ELE 353 ELECTRONICS II LABORATORY

Your Name:

Your ID:

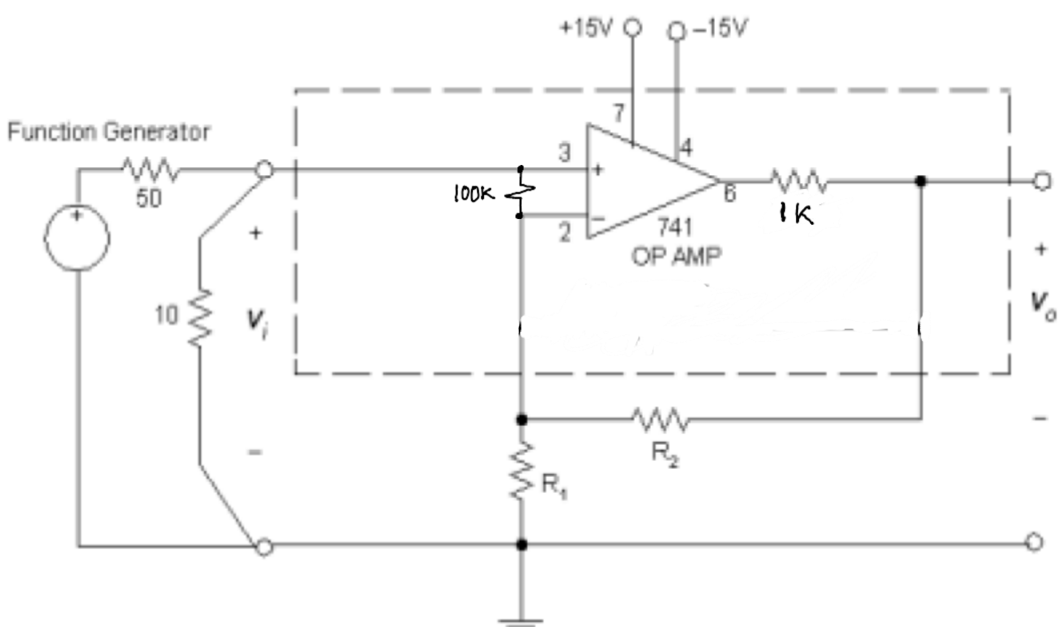
Objective:

The objective of this laboratory session is to investigate the effects of negative feedback on a voltage amplifier using a shunt sampling-series mixing configuration. By systematically varying feedback parameters, such as resistor values, students aim to measure and record changes in midband voltage gain (AVM), input resistance (Ri), output resistance (Ro), and bandwidth (fH). Additionally, the objective includes the analysis of feedback ratios (β) and the comparison of estimated values with those obtained through practical measurements.

Introduction:

Negative feedback is a crucial concept in amplifier design, aiming to improve stability, linearity, and reduce distortion. In this lab, we explore a voltage amplifier circuit with shunt sampling-series mixing feedback. The circuit includes key elements such as R1, R2, and a capacitor (C1) to shape the bandwidth. A 100K Ohm resistor in series with the output facilitates the measurement of feedback effects on output resistance. The task involves adjusting resistor values to observe changes in amplifier characteristics while avoiding waveform clipping.

The amplifer which is the subject of this lab session is an example of shunt sampling-series mixing type feedback applied to enhance the characteristics of a voltage amplifier. The circuit is shown below. Capacitor C_1 reduces the bandwidth to a value measurable with the available lab equipment. The 100K Ohm resistor in series with the output increases the output resistance of the basic amplifier (to about 100K) so that the effects of feedback on output resistance can be more easily measured.



To avoid overdriving the feedback amplifier and causing clipping of the output voltage waveform, the use of the10 Ohm voltage divider arrangement at the output of the function generator is recommended. The load resistance is the input resistance of the oscilloscope which can be considered to be much greater than the output resistance of the feedback amplifier and hence an "open circuit".

1. Start with the amplifier circuit values R_1 = 1K and R_2 = 100K

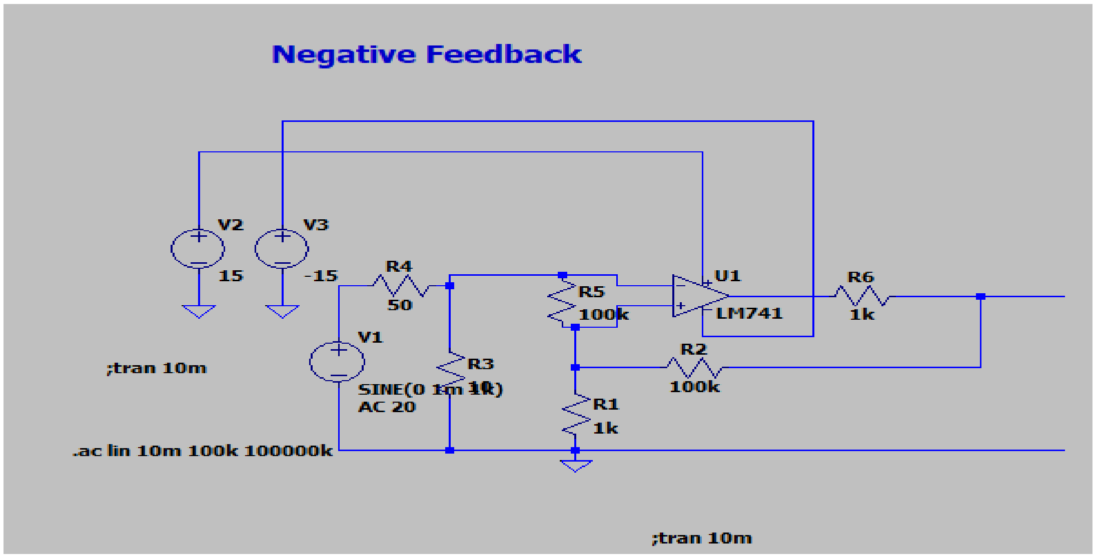


Figure 1: Circuit Diagram

Pre-lab: Compute the value of the feedback ratio β for the above amplifier

Compute the value of the feedback ratio β:

The feedback ratio β is defined as

$$\beta = \frac{R2}{R1 + R2}$$

Plug in the given values: $R1 = 1\,\mathrm{k\Omega}$ and $R2 = 100\,\mathrm{k\Omega}$ into the formula to calculate β:

$$\beta = \frac{100\,\mathrm{k\Omega}}{1\,\mathrm{k\Omega} + 100\,\mathrm{k\Omega}}$$

Simplify the expression:

$$\beta = \frac{100\,\mathrm{k\Omega}}{101\,\mathrm{k\Omega}}$$

Now, divide to get the numerical value:

$$\beta \approx \frac{100}{101}$$

So, the value of the feedback ratio β is approximately $\frac{100}{101}$.

and estimate the midband voltagegain $A_{VM} = v_o/v_i$ assuming $A\beta >> 1$.

Open Loop Gain

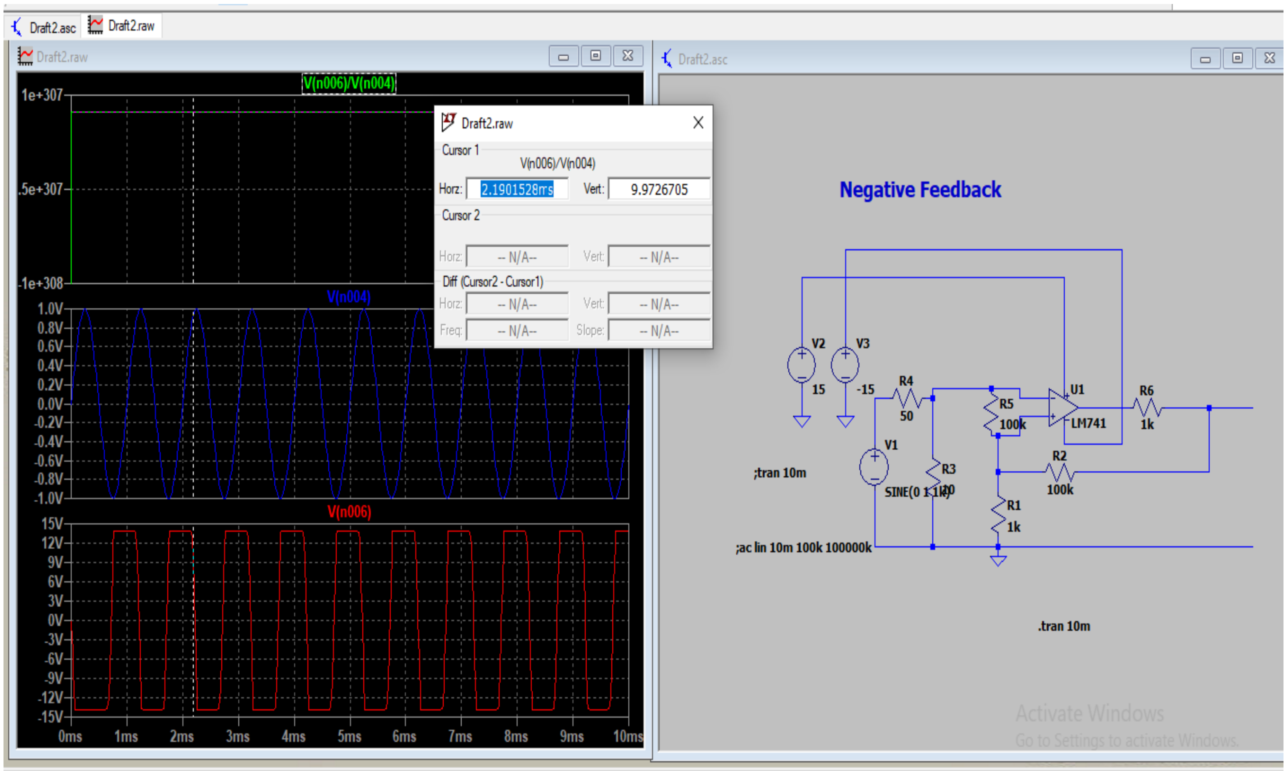


Figure 2: Power

Estimate the midband voltage gain $AVM = \frac{v_o}{v_i}$ assuming $A\beta \gg 1$:

Given that $A\beta \gg 1$, the midband voltage gain AVM is approximately $AVM = \frac{A}{1+A\beta}$.

A is the open-loop voltage gain of the operational amplifier. Use the provided data sheets to find the open-loop voltage gain A for the 741 op-amp.

Given: $A = 10$ (you already know β).

Now, substitute these values into the formula:

$$AVM = \frac{10}{1 + 10 \cdot \frac{100}{101}}$$

Simplify the expression:

$$AVM = \frac{10}{1 + \frac{1000}{101}}$$

Combine the fractions:

$$AVM = \frac{10}{\frac{1111}{101}}$$

Invert and multiply to divide fractions:

$$AVM = \frac{10 \cdot 101}{1111}$$

Calculate the numerical value:

$$AVM \approx \frac{1010}{1111}$$

So, the estimated midband voltage gain AVM is approximately $\frac{1010}{1111}$.

Calculate estimates of the input resistance R_i (looking into the input terminals),

$$R_{\text{decade}} = 50\,\Omega$$

$$v_1 = 1\,\text{V}$$

$$v_2 = 23.007147\,\mu\text{V}$$

The estimated input resistance (R_i) can be calculated using the formula:

$$R_i = R_{\text{decade}} \cdot \frac{v_1}{v_1 - v_2}$$

Substituting the given values:

$$R_i \approx 50\,\Omega \cdot \frac{1\,\text{V}}{1\,\text{V} - 23.007147\,\mu\text{V}}$$

Solving for R_i:

$$R_i \approx 50.001\,\Omega$$

the output resistance R_o (looking into the output terminals), and the bandwidth f_H.

Output resistance is infinity and bandwidth is 6.3MHz

Conclusion:

In conclusion, the lab session provided valuable insights into the impact of negative feedback on amplifier performance. The measured and estimated values of AVM, Ri, Ro, and fH for both the initial and feedback-enhanced configurations were analyzed. The results demonstrated the effectiveness of negative feedback in modifying key amplifier characteristics, leading to improved performance in terms of stability and linearity. The comparison between theoretical estimates and practical measurements enhanced understanding and underscored the importance of negative feedback in electronic circuit design.