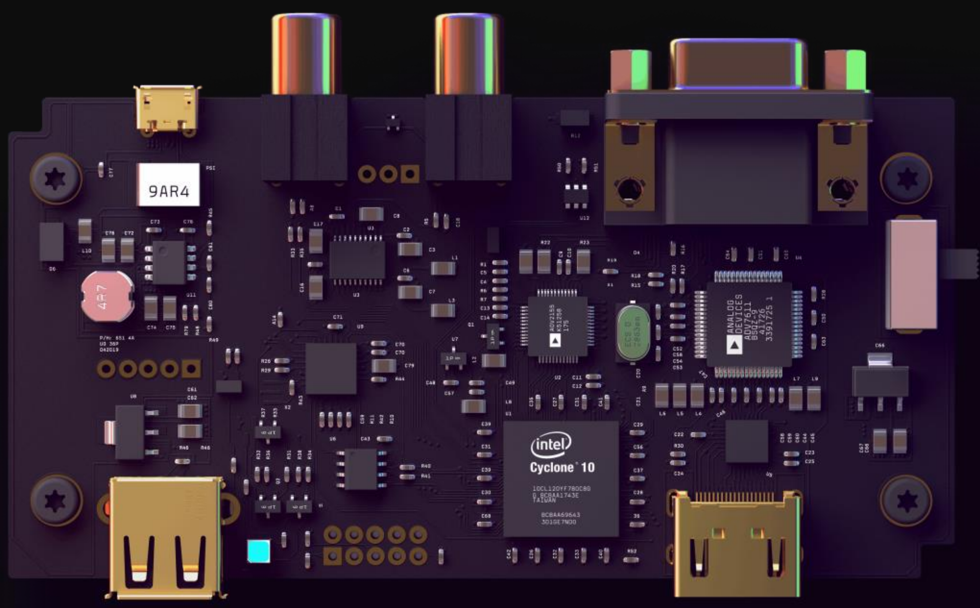
EC205

Analog Electronics Lab

Lab – 5



Utkarsh R Mahajan 201EC164

Sannan Ali 201EC159

Experiment 5: Effect of Negative Feedback

Aim: To study the effect of negative feedback on gain and bandwidth of the amplifier.

Background :

This experiment helps to analyse the effect of negative feedback on the gain and bandwith of a system. Here we will consider a forward amplifier with gain defined as $A = \frac{A_0}{1 + j(\omega/\omega_0)}$. It is a first order lowpass filter with DC gain $= A_0$ and 3-dB bandwidth $= \omega_0$ rad/sec. Assuming a feedback factor β, the block diagram of the closed loop system can be written as shown in Figure 1(a). Let us modify the Figure 1(a) to a form shown in Figure 1(b).

The block $\frac{1}{1 + j(\omega/\omega_0)}$ can be implemented by using a simple RC lowpass filter (as we did in Experiment 4). The dashed box in Figure 1(b) can be implemented using a OPAMP based difference amplifier, as shown in Figure 2. The output of the difference amplifier is

$$V_d(j\omega) = \frac{R_2}{R_1}\left[V_s(j\omega) - V_f(j\omega)\right]$$

Therefore, $A_0 = \frac{R_2}{R_1}$ and A_0 can be set by proper choice of R_2 & R_1. Note, how $V_s(j\omega)$ & $V_f(j\omega)$ are connected in the circuit.

For this experiment let us choose β =1. Ideally, this means we have to short $V_o(j\omega)$ to $V_f(j\omega)$. But, the difference amplifier may load the output. Therefore it will be wise to realize the β-network by a voltage buffer which can be easily implemented using μA741 OPAMP as shown in Figure 3.

Procedure:

Design the RC-filter for a cutoff frequency of 200 Hz (Design such that R Is of the order of kΩ)

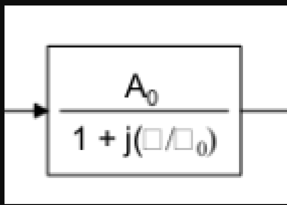
f_{Cutoff} = 200Hz = $\frac{1}{2\pi RC}$

Considering R =10kΩ,

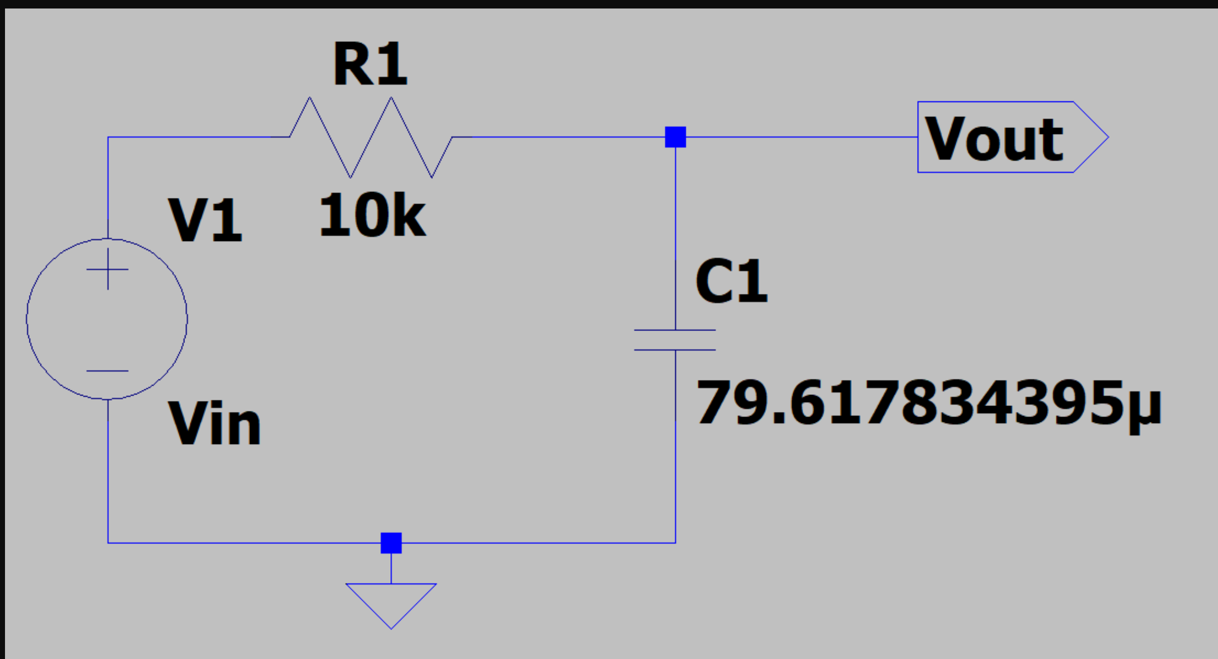
using the above formula for cutoff frequency,

we get, C=79.617834395μF

Circuit Diagram:

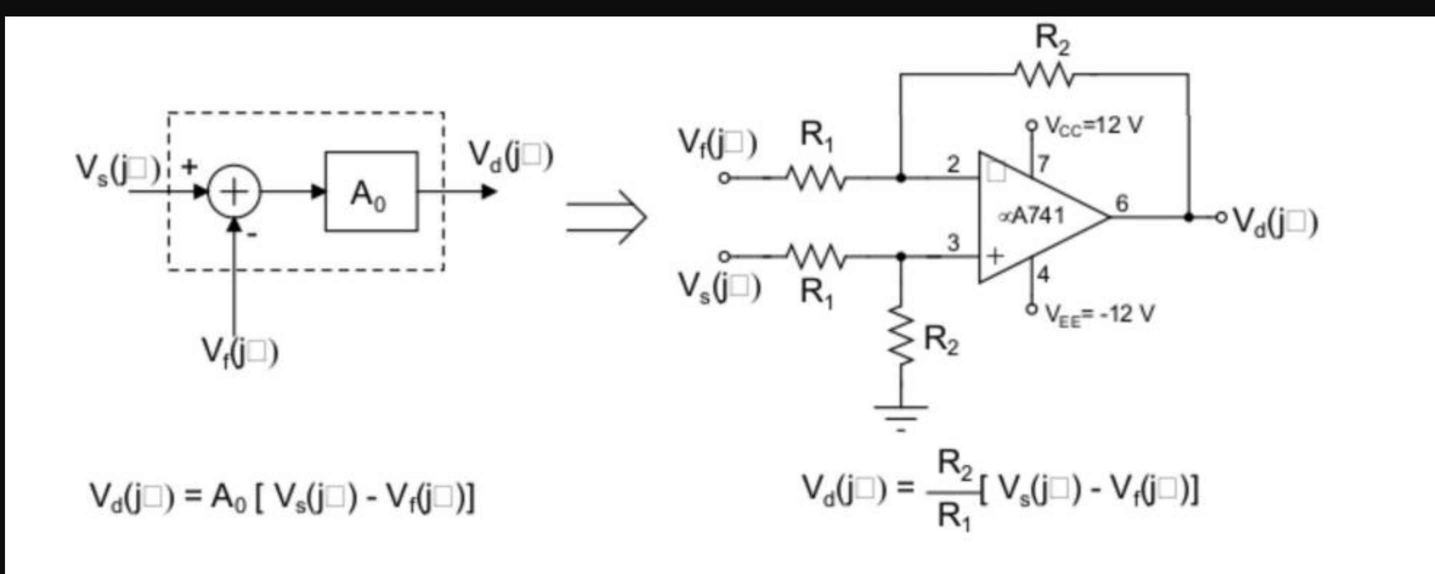


Circuit in LTSpice:



Design the difference amplifier for A_0=10.

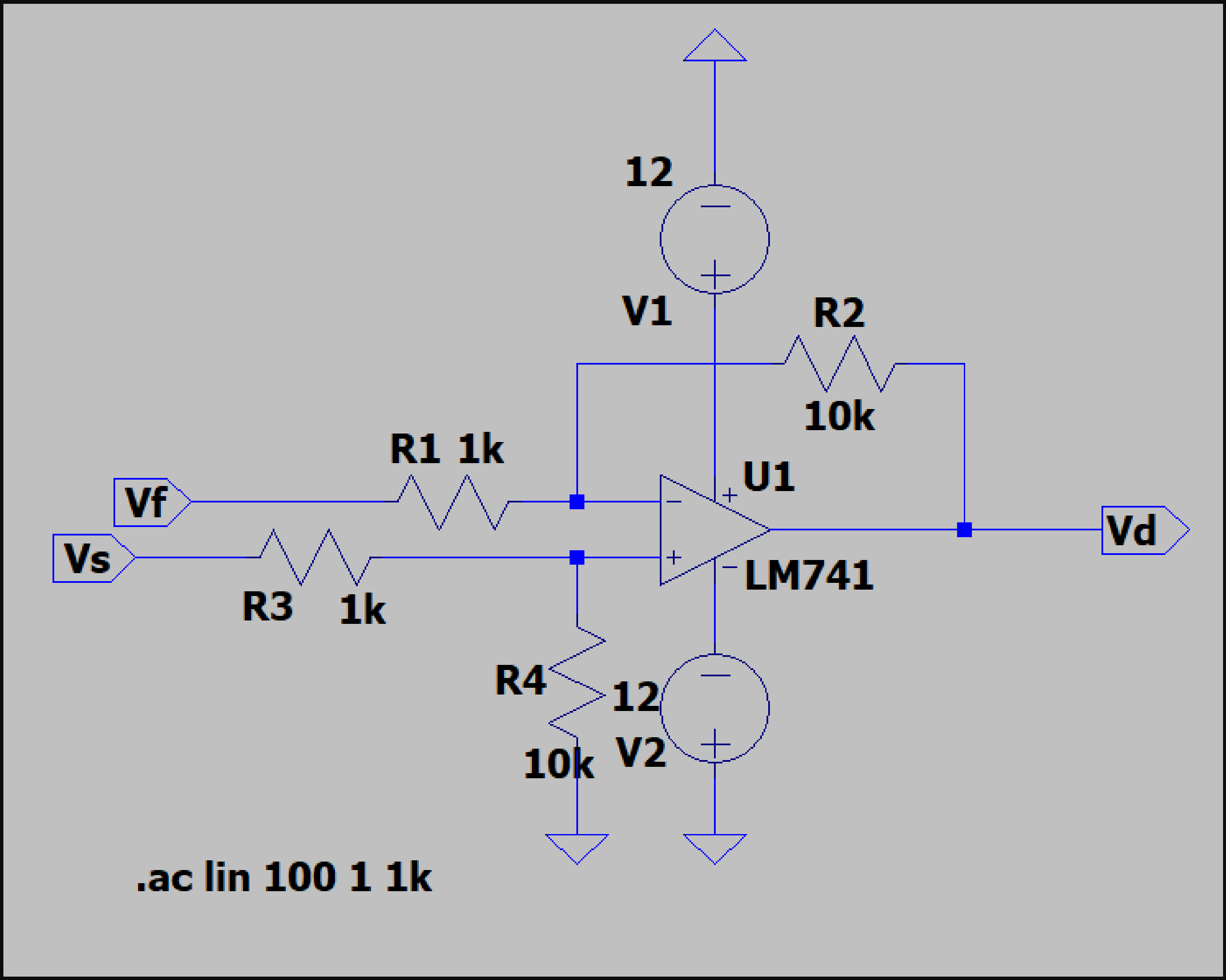
Circuit Diagram:



For A_0=10, We have to choose R2 and R1 such that they are in ration 10:1.

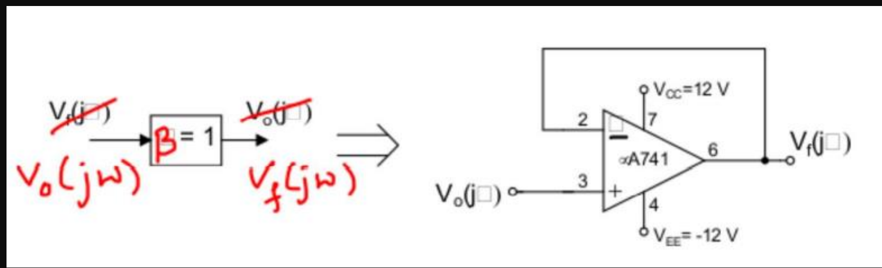
So lets consider R2 = 10kΩ and R1 = 1kΩ

Circuit in LTSpice:

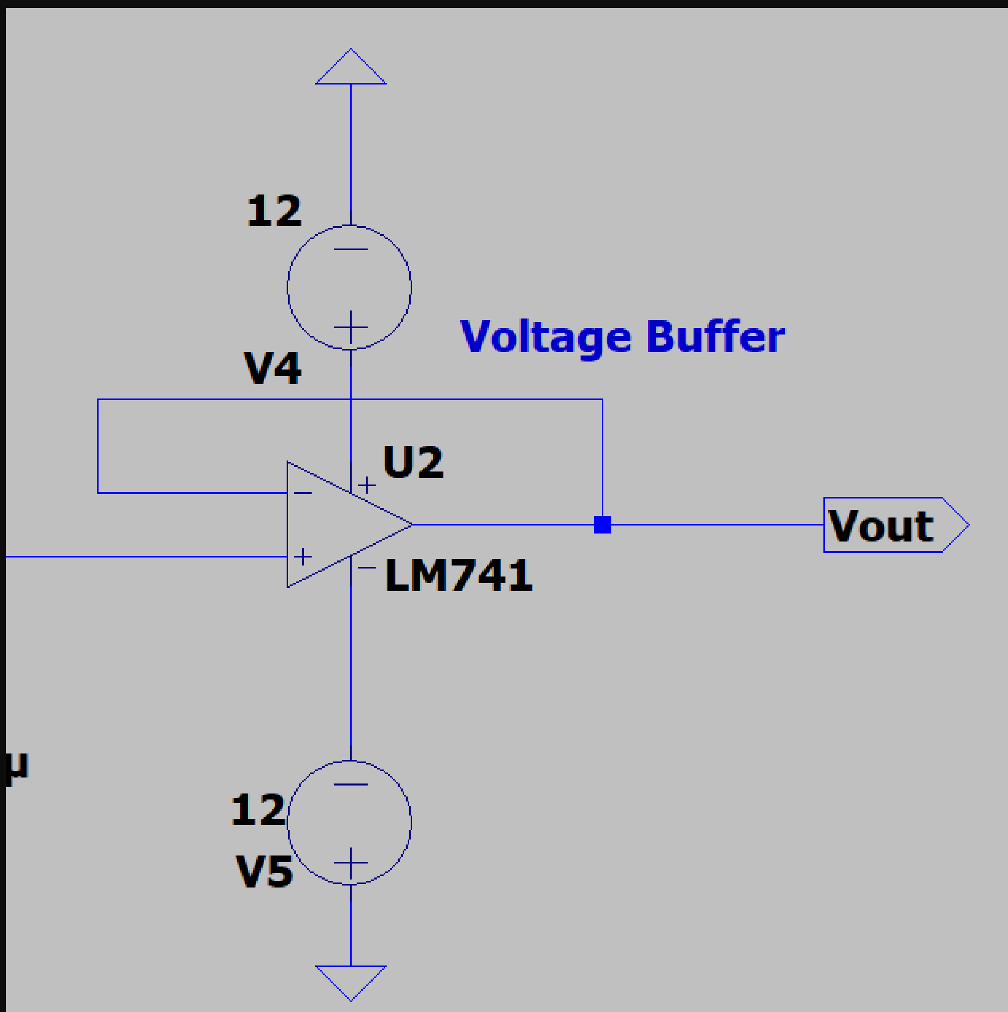


Voltage Buffer:

Circuit Diagram:

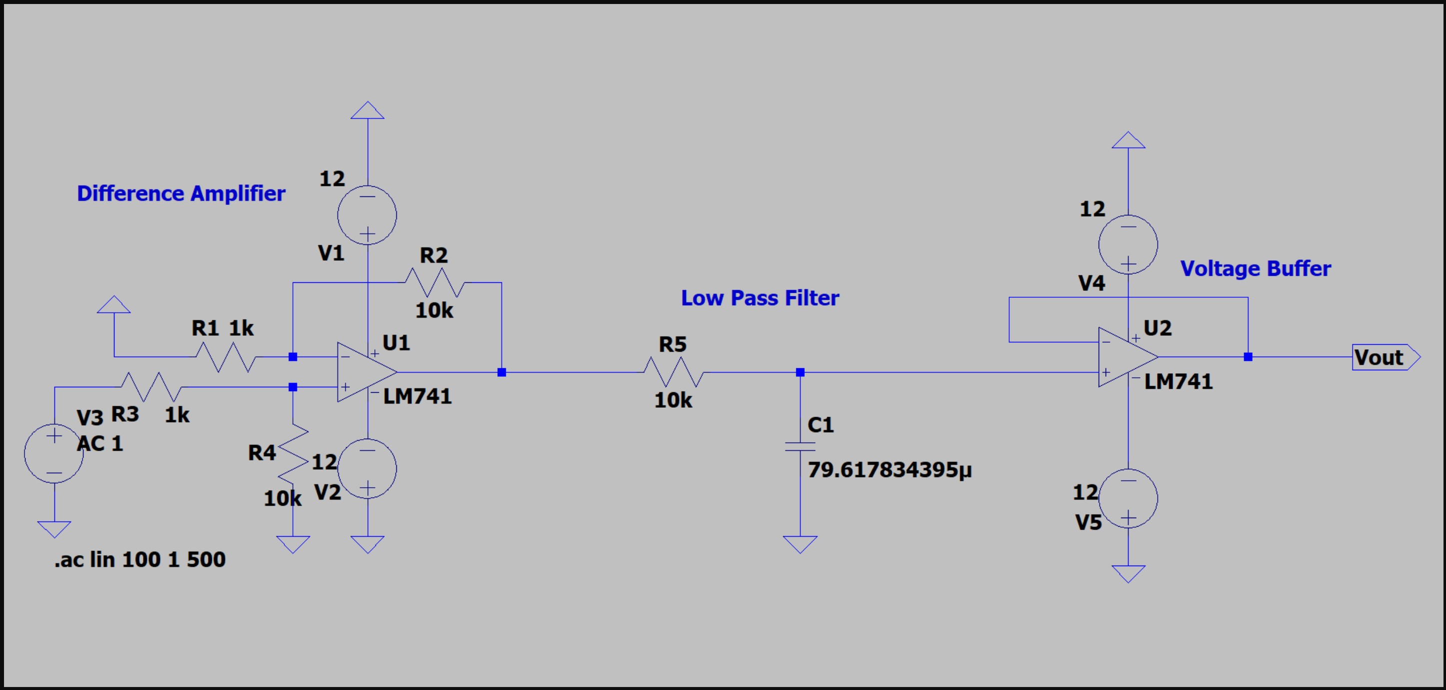


Circuit in LTspice:



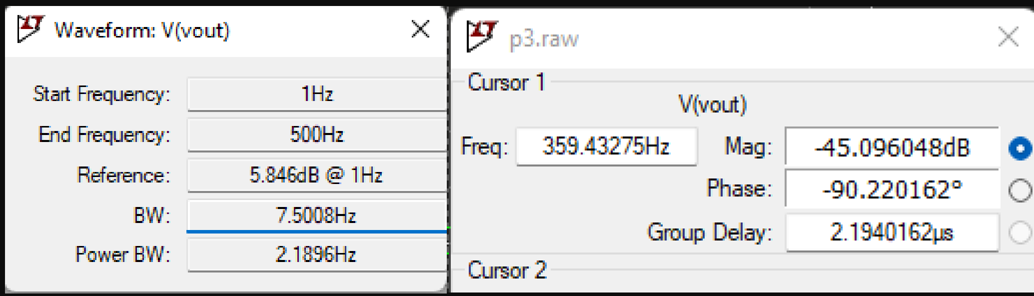
Obtain the magnitude response of the forward amplifier. For this, set the feedback input of the difference amplifier $V_f(j\omega)=0$ and set the other input to 1 V_{pp} (Note: Take care not to connect output of the buffer to the input of the difference amplifier, otherwise you will end up shorting the output of the buffer to ground which can damage the op-amp used for the buffer in the hardware lab). Find all the salient features of the magnitude response.

Circuit in LTspice:



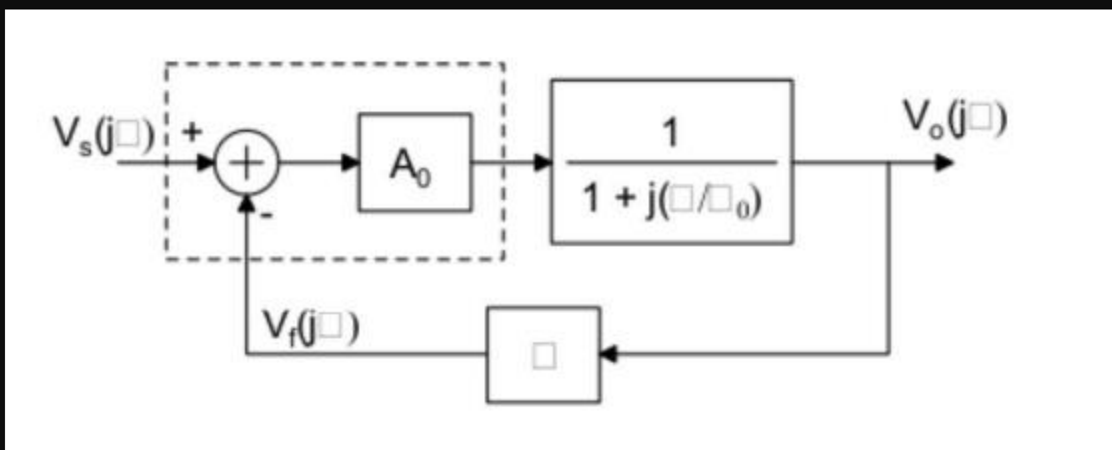
Observations:

Waveform:

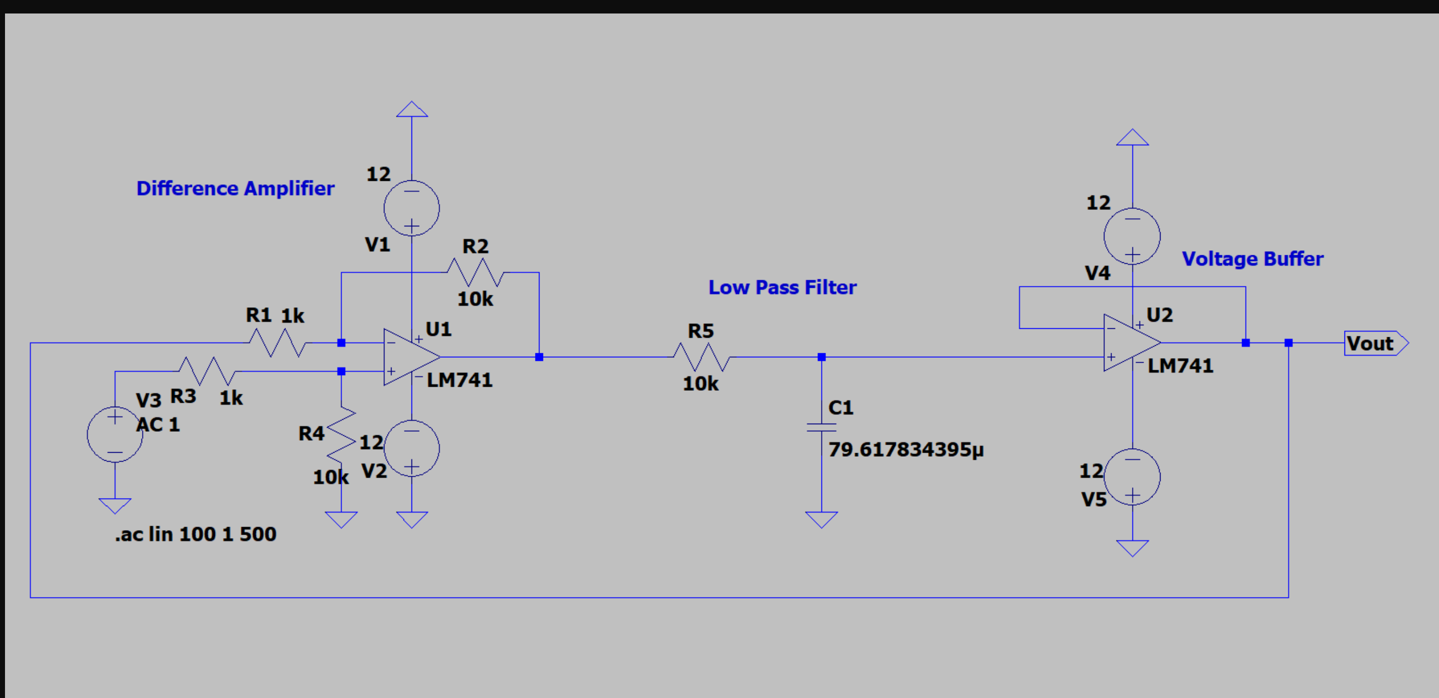


Now close the loop by connecting output of the voltage buffer to the feedback input of difference amplifier.

Circuit Diagram:



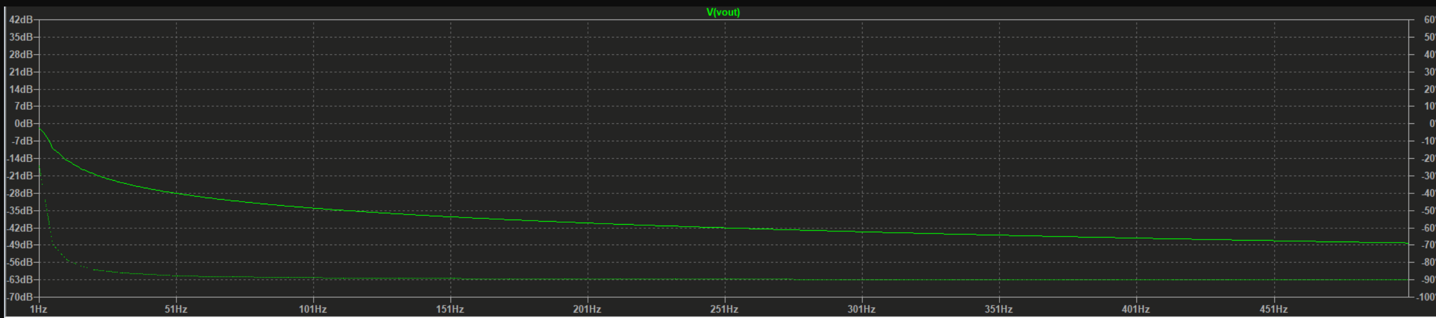
Circuit in LTspice:

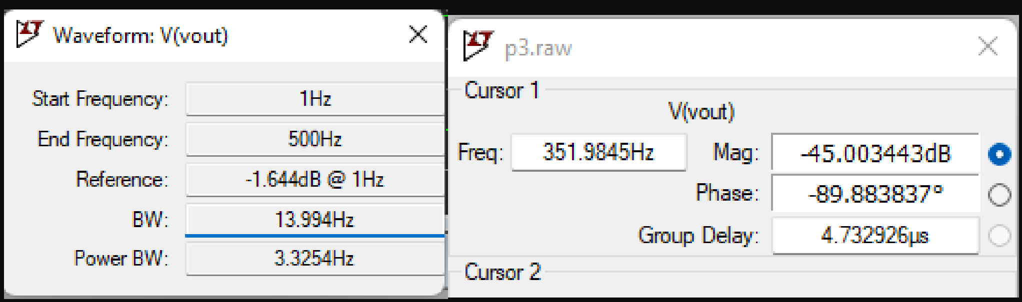


Obtain the magnitude response and compare it with that of the forward amplifier

Observations:

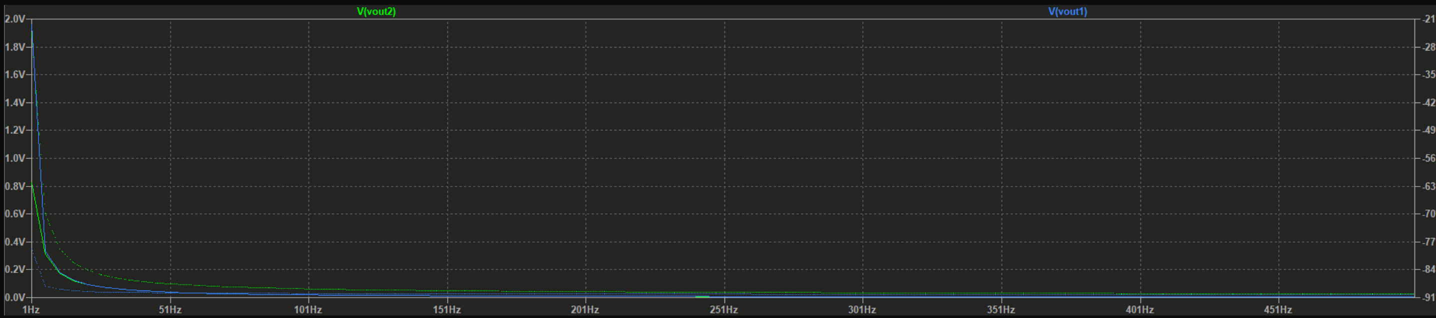
Waveform:





Comparison:

Taking both the circuits and and developing the waveform, we get.



From which we can see that the voltage in the 2nd case is of lower value at lower frequency as compared to in the 1st case(grounded feedback).