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EGR 24L Introduction of Circuit Analysis Laboratory

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Lab#6A
Lab 6A: Op amp part 1 – voltage follower, current limitation

Introduction:

This lab we got to learn about the Op amp and its properties. An operational amplifier (op amp) is a high gain electronic components which have two inputs terminal (inverting and non- inverting) and out output terminal. Op amp will amplify the voltage difference between its input. Op amp have special properties including infinite gain and high input impedance.

Our goal for this lab is to learn basic setting up on Op amp, understand how each pin work. Additionally, we also exploring the loading effect of a voltage divider, how to use buffer circuit to solve the issue and we also learn to understand the limitation of op amp current output.

Procedure:

1) We constructed an op amp circuit follow the design on spec sheet by using two voltage source V1= -15V andV2 = +15V. After that we record its value of Vin (Voltage input) and Vout(Voltage output). Due to Op amp property, we see the voltage follower relationship between Vin and Vout.

2) Next, we move on part1 B, we construct two new circuits match the circuit on the spec sheet. We investigate the circuit without Op amp to verify voltage divider. However, what we see is the impact of loading effect in the circuit. After we record the data from the change of Vout. we move on to a circuit with Op amp. We see that loading effect can be slove in circuit with op amp by using circuit voltage buffer. Circuit buffer is the form of a voltage follower, it effectively addresses the loading effect by isolating the load from the op-amp output.

3) Next, we move on part 2: Current limitation we reuse the design of circuit one. But we change the input voltage to maintain at 2V. We are using decade box to change the load of the output node. Next, we observe the output of Vout and Rload. We see the limitation of op amp. Because at some point the voltage follower stop working. The output of op amp also giving out smaller number than what we see in input. This is due to the saturation of amplifier. When the Vout implied by circuit would exceed possible range. Op amp can only output voltages contained within the range of its power supply.

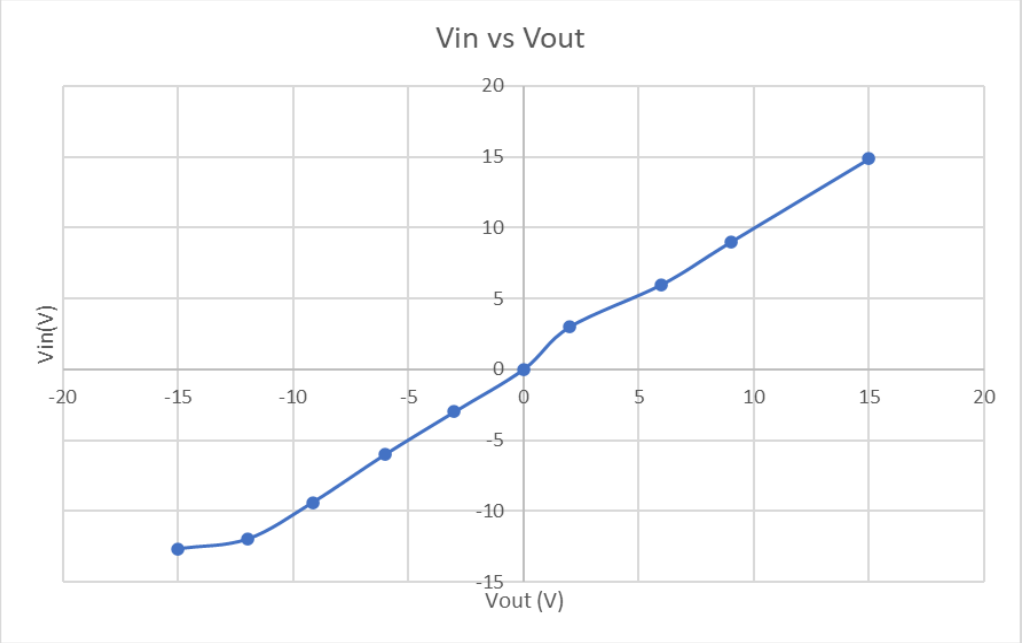
Conclusion:

The op-amp lab experience has been enlightening. We had learned various significant lessons of operational amplifiers. We get to use voltage buffer to mitigating the loading effect in op-amp circuit. By using op amp property voltage follower to maintain high input impedance and provide low output impedance to the load. We also exploring the op-amp saturation or limitation of op-amp. When the op amp is saturated. The voltage output is exceeding the possible range of power supply. This can lead to damage the electrical components. In this lab, we got to learn so many importance keys for electrical engineer. I believe these lessons will undoubtedly serve as valuable tools in our future endeavors with op-amp circuit.

Appendixes:

Data:

Plot the VTC of the op amp voltage follower.



Part 1a data table:

Plot the VTC of the op amp voltage follower	
Why is this circuit called a voltage follower?	Because Vin = Vout when we measured the circuit. It is voltage follower
Explain the nonlinearity near the ends of the VTC	The nonlinearity near the ends of the VTC refers to the behavior of the circuit when the input voltage approaches extreme values, such as the supply voltage limits or other saturation points.

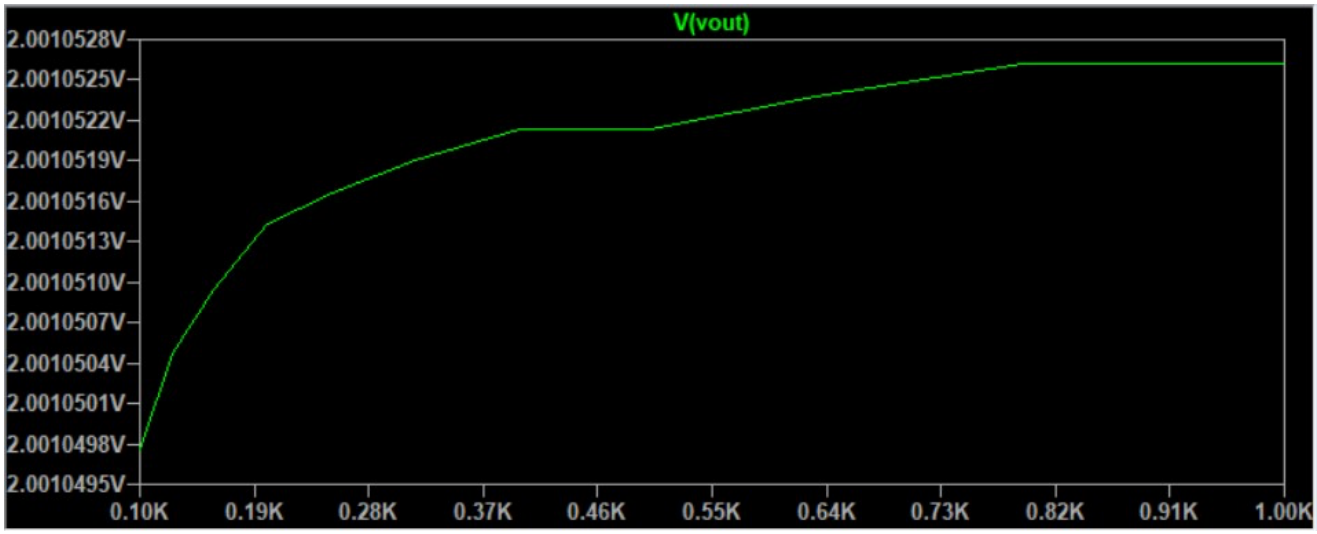
Part 1b data:

Classic voltage divider circuit	
Without attaching the load, what is Vout1?	2V
After attaching the load, what is Vout1	1.3V
Why does VDR no longer work after attaching the load?	Due to **Loading Effect**: When you connect a load to the output of the voltage divider, the load itself has a resistance. If the load resistance is not significantly larger than the resistance of the lower resistor in the divider (R2), it can significantly affect the division ratio. This means that the load resistance essentially becomes in parallel with another resistor on circuit.
Op amp buffer circuit	
Without attaching the load, what is Vout2?	**If Vin =15V, Vout = 5.9 V.** **If Vin=-15V Vout = -5.9 V**
After attaching the load, what is Vout2?	**If Vin= 15 V Vout = 5.2 V,** **if Vin= -15V Vout =-5.9 V**
How does the op amp buffer overcome the loading effect?	By using op amp property voltage follower to maintain high input impedance and provide low output impedance to the load

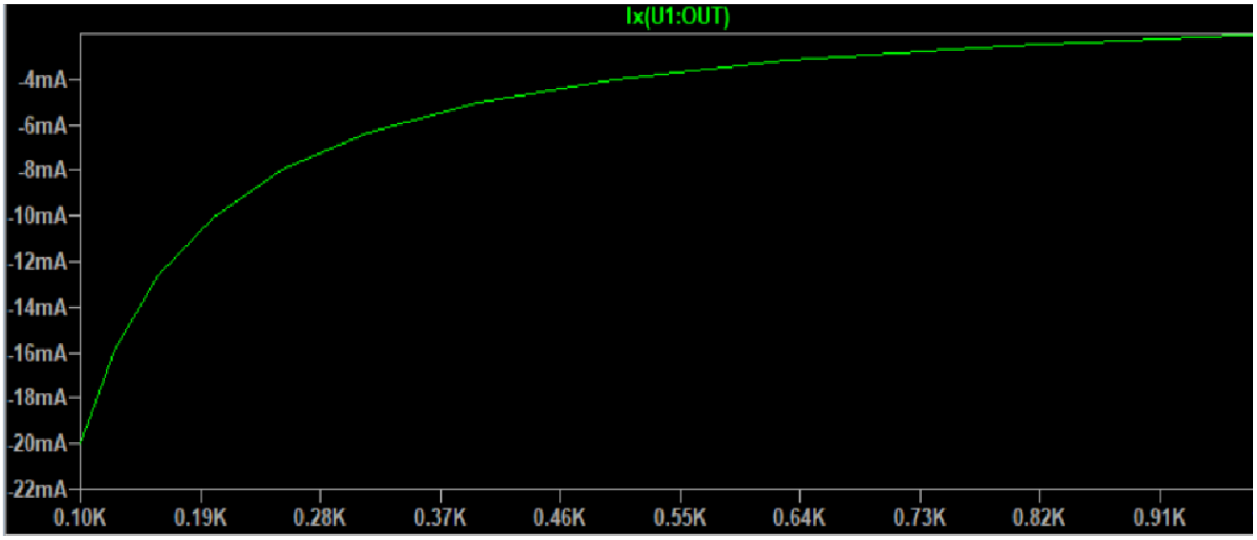
incorrect data

Part 2 data table:

Plot Vout vs. RLoad to show what happens with Vout when RLoad is too small.



Plot I_Load vs. RLoad to show what happens with I_Load when RLoad is too small.



Plot Vout vs. RLoad to show what happens with Vout when RLoad is too small.	See graph above.
Plot I_Load vs. RLoad to show what happens with I_Load when RLoad is too small.	See graph above
At what load does the voltage follower stop working properly?	At very low volts like 0.5 or 1 it doesn't work correctly and if you increase it above 15v. This is due to the limitations of the LM741 op amp.
What is the op amp output current at this point?	The opamp is at the value where its limit is set for max and min current.
What is the maximum output current (current limit) of this op amp?	The maximum output current is around 10mA of this op-amp
When this op amp reaches its output current limit, why will it no longer function as a voltage follower?	Op-amp can only work within range of Vin from power supply. However, when its saturated. Vout would exceed possible ranged, and it is no longer voltage follower