Experiment 40

Friday, February 10, 2023 4:56 PM

Objectives: Lillian Tucker

1. Examine the specifications of an IC op amp.
2. Build and demonstrate the operation and characteristics of common op-amp circuits.

Prelab-Information:

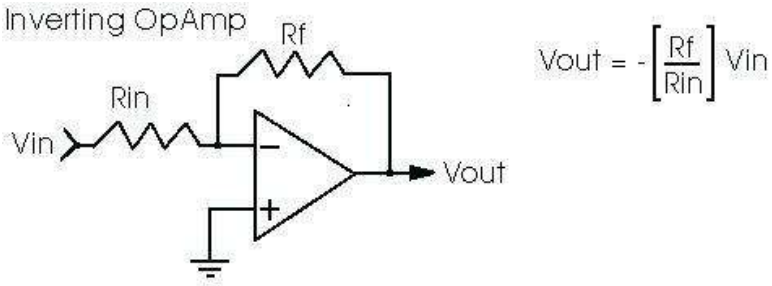

Figure 1 (Inverting Op Amp)

- $A = -\frac{Rf}{Ri} = \frac{Vout}{Vin}$
- $Vout = Vin \times A$

Procedure:

- Step 1-2:

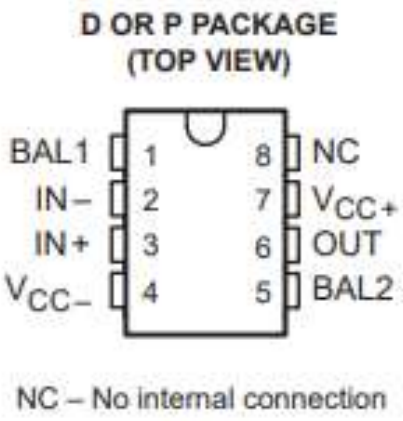

Figure 2 (LF411 Op Amp diagram)

Figure 3 (LF411 Info from Datasheet)

Max DC Supply [V]	Max Input [V]	Unity Gain [MHz]	Input Impedance [Ω]	Slew Rate [V/us]
18	15	3	10^12	13

- Step 4-5:

$A = -\frac{Rf}{Ri} = \frac{Vout}{Vin}$

$Vout = Vin \times A$

- **NOTE:** Vin and Vout are not placed on proportionate graphs on oscilloscope. True values are annotated under each oscilloscope image

Experiment 40-2:

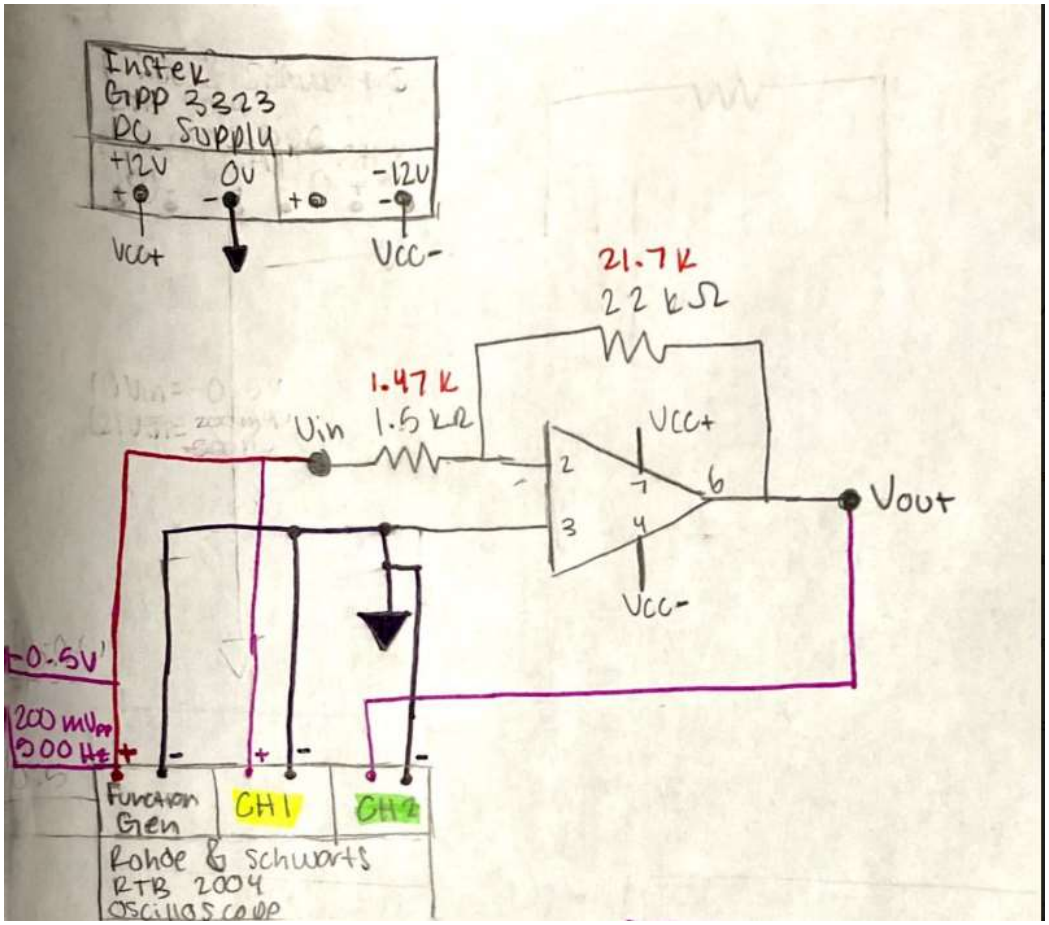

Figure 4 (Circuit Sketch with LF411, Power Supply, and Oscilloscope, Vin at pin 2)

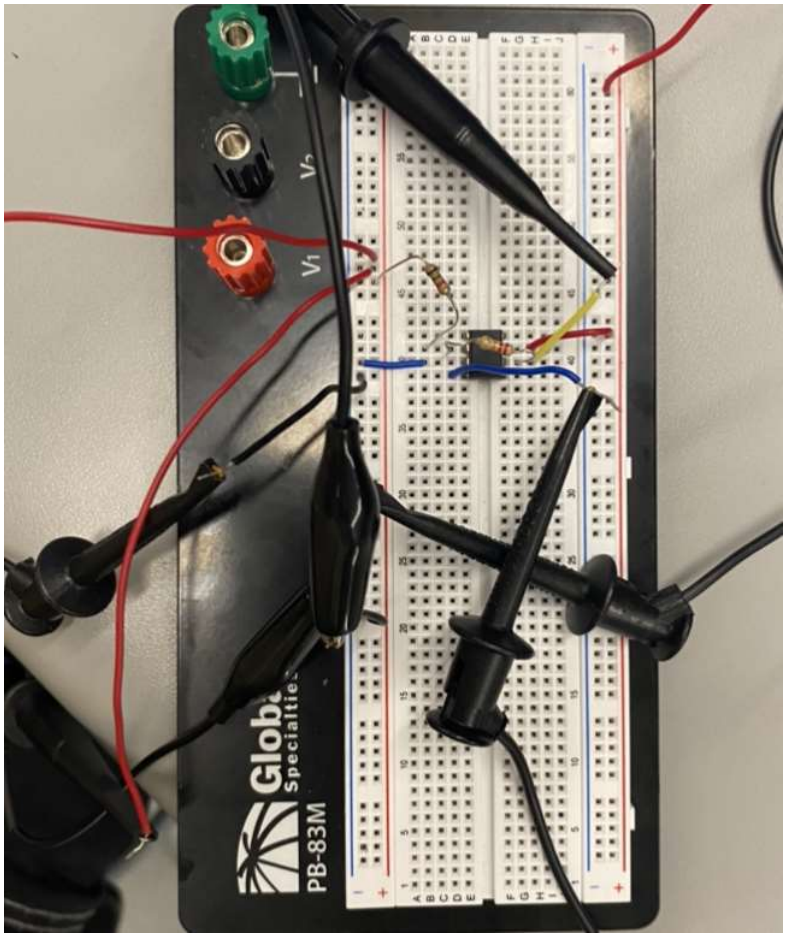

Figure 5 (Real Circuit Set Up: red = voltage sources, blue = -12 V, black = ground, yellow = oscilloscope channels)

Figure 6 (Calculated and measured circuit values)

DC	Input Voltage [V]	Output Voltage [V]	Output Saturation [V]	Gain
Calculated (Ideal)	-0.5	7.3	NA	-14.6
Calculated (Real)	-0.5	7.4	NA	-14.8
Measured	-0.5	7.1	NA	-14.2
AC/SINE	Input Voltage [mVpp]	Output Voltage [Vpp]	Output Saturation [Vpp]	Gain
Calculated (Ideal)	200	2.9	NA	-14.6
Calculated (Real)	200	3.0	NA	-14.8
Measured	200	3.0 < 90	11.5	15

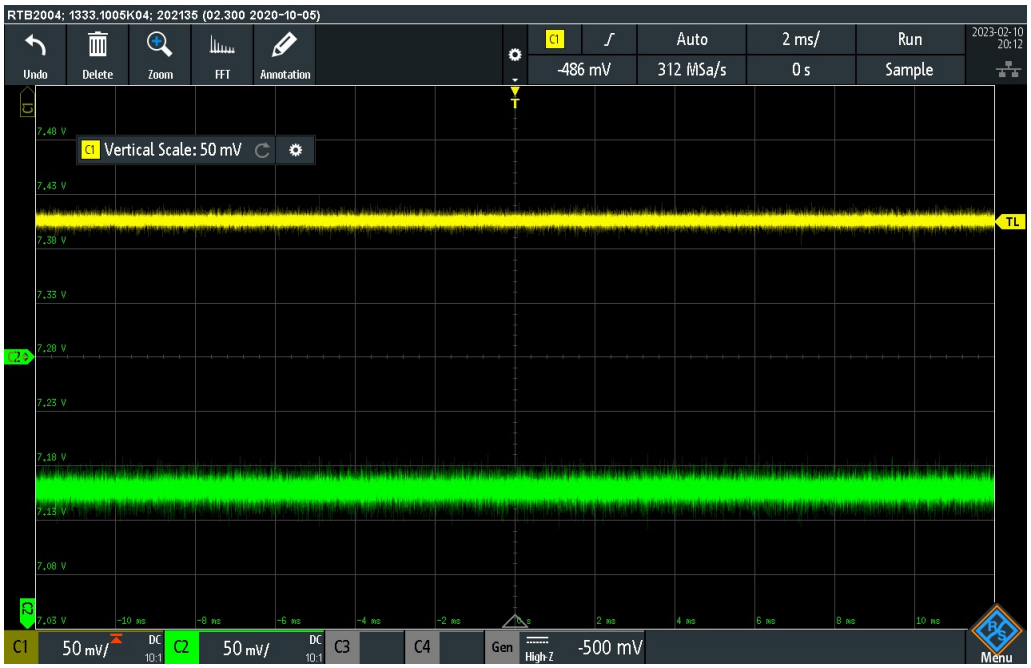

Figure 7 (Oscilloscope screenshot(DC Voltage): Vin (yellow channel 1) = -0.5 V, Vout (green channel 2) = 7.1 V)

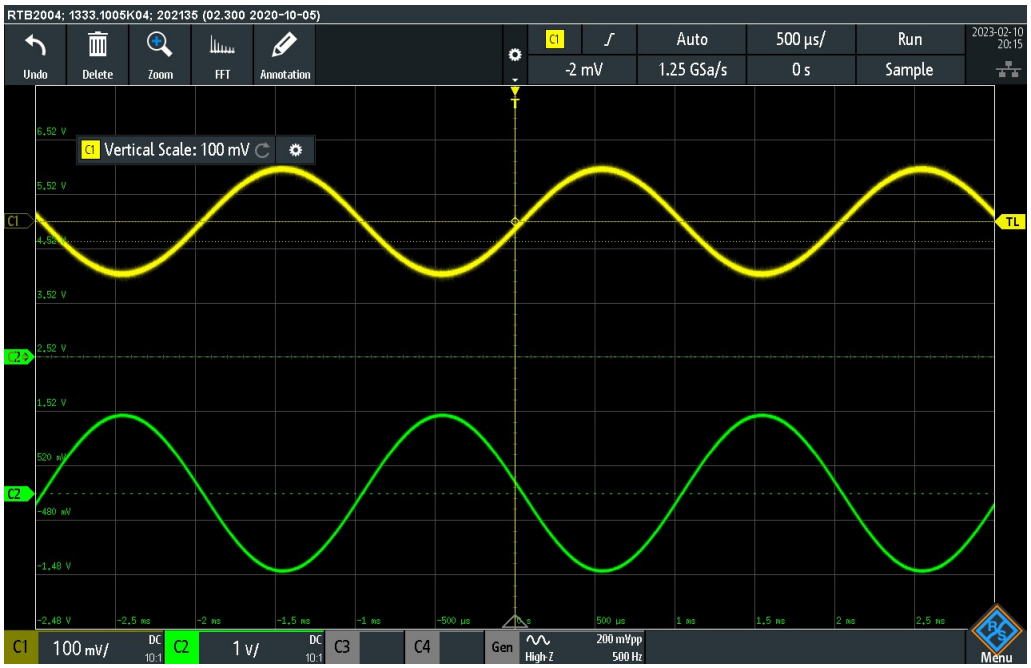

Figure 8 (Oscilloscope screenshot (AC/Sine Voltage): Vin (yellow channel 1) = 200 mVpp, Vout (green channel 2) = 1.5 Vpp

Experiment 40-3:

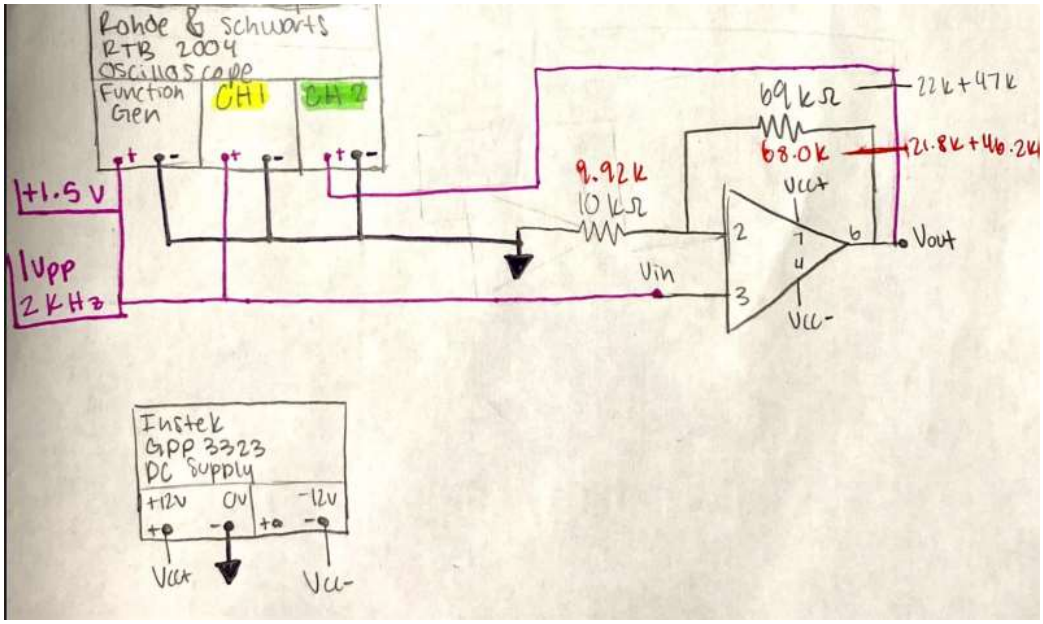

Figure 9(Circuit Sketch with LF411, Power Supply, and Oscilloscope, Vin at pin 3)

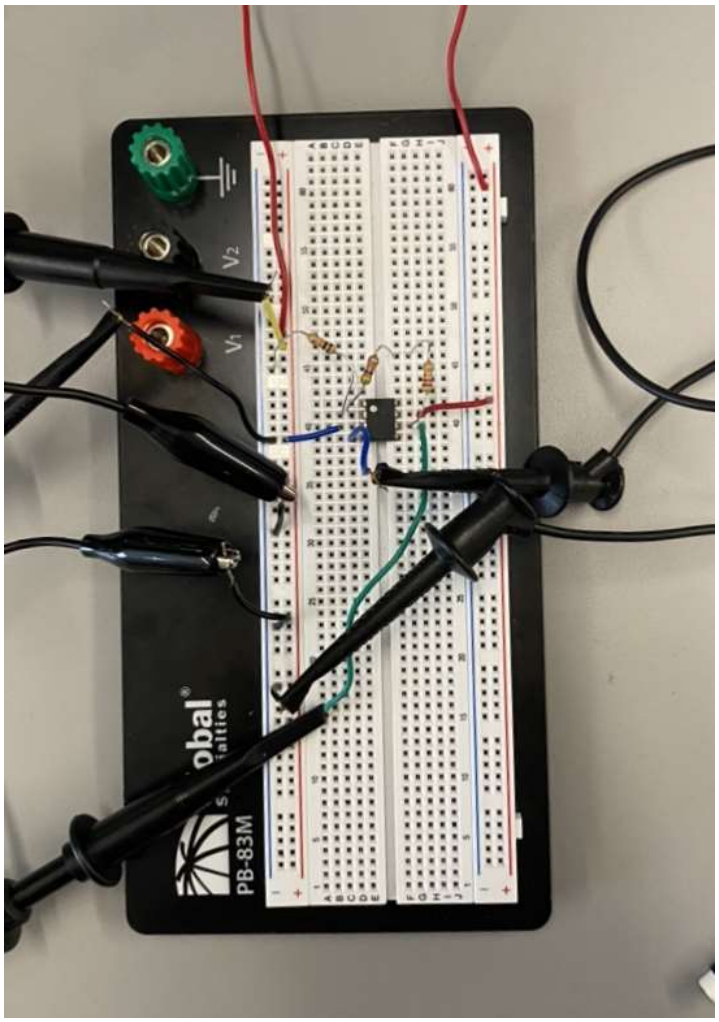

Figure 10 (Real Circuit Set Up: red = voltage sources, blue = -12 V, black = ground, yellow = channel 1, green = channel 2)

Figure 11 (Calculated and measured circuit values AC and DC)

DC	Input Voltage [V]	Output Voltage [V]	Output Saturation [V]	Gain
Calculated (Ideal)	+1.5	10.4	NA	-6.9
Calculated (Real)	+1.5	10.3	NA	-6.9

Measured	+1.5	11.3	NA	
AC/SINE	Input Voltage [mVpp]	Output Voltage [Vpp]	Output Saturation [Vpp]	Gain
Calculated (Ideal)	1	6.9	NA	-6.9
Calculated (Real)	1	6.9	NA	-6.9
Measured	1	5.5 < 0	11.5	5.5

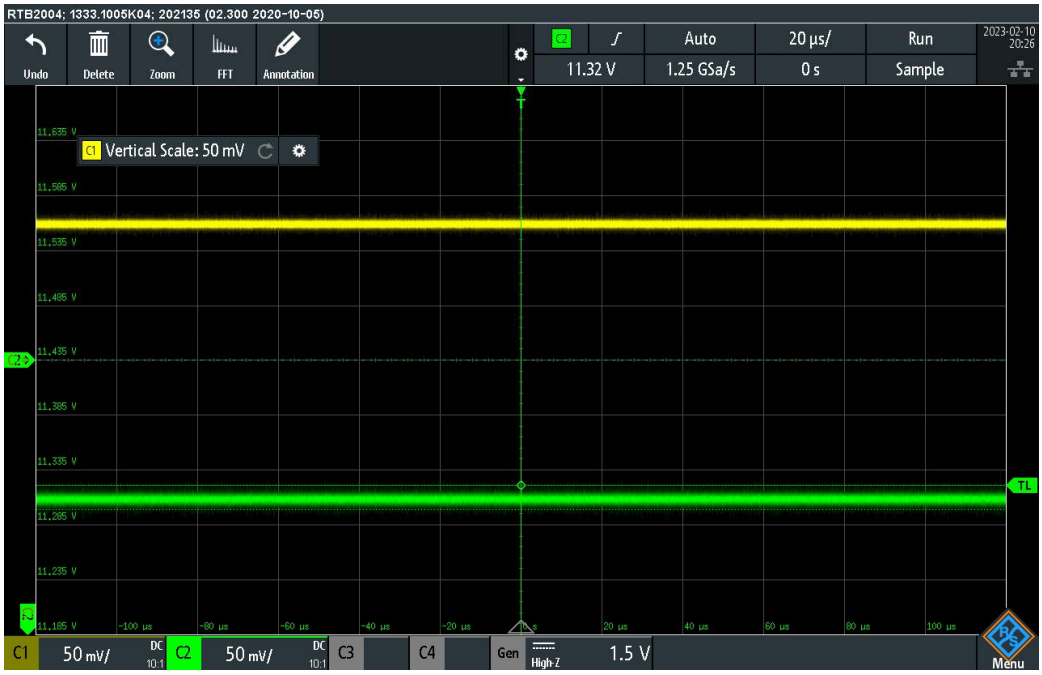

Figure 12 (Oscilloscope screenshot (DC Voltage): Vin (yellow channel 1) = +1.5 V, Vout (green channel 2) = 11.3 V

Figure 13 (Oscilloscope screenshot (AC/Sine Voltage): Vin (yellow channel 1) = 1 Vpp, Vout (green channel 2) = 5.5 Vpp - clipping/saturation at 11.5 Vpp note for Figure 13: if voltage signal did not reach saturation, Vout ≈ 6.9 Vpp so the Vout is more than half the predicted value)

Questions:

1. Op amps amplify both dc and ac signals? a. True b. False
   True
2. An op-amp circuit could be made to have a gain of less than 1. a. True b. False
   True
3. What type of transistors are used to build this op amp. (See data sheet.)