LABORATORY IV

***Name:*_________________________**

BAE 5413
SPRING 2007

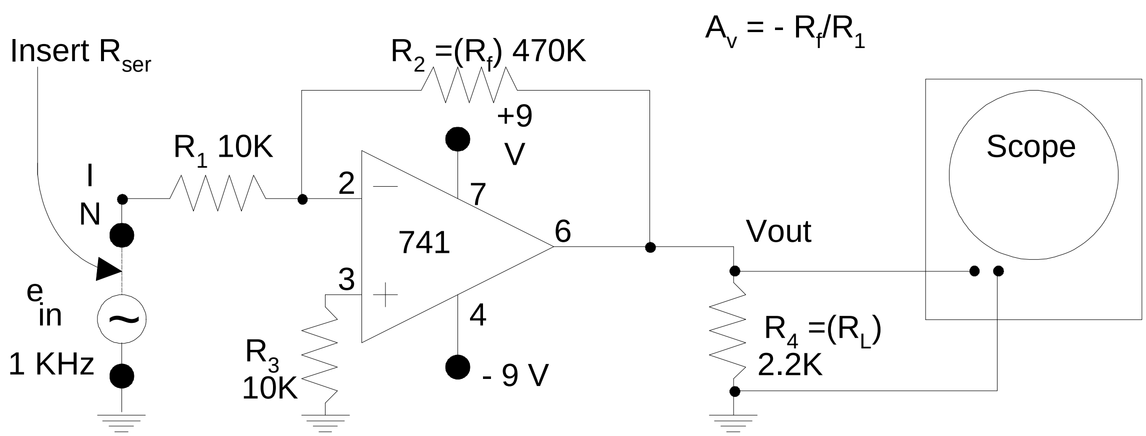
TITLE: Basic Op Amp Configurations

OBJECTIVE:

To experimentally illustrate the input-output characteristics of basic OP-AMP circuit configurations

PROCEDURE:

1. INVERTING MODE
   (a) **Connect the circuit.** With the POWER OFF, breadboard the circuit shown in the attached figure (a). Set the dual variable power supply to an indicated $\pm$ 9 VDC. Connect your dual channel oscilloscope to monitor the input and output signals. Double check your circuit for correct value of components and correct connections.
   (b) **Observe the amplifier performance**. Turn the POWER ON and apply a .1 Vp-p, 1 kHz sine wave signal (e_{in}) to the input. Record the input and output voltages measured on the scope as well as the phase relationship. Change e_{in} to 0.25 Vp-p, observe and record the input and output. Increase and decrease the power supply voltage and observe the effect on the output. Prepare to explain deviations from the calculated and expected output.
   (c) **Measure input impedance of the amplifier circuit.** With the POWER OFF, add a resistance (Rser) of about 10K in series with the signal source. Use the resistance-capacitance box to supply the required resistance. Turn the POWER ON and monitor the voltage level between the IN terminal and ground. Adjust Rser to reduce e_{in} to approximately 500 mV (1/2 of it's initial value). Record the value of Rser.

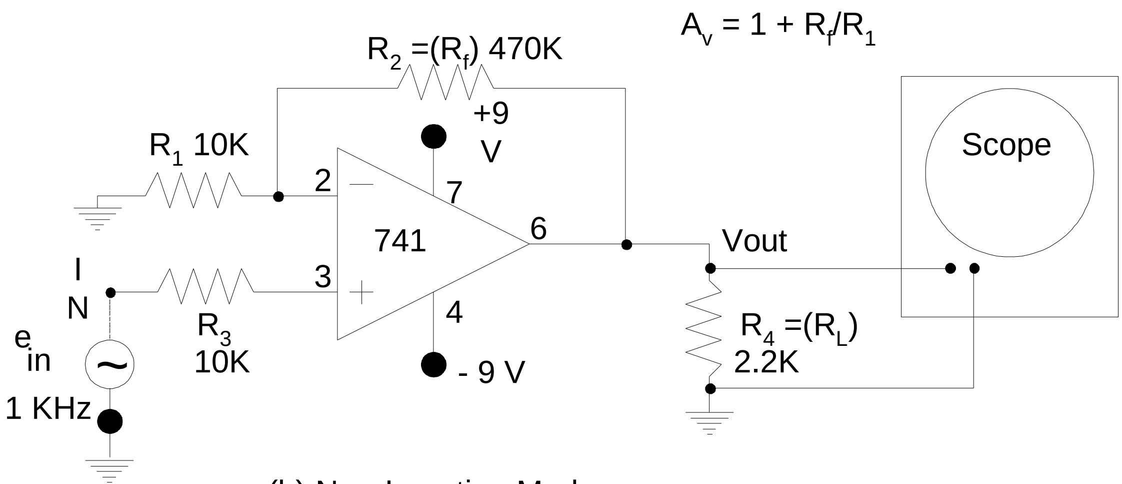


(a) Inverting Mode

2. NON-INVERTING MODE

(a) **Connect the circuit and test.** With the POWER OFF, breadboard the circuit shown in figure (b). Repeat steps (b) and (c) of part 1.

(b) **Record component values.** Using a multimeter, measure and record the values of the resistances R1, R2, and R3.



(b) Non-Inverting Mode

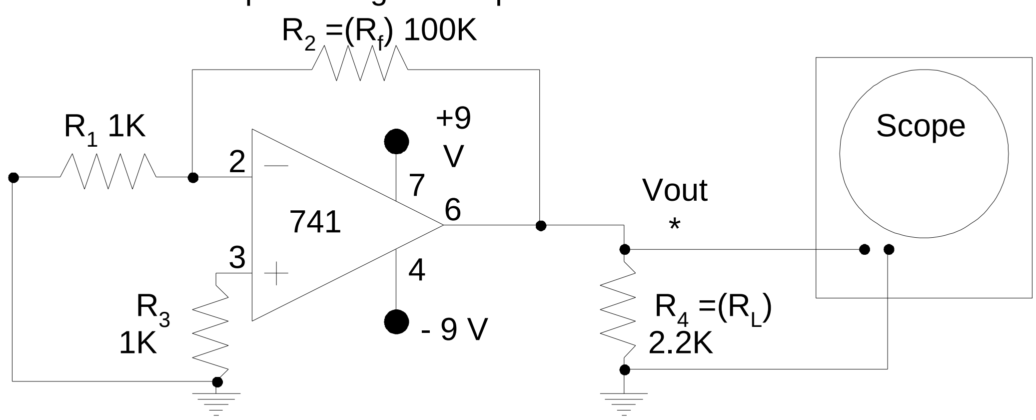
3. DC OFFSET / NULL CONTROL

(a) **Connect the circuit.** With the POWER OFF, breadboard the circuit shown in figure (c). Set the dual variable power supply to an indicated $\pm$ 9 VDC. Connect the oscilloscope to monitor the output voltage across the load resistor (R_L). Double check your circuit for correct component values and correct connections.

(b) **Measure input offset voltage of the Op-Amp.** With POWER ON, read and record the DC output voltage. The sensitivity of the oscilloscope may need to be increased to obtain an accurate reading.

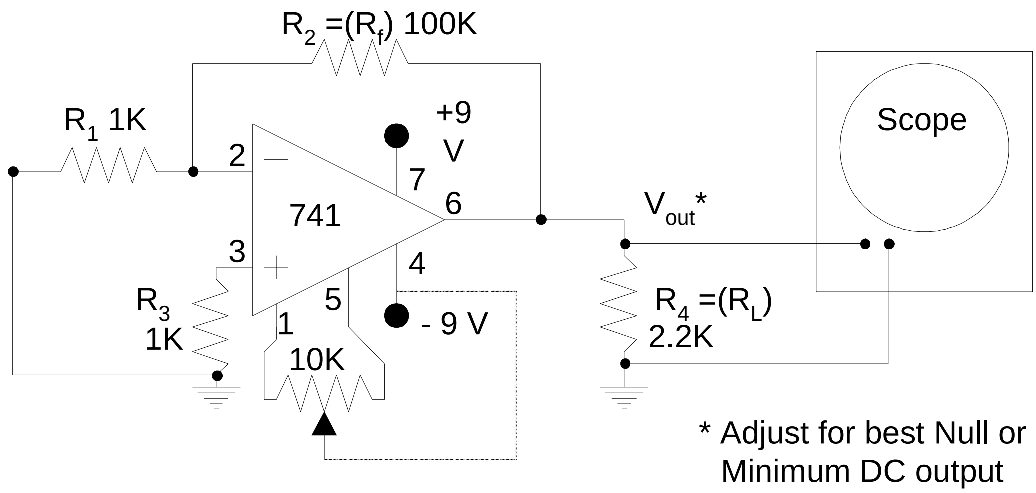
(c) **Null the offset voltage of the Op-Amp.** Turn the POWER OFF and add the null potentiometer to your circuit as shown in figure (d). Use the 10K potentiometer ("pot") on your breadboard system.

(d) With the POWER ON, adjust the potentiometer to obtain minimum output or "null" condition. Attempt to bring the output to o VDC.



* $V_{io} = V_{out}/(R_2/R_1) = V_{out}/100$

(c) Measurement of V_{io}, Input Offset Voltage



(d) Nulling Offset Voltage

4. INTEGRATOR MODE

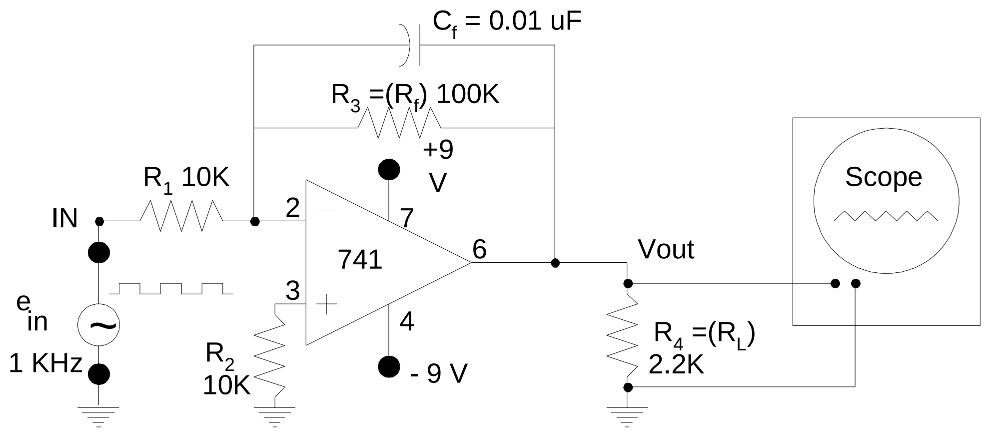
(a) **Connect the circuit.** With the POWER OFF, breadboard the circuit shown in figure (e). Set the dual variable power supply to an indicated $\pm$ 9 VDC. Connect your dual channel oscilloscope to monitor the input and output signals. Double check your circuit for correct value of components and correct connections.

(b) **Observe the effect of integration.** Turn the POWER ON and apply a 2Vp-p, 1kHz square wave signal to the input. Sketch the output. Cut the frequency of the input signal to about 10 Hz and sketch the output. Increase the slowly to 5 kHz while observing the shape of output signal. Record the approximate frequency the distortion of the square wave begins. Record the frequency at which integration appears complete. Record your criteria for distortion and complete integration.

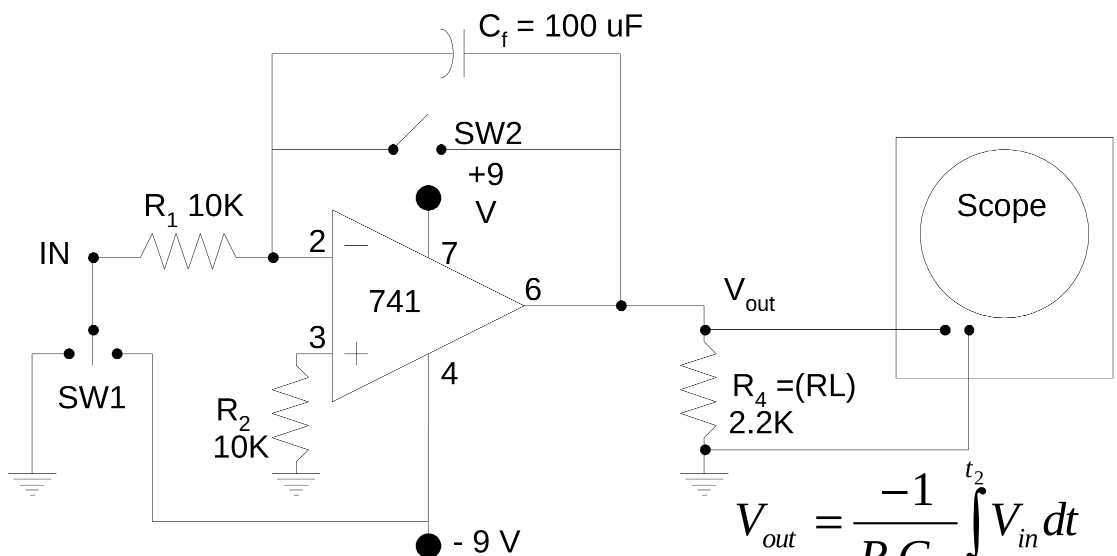
(c) **Observe frequency response of the amplifier.** Change the input signal to a sine wave and measure input to output magnitude ratios at frequencies of $0.1/(2\pi R_f C_f)$, $1/(2\pi R_f C_f)$, $10/(2\pi R_f C_f)$, and $100/(2\pi R_f C_f)$.

(d) **Connect the ramp circuit.** Turn the POWER OFF and replace the capacitance with a 100 µF capacitor and the resistance with a SPST switch. Disconnect the signal generator and use a SPDT switch to allow connection of the input to 9V or to ground as shown in figure (f). With SW2 in the CLOSED position, and SW1 set to ground, turn the power on. Check the DC voltage offset and adjust the null control if necessary.

(f) **Observe the performance of the ramp circuit.** Flip both switches simultaneously to generate a ramp output signal. Observe the output with the output set at a slow sweep speed. Determine the duration of the ramp and the maximum and minimum voltage levels.



(e) Integration Effect



$$V_{out} = \frac{-1}{R_1 C_f} \int_{t_1}^{t_2} V_{in} dt$$

(f) Ramp Function Test

5. REPORT

Generate a brief report using this handout as a cover page. Place the answers to the above questions in an appendix. Answer the questions below as the body of the report.

(a) Compare the gain and input impedance obtained in parts 1 and 2 with expected values for the circuit elements being used. Comment on the discrepancies.

(b) Compare the DC offset voltage measured in part 3 with the specified maximum value published for a 741 OP-AMP. Was your amp within specifications?

(c) Explain the distortion of the square wave output observed in part 4. How does this waveform relate to what we studied previously regarding first order responsed? What was your criteria for complete integration?

(d) What filter function could the circuit shown in figure (e) be used for.

(e) How does the observed ramp duration compare to the computed ramp duration for the circuit shown in figure (f).