Name: Roll Number:

Laboratory 5

A: /4	**B**: /6	**Tot:** /10

Part A: Measurement of opamp imperfections: V_{os}

As discussed in the lecture, any opamp suffers from two sources of error *without an external input*. The first is an offset voltage caused by mismatched currents in the emitter legs of the two input transistors that make up the differential input pair. This is relatively easy to measure and compensate. Setup a simple feedback amplifier with a large gain of +1000. Connect *both* V_{in} and the unused opamp input to 0V using short *equal* lengths of wire. Use the measured output value to calculate V_{os}

Note: V_{os} is the offset voltage created at the *input* which is amplified by the gain of your amplifier

Compare the measured value with the specifications of typical V_{os} for LM741 in the datasheet.

Circuit Diagram to measure V_{os} (with component values):

/1 design

/2 demo

/1 measurement + offset null

Measurement of V_{os} ____

Comparison with expected typical values from the LM741 datasheet:_______________

Use a potentiometer connected to the offset null pins 1 and 5 and pin 4 to balance the emitter leg currents of the two halves of the input differential pair (look at the datasheet for the connection details) Demonstrate that you can get rid of V_{os} in your opamp by fine-tuning the value of the potentiometer.

<u>Hint:</u> $\mathcal{O}$(10 kΩ) potentiometer values are usually needed. Multi-turn potentiometers are notoriously sensitive to slight movements of the knob. Make sure that you measure the potentiometer setting after you have fine-tuned the value to null V_{os}. Set it aside so that you don't bump it accidentally and change the settings for Part B of today's experiment.

Part B: Measurement of opamp imperfections: I_{bias}

The second source of error in an opamp at DC is the mismatch between the bias currents into the bases of the two input transistors. This is called I_{bias}. It is typically:

- Of very small value (µA or less)
- Can be different for the two inputs of the opamp, in general $I_{bias+} \neq I_{bias-}$
- Hence, somewhat harder to measure.

Setup a feedback circuit to measure I_{bias} for the LM741 with the assumption that V_{os} has been compensated accurately using the offset null as in Part A

Hints:

1. Putting a capacitor in the feedback loop integrates any current present at the input with $V_{in} = 0$

2. A capacitor's I-V relation gives you $V = 1/C*\int I\, dt$, or more usefully: $I = C*dV/dt$

3. After integrating I_{bias},V_{out} is limited to the saturation values $\pm V_{sat}$ The important point is to determine the *slope* dV/dt

4. You must measure I_{bias+} *and* I_{bias-} *separately:* the circuit connections to measure each are similar. When measuring one, the other terminal must be grounded to 0V.

Circuit Diagram to measure I_{bias} (with component values):

/3 design

/2 demo

/1 measurement

Measurement of I_{bias} ____

Comparison with expected typical values from the LM741 datasheet:______________