*Your Name*
Operational Amplifiers Lab
*Date Completed*

## PRELAB

1. **Using the data sheet for your operational amplifier, determine the pin number for the following inputs and outputs. Type your answers in Table A.**

| I/O | Pin Number |
|---|---|
| V- | |
| V+ | |
| $V_{OUT}$ | |
| $V_{CC-}$ | |
| $V_{CC+}$ | |

**Table A. Operational Aplifier Pin Assingment.**

2. **What are the maximum values for $V_{CC+}$ and $V_{CC-}$?**
3. **What are the maximum values for the input voltages?**
4. **What is the nominal input and output resistance of your op amp?**
5. **What is the voltage gain of your amplifier? Express you answer in dB and decimal.**
6. **What is the op amp's CMRR value in dB? What is the value in decimal?**
7. **Using an op amp, design a circuit that would act as a buffer and eliminate the internal 50 Ω resistance of the function generator. Would this circuit work? (Hint: What would be the output resistance of the circuit?)**

## INPUT RESISTANCE

8. **With the op amp powered down, measure the resistance between V+ and V- and record your measurement in Table B.**
9. **Power up the op amp and measure the resistance between V+ and V-. Record measurement in Table B.**
10. **Record the value of the input resistance in Table B. How do the measurements taken compare to the value from the data sheet? If there is a discrepancy, explain the cause.**

| | Powered Down | Powered Up | Data Sheet |
|---|---|---|---|
| Input Resistance (kΩ) | | | |

**Table B. Input Resistance I.**

**11. Measure the actual resistance for $R_1$ and $R_2$ with the DMM and record their values in Table C.**

**12. Power up the circuit. Measure the voltage drop across $R_1$ and $R_2$. Record your results in Table C.**

**13. Calculate and record the currents through R1 and R2.**

| | Resistance (kΩ) | Voltage (mV) | Current (nA) |
|---|---|---|---|
| $R_1$ | | | |
| $R_2$ | | | |

**Table C. Input Resistance II.**

**14. From the data in Table C, calculate $i_N$, and record in Table D.**

**15. Measure and record the value for V-.**

**16. From the data in Table D, calculate and record the input resistance.**

| $i_N$ (nA) | V- (V) | Input Resistance (MΩ) |
|---|---|---|
| | | |

**Table D. Input Resistance III.**

**17. How does the input resistance from Table D compare to the values in Table B? If there is a discrepancy, explain the cause.**

**18. Replace the $R_1$ and $R_2$ with 470 Ω resistors. Repeat Question 11 – 13. Record your results in Table E.**

| | Resistance (kΩ) | Voltage (mV) | Current (nA) |
|---|---|---|---|
| $R_1$ | | | |
| $R_2$ | | | |

**Table E. Input Resistance IV.**

**19. From the data in Table E, would you be able to determine the input resistance of the op amp (would you be able to repeat Questions 14 - 16)? Explain.**

## OUTPUT RESISTANCE

**20. Set the potentiometer to approximately 100 Ω and record its value in Table F. Measure $V_O$ and record the value in Table B. Decrease the value of the potentiometer by approximately 5 Ω and repeat the measurements. Continue this process until the potentiometer is at approximately 50 Ω.**

| $R_L$ (Ω) | $V_O$ (V) |
|---|---|
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**Table F. Output Resistance.**

**21. What happens to the output voltage as the value of the potentiometer is decreased?**

**22. Given $V_O = V_S\left(\frac{R_L}{R_L + R_O}\right)$, use MATLAB to plot the estimated value of the output resistance $R_O$ versus the potentiometer resistance $R_L$. You may need more data sets than there is room for and have to add rows to Table F. Paste the plot below. Include your name in the title of the plot and label both axes.**

**23. From your plot determine the output resistance of the op amp and compare it to the value from the data sheet. What is the percent difference between the estimated output resistance and the nominal output resistance?**

## CLIPPING AND OUTPUT SATURATION

**24. Sweep $V_S$ through a range of positive and negative values. For each value of $V_S$, record $V_S$ and $V_O$ in Table G. Ensure that the values for $V_S$ are adequate to show the saturation characteristics of the op amp. You may need more data sets than there is room for and have to add rows to Table G.**

| $V_S$ (V) | $V_O$ (V) |
|---|---|
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**Table G. Vo Versus Vs.**

**25. Use MATLAB to plot the data in Table G. Paste your plot below. Include your name in the title of the plot and label both axes.**

**26. Does the op amp operate within specifications? Explain.**

## PROTECTION

**27. Short the output of the op amp with $V_S$ set equal to 5 V for at least 10 seconds. CAUTION! Op amp may become very hot! Remove the short and measure $V_O$. Does the op amp still work?**

## AUDIO AMPLIFIERS

### INVERTING AUDIO AMPLIFIER

**28. How does adjusting the potentiometer affect the sound of the signal?**

**29. How could this be used in a stereo system?**

**30. What is the highest frequency that you can hear?**

**31. What do you hear when $V_S$ is a DC signal?**

**32. At what DC voltage value does the sound start to distort?**

**33. Explain what is causing the distortion.**

### SUMMING AUDIO AMPLIFIER

**34. Describe the sound you hear (be very descriptive).**