

EXPERIMENT 4

NISARG UPADHYAYA
19CS30031 Nisarg..

ACTIVE LOW PASS FILTERS

AIM

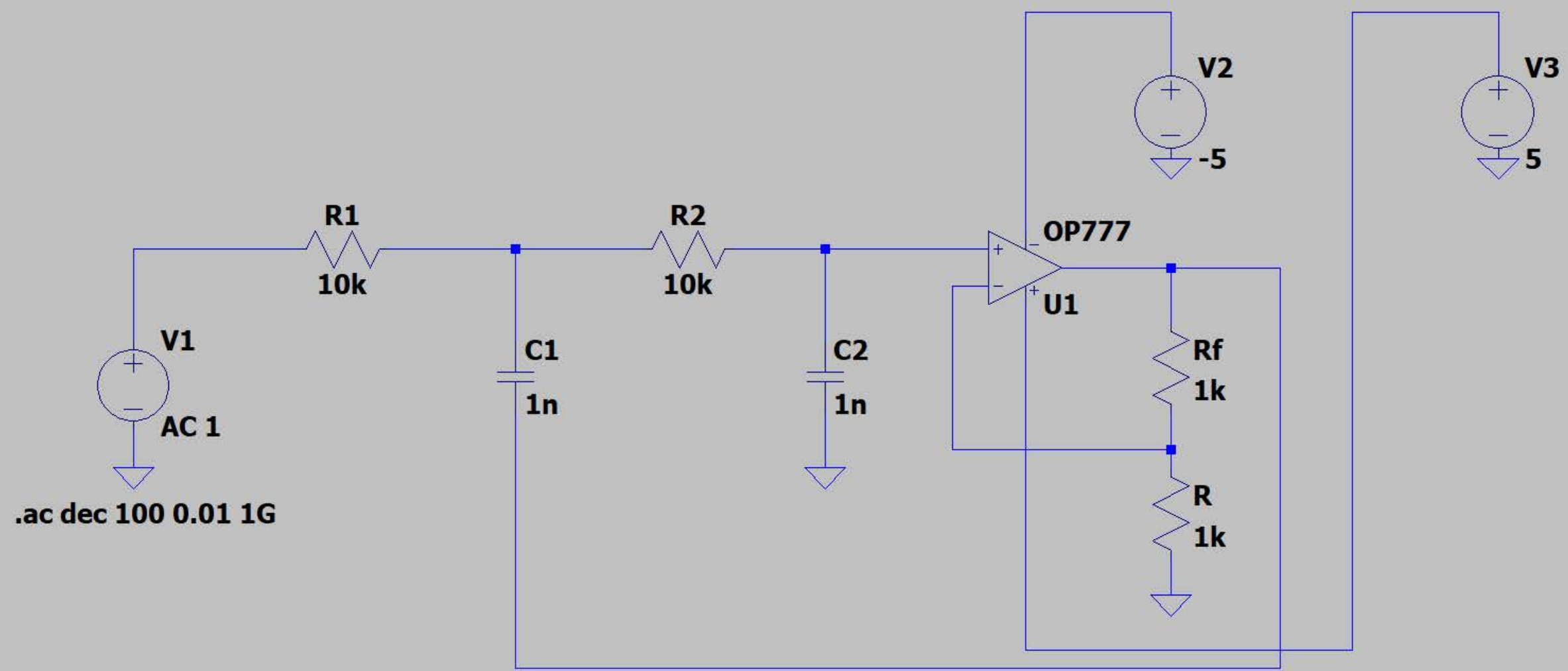
To familiarize with 2nd order Sallen Key active low pass filters and to measure their frequency responses.

REPORT

① LT Spice Circuit Diagram

Attached below.

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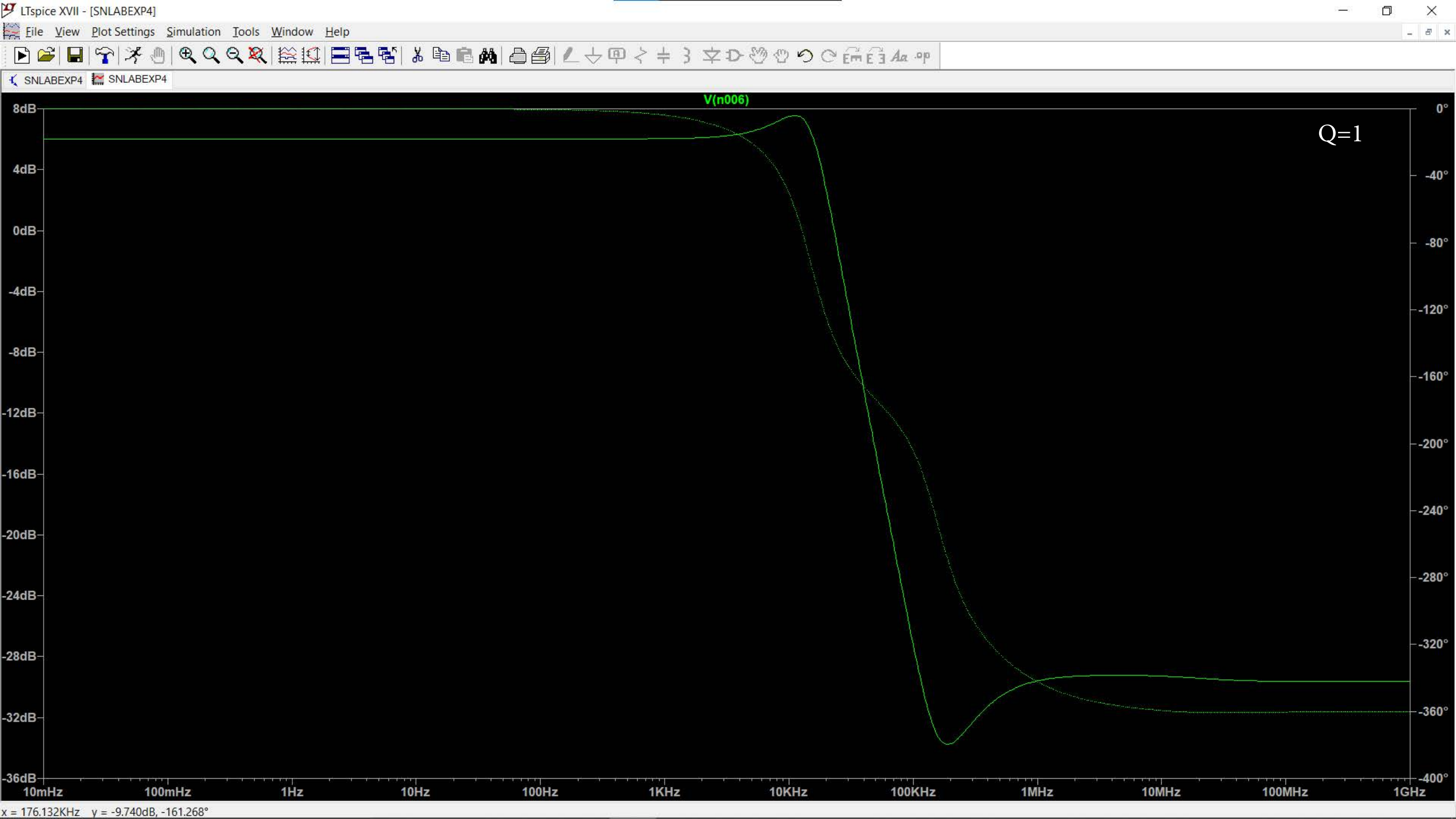
$$\textcircled{2} \quad R_1 = R_2 = 10 \text{ k}\Omega, \quad C_1 = C_2 = 1 \text{ nF}, \quad Q = 1$$

$$\Rightarrow Q = \frac{1}{3-K} = 1 \Rightarrow K=2 \Rightarrow 1 + \frac{R_f}{R} = 2 \Rightarrow \frac{R_f}{R} = 1$$

Hence, we can choose $R = R_f = 1 \text{ k}\Omega$.

$$\Rightarrow f_c = \frac{1}{2\pi\sqrt{C_1 C_2 R_1 R_2}} \text{ Hz} = \frac{1}{2\pi \times 10^{-4} \times 10^{-9}} \text{ Hz} = \frac{10^5}{2\pi} \text{ Hz} = 15915 \text{ Hz}$$

Experimentally the peak in gain is obtained around 11.3 kHz. The peak is not very sharp though owing to the low Q-factor. The transition is not very sharp.



$$\textcircled{3} \quad Q = 1.5, 2.5$$

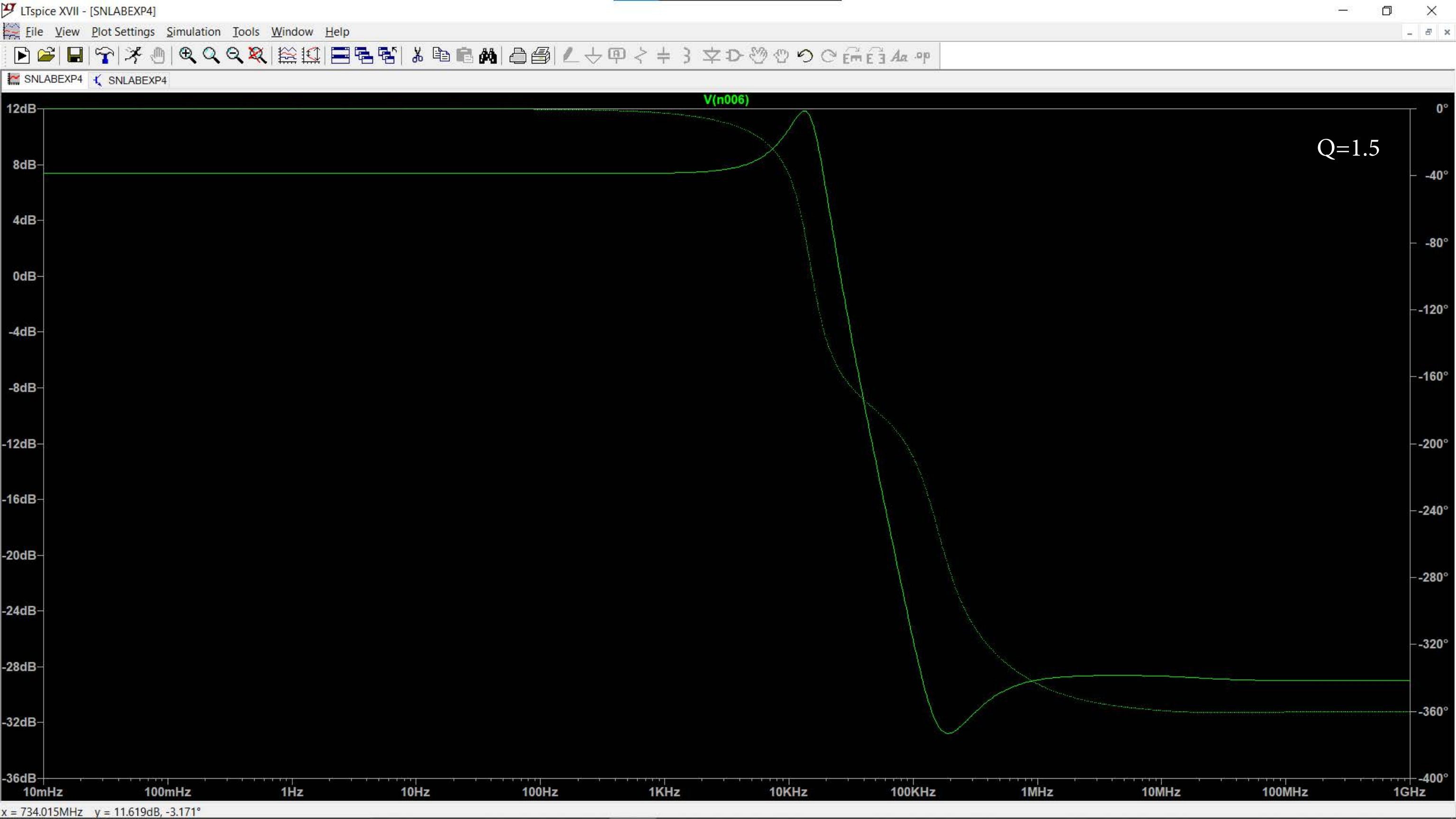
$$\Rightarrow Q = \frac{1}{3-K} = \frac{3}{2} \Rightarrow K = \frac{7}{3} \Rightarrow 1 + \frac{R_f}{R} = \frac{7}{3} \Rightarrow \frac{R_f}{R} = \frac{4}{3}$$

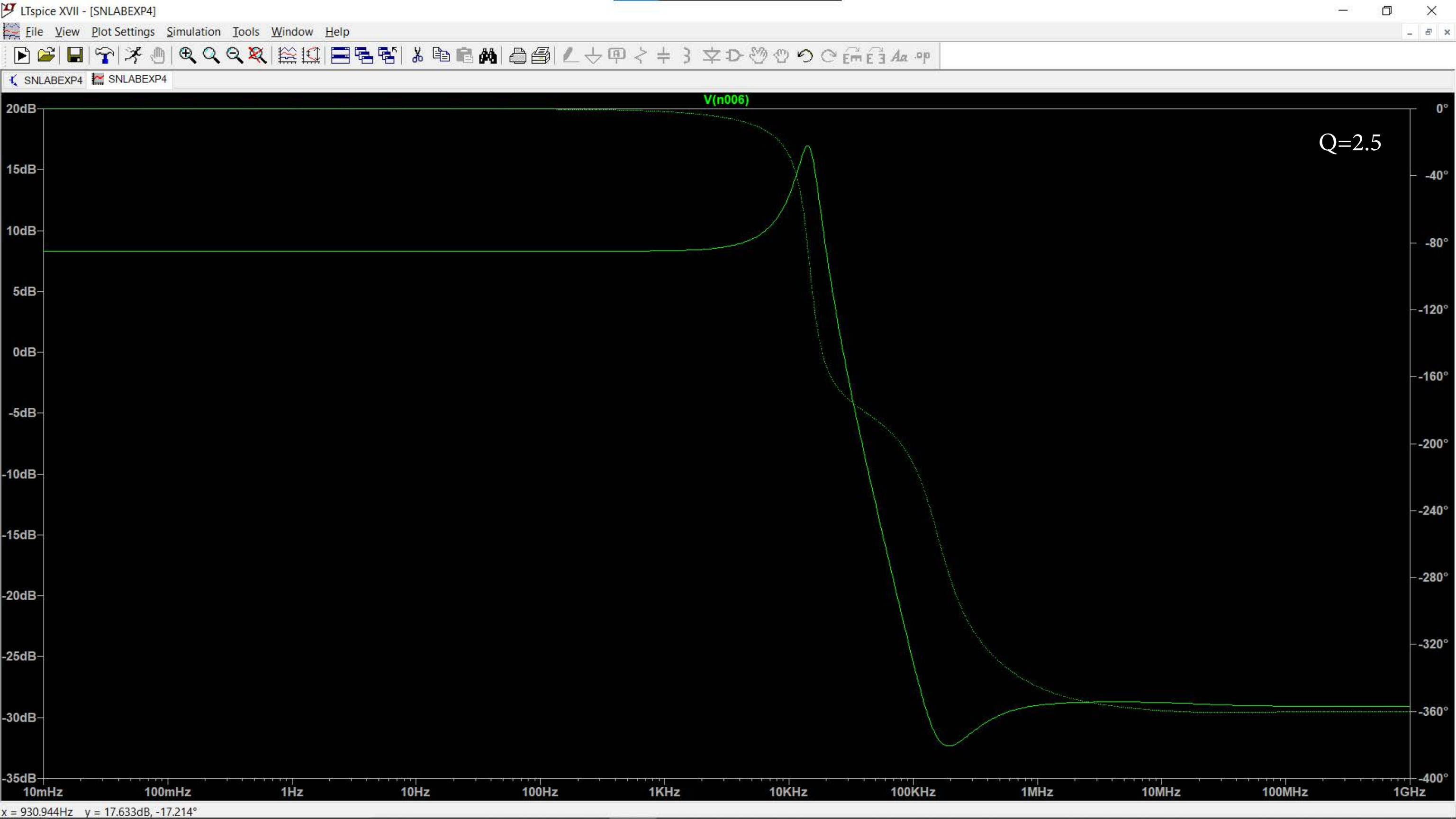
Hence, we can choose $R_f = 2k\Omega$ and $R = 1.5k\Omega$

$$\Rightarrow Q = \frac{1}{3-K} = \frac{5}{2} \Rightarrow K = \frac{13}{5} \Rightarrow 1 + \frac{R_f}{R} = \frac{13}{5} \Rightarrow \frac{R_f}{R} = \frac{8}{5}$$

Hence, we can choose $R_f = 2k\Omega$ and $R = 1.25k\Omega$.

As expected, when we increase the Q -factor the sharpness of the peak increases. The filter now offers a much sharper transition. The peak in gain now occurs around a frequency of $14.5kHz$. Also the initial fall (roll off) after the peak is much steeper than for $Q=1$. Thus this offers a comparatively higher selectivity.





$$(4) \quad R_1 = R_2 = 10 \text{ k}\Omega, \quad C_1 = C_2 = 1 \mu\text{F}, \quad Q = 2.5$$

$$\Rightarrow Q = \frac{1}{3-K} = \frac{S}{2} \Rightarrow K = \frac{13}{S} \Rightarrow 1 + \frac{R_f}{R} = \frac{13}{S} \Rightarrow \frac{R_f}{R} = \frac{8}{S}$$

Hence we can choose $R_f = 2 \text{ k}\Omega$ and $R = 1.25 \text{ k}\Omega$.

$$\Rightarrow f_c = \frac{1}{2\pi\sqrt{R_1 R_2 C_1 C_2}} = \frac{1}{2\pi RC} \text{ Hz} = \frac{1}{2\pi 10^{-3} 10^{-12}} \text{ Hz} = \frac{10^8}{2\pi} \text{ Hz} = 15915 \text{ kHz}$$

As expected even experimentally the cut off frequency shifts forward with a decrease in capacitance value. Experimentally the gain starts to drop around 150 kHz and reaches -3dB value at around 300 kHz. The low capacitance value which leads to a high impedance and parasitic effects at higher frequencies cause deviation from ideality.

