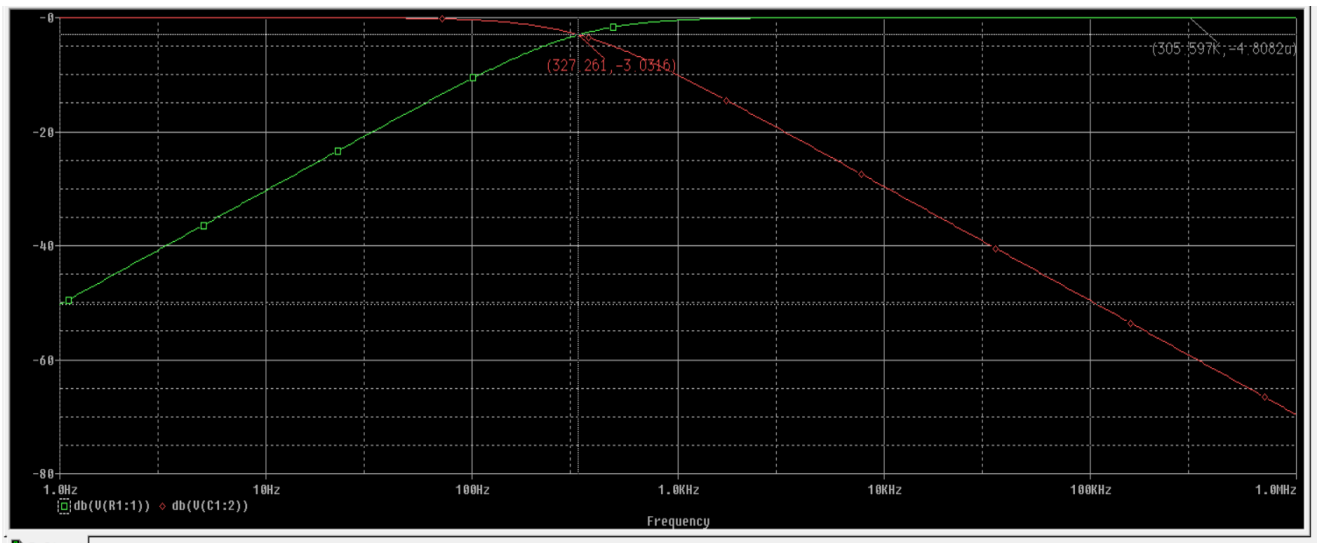


Figure 1-3: First Order Filter in Pspice, part 1

Theoretically:

- $f_C = \frac{1}{2\pi RC} = \frac{1}{2\pi(2.2k)\,(220nF)} = 328.7002254\ Hz.$
- $\varphi_C = \varphi_R = -\tan^{-1} 2\pi\, f\, R\, C = -\tan^{-1} 2\pi\,(328.7002254)\,(2.2k)\,(220n) = -\tan^{-1} 1 = -45°.$



Based on the graph, the following experimental values can be determined:

- $f_C = 327.261$ Hz
- $\varphi_c = \varphi_R = -\tan^{-1}(2\pi fRC) = -\tan^{-1}(2\pi(327.261)(2.2k)(220n)) = -\tan^{-1}(0.995621465) =$ -44.8742892°.

3.The Phase of V_R and V_C in degrees:

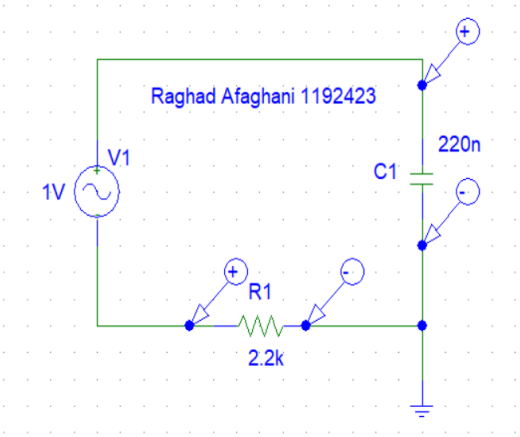
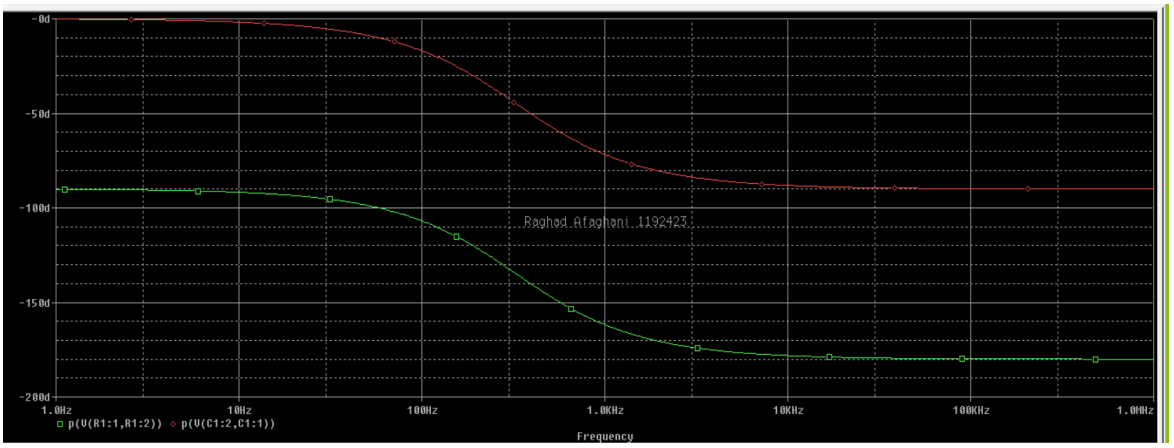


Figure 1-4: First Order Filter in Pspice, part 2



II.Second Order Filters:

Theoretically:

• $f_C = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi\sqrt{(100m)(470n)}} = 733.8316428$ Hz.

• $f_{C1} = \frac{1}{2\pi}\sqrt{(\frac{R}{2L})^2 + \frac{1}{LC}} - \frac{R}{2L}) = \frac{1}{2\pi}(\sqrt{5000^2 + \frac{1}{(100m)(470n)}} - 5000) =$ 286.79 Hz.

• $f_{C2} = \frac{1}{2\pi}(\sqrt{(\frac{R}{2L})^2 + \frac{1}{LC}} + \frac{R}{2L}) = \frac{1}{2\pi}(\sqrt{5000^2 + \frac{1}{(100m)(470n)}} + 5000) =$ 1877.7 Hz.

❖ The decibel values for the magnitudes of VR and (VC+VL) are:

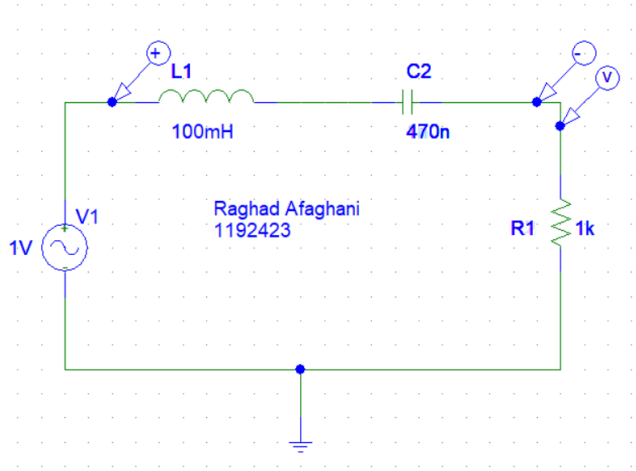
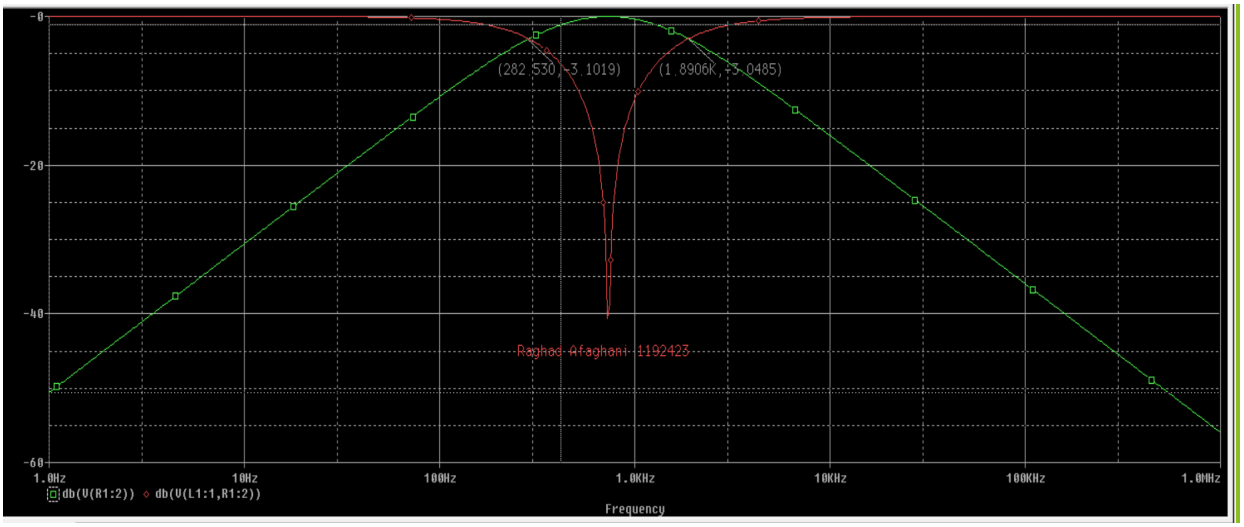
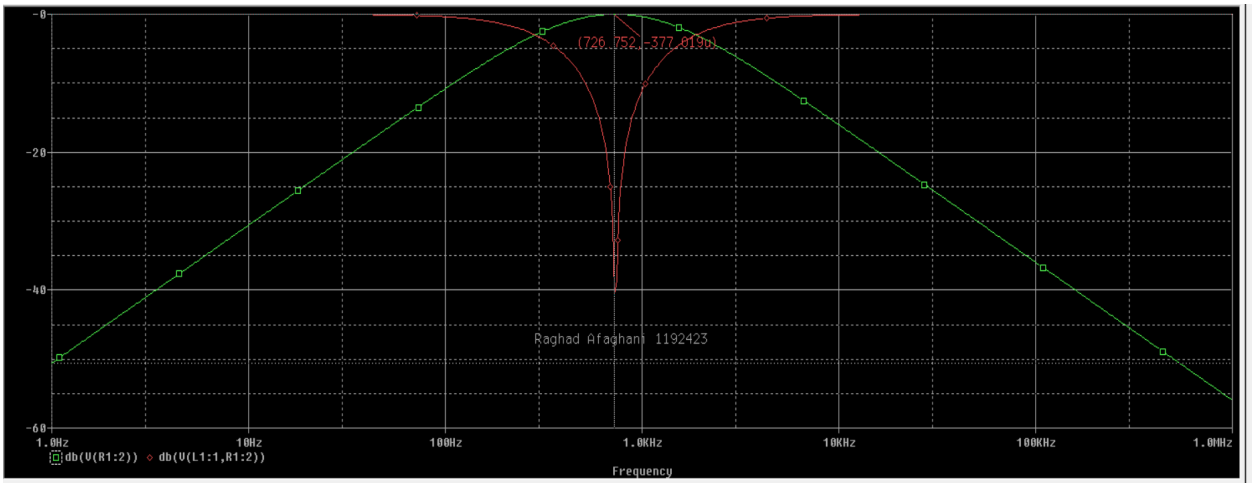
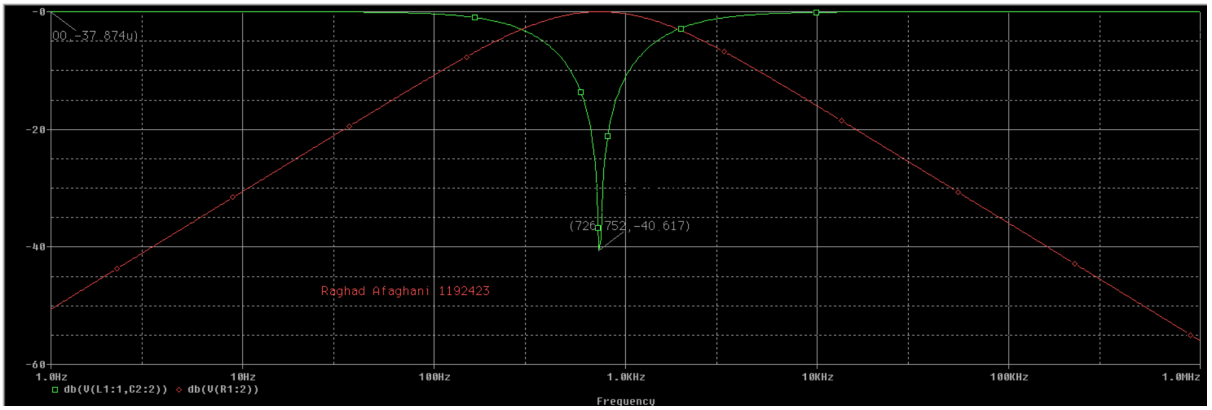


Figure 1-5: Second Order Filter in Pspice, part 1







Based on the graphs, the following information can be inferred:
The magnitude of (VC+VL) is approximately -37.874u dB and its center frequency is around 730.853 Hz. The filter has two cutoff frequencies, fc1 at approximately 282.530 Hz and fc2 at approximately 1.8906 kHz. This indicates that it is a Band Pass Filter (BPF).
The magnitude of VR is approximately −377.019u dB and its center frequency is around 726.752 Hz. The filter also has two cutoff frequencies, fc1 at approximately 282.530 Hz and fc2 at approximately 1.8906 kHz. This indicates that it is a Band rejection Filter.

- The phase values of VR and (VC+VL) are:

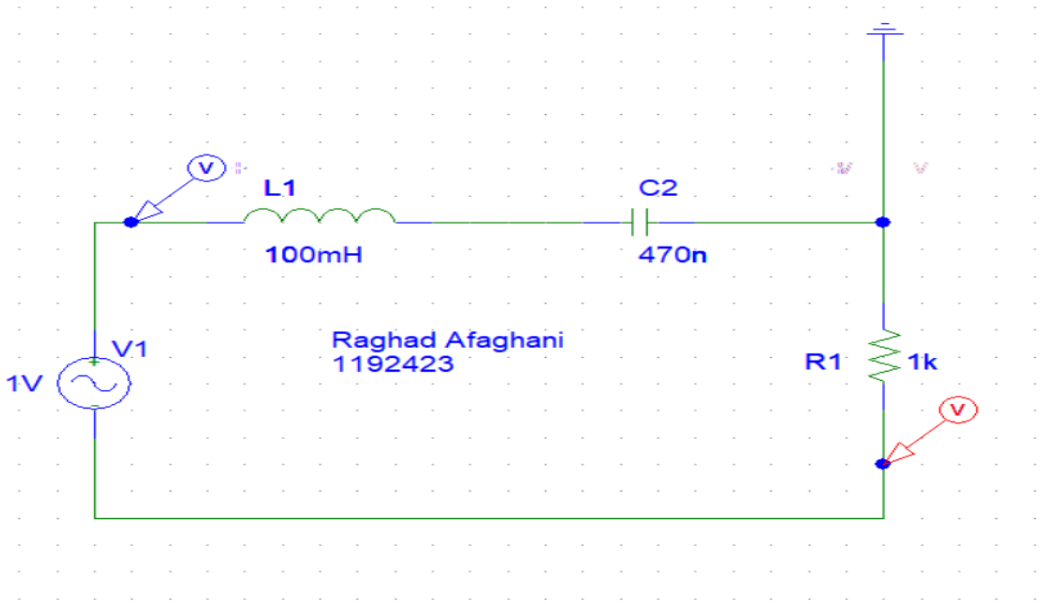
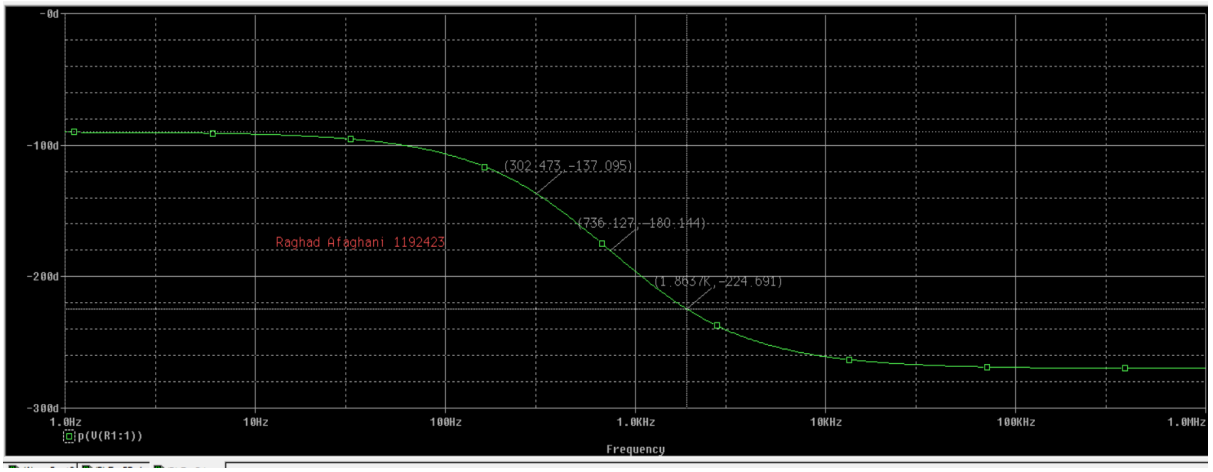
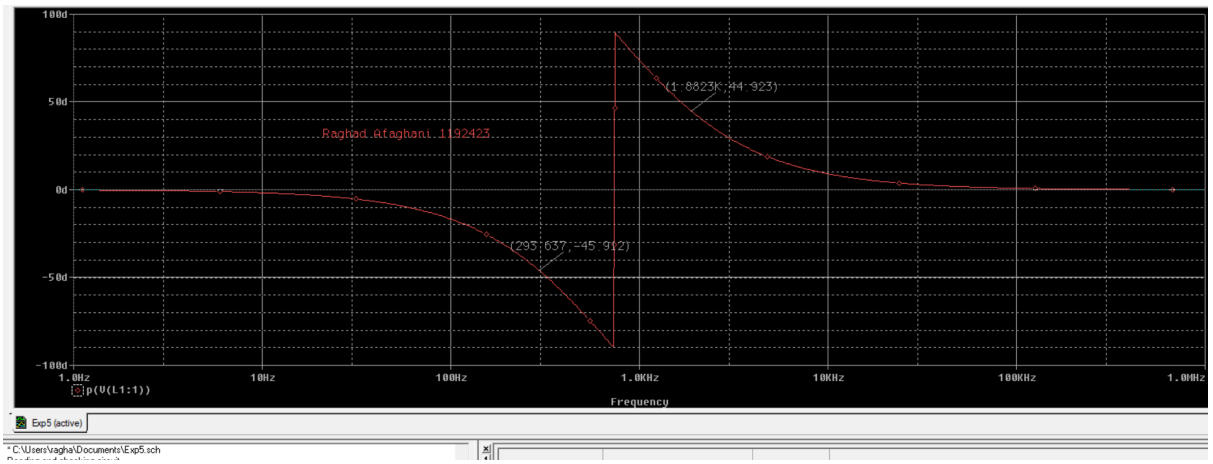


Figure 1-6: Second Order Filter in Pspice, part 2

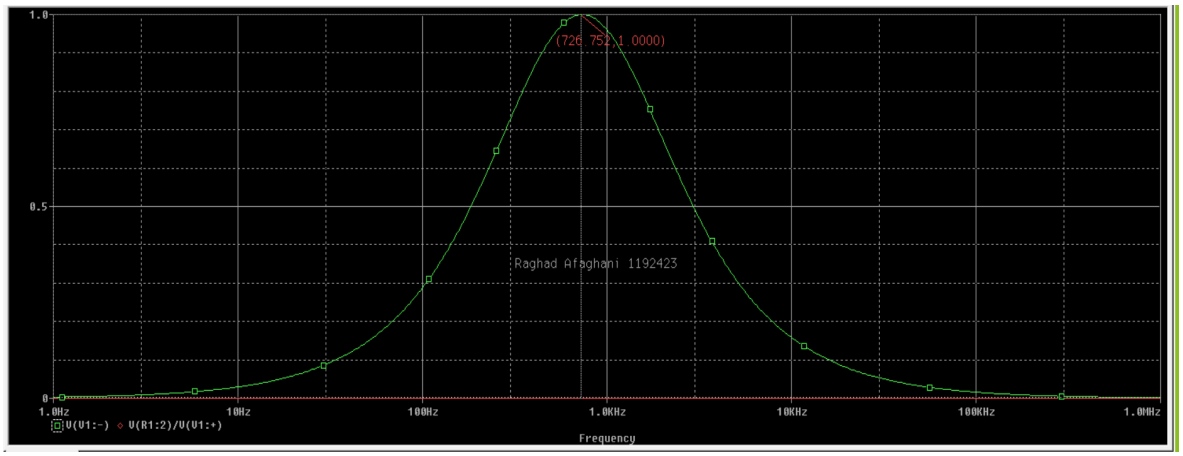




Based on the graph:

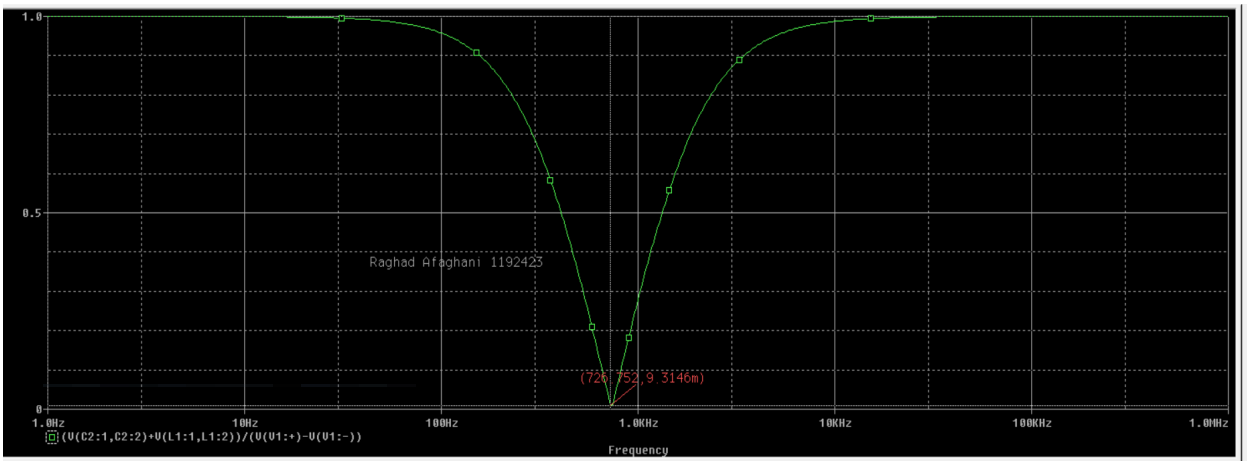
- $\varphi_C = -\tan^{-1}\left(\frac{\frac{1}{LC}-(2\pi f_C)^2}{\frac{2\pi f_C R}{L}}\right) = -\tan^{-1}\left(\frac{\frac{1}{(100m)(470n)}-(2\pi(736.127))^2}{(\frac{2\pi(736.127)(1k)}{100m})}\right) = 0°.$
- $\varphi_{C1} = -\tan^{-1}\left(\frac{\frac{1}{LC}-(2\pi f_{C1})^2}{\frac{2\pi f_{C1} R}{L}}\right) = -\tan^{-1}\left(\frac{\frac{1}{(100m)(470n)}-(2\pi(302.473))^2}{(\frac{2\pi(302.473)(1k)}{100m})}\right) = -45°.$
- $\varphi_{C2} = -\tan^{-1}\left(\frac{\frac{1}{LC}-(2\pi f_{C2})^2}{\frac{2\pi f_{C2} R}{L}}\right) = -\tan^{-1}\left(\frac{\frac{1}{(100m)(470n)}-(2\pi(1.8637k))^2}{(\frac{2\pi(1.8637k)(1k)}{100m})}\right) = 45°.$
- φ_C = -180.144° ≡0°
- φ_{C1} = -137.01° ≡ 43°.
- φ_{C2} = -224.691° ≡− 45°.
- φ_{C1} = -45.9112.
- φ_{C2} = 44.923°.

❖ **Plot of $\frac{VR}{Vi}$**



The filter shown above is a bandpass filter

❖ **Plot of $\frac{(VC + VL)}{Vi}$**



The filter shown above is a band-reject filter

❖ **The 3db cut-off frequency:**

F1=Fl= $(-\frac{R}{2L} + \sqrt{(\frac{R}{2L})\text{^}p + \frac{1}{LC}}) * \frac{1}{2\pi}$

F1=Fh= $(\frac{R}{2L} + \sqrt{(\frac{R}{2L})\text{^}p + \frac{1}{LC}}) * \frac{1}{2\pi}$

Knowing that R=1k, C=470nF, L=100mH.

⇒ f1= 286.9Hz
⇒ f2= 1878.46Hz= 1.88kHz

Part 2: Active filters:

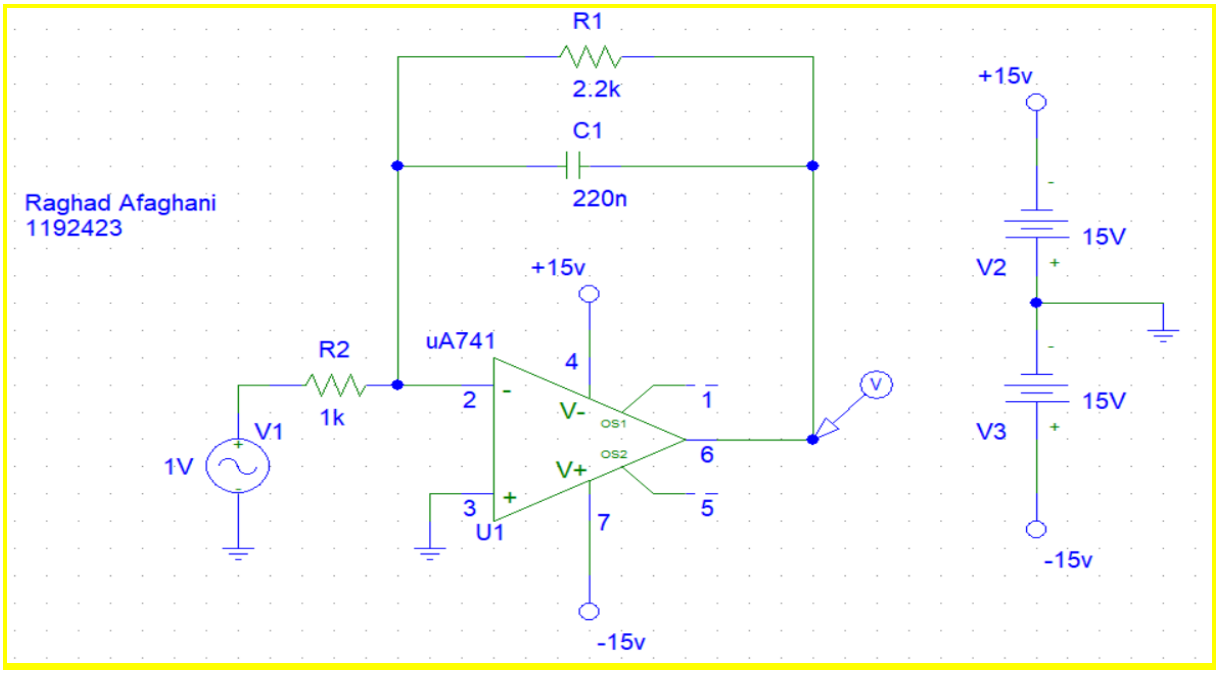


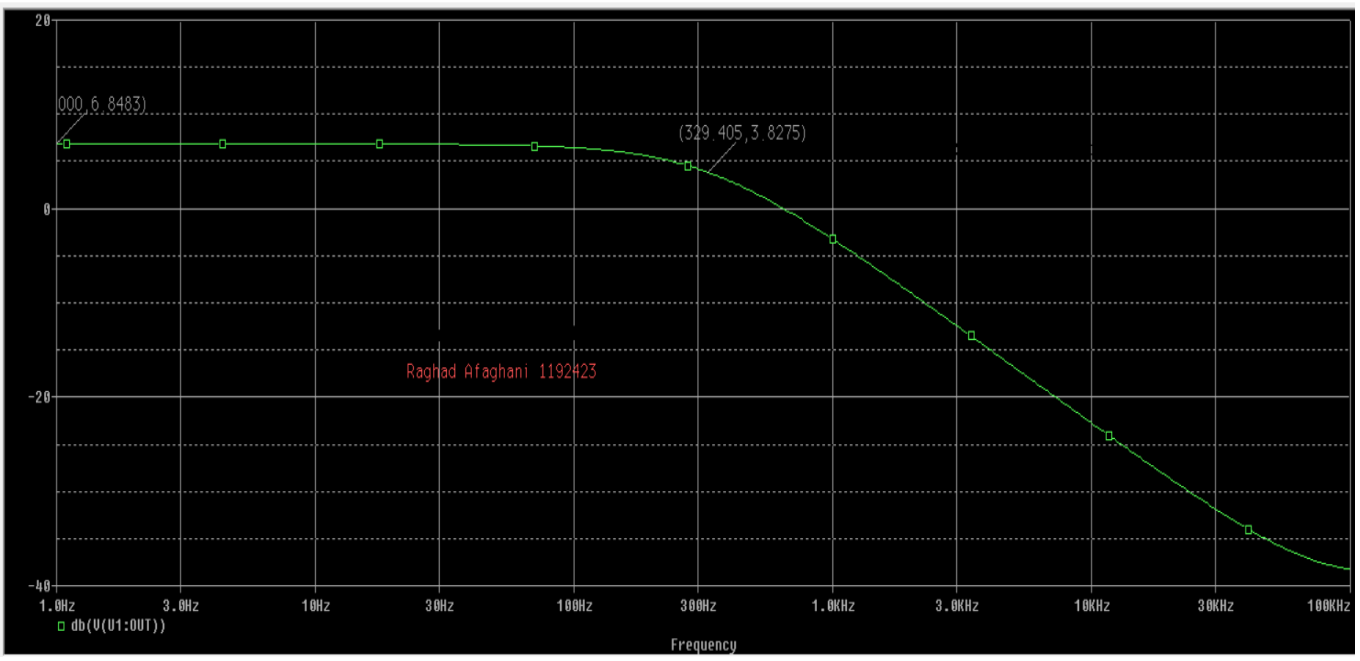
Figure 2-1: Active Filter in Pspice

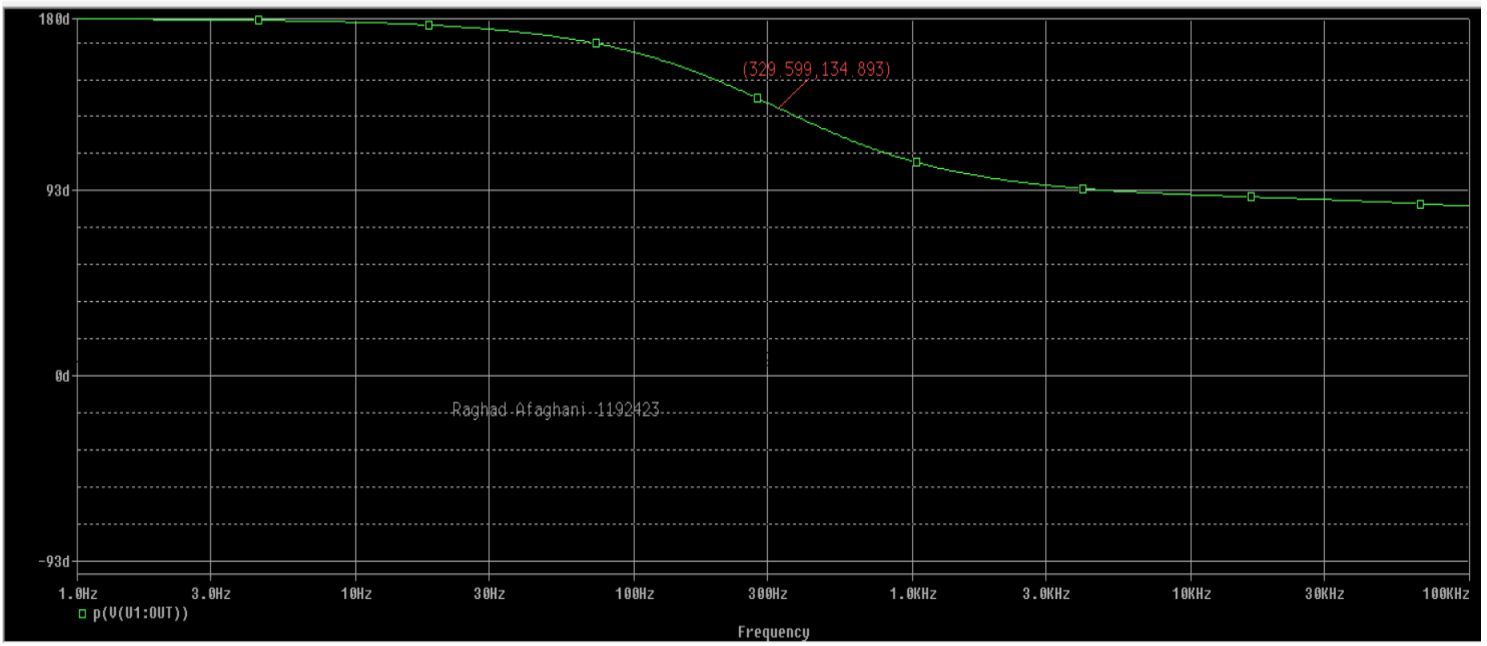
Theoretically:

- fc = $1/2\pi R1C = 1/(2\pi * (2.2k) * (220n)) = 328.99$ Hz
- Vo = $|\frac{Vo}{Vi}| = |\frac{-\frac{R1}{R2}Vi}{Vi}| = \frac{R1}{R2} = \frac{2.2k}{1k} = 2.2$ volt.

Then, 20 log (2.2) db = 6.84845 db.

- φc = $-\tan^{-1}(2\pi\ f\ R\ C) = -\tan^{-1} 2\ \pi\ (328.7002254)\ (2.2k)\ (220n) = -\tan^{-1} 1 = -45°$.





Experimentally:

- The *magnitude* of *vo*= 6.8483 *db*
- *When v* = (6.8483 − 3) *db* ≈ 3.8483 *db*,
- *fc* ≅ 329.599 *HZ.*
- *φ when f=fc* = 134.893 *degrees* ≈ 135 *degrees* = −45 *in* tan *φ*
- **the filter is a low pass filter.**