Lab 02 Basic OPAMP Circuit: Negative Feedback

【Purpose】

Build basic negative feedback OP amplifier. Understand the working principle of the inverted amplifier, integrator and differentiator

【Theory】

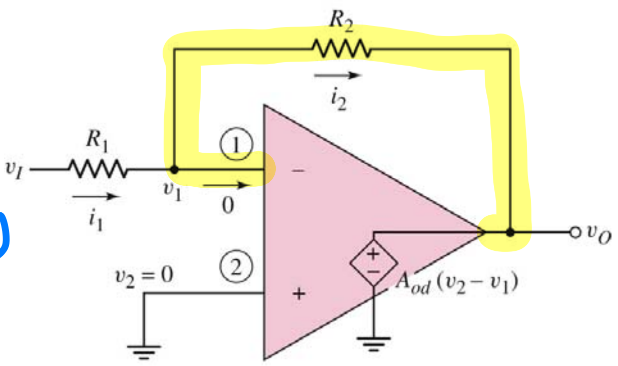
Negative feedback circuit: Inverting amplifier

Negative feedback is studied in control system for constructing a very stable, accurate system. The concept has been widely used in engineering including mechanical, electronic engineering, and can be seen in many other fields such as biology, chemistry and economics. In a feedback control system, the output is sampled and a fraction of it is sent back to the input. The returning signal combines with the original input, producing unusual changes in the system performance. For the negative feedback circuit, the output (voltage or current) is fed back to the inverting input of OPAMP as part of the input. The advantages of the negative feedback circuit are: stabilizing the gain, improving input and output impedances, and increasing bandwidth. The figure shows a common negative feedback circuit, inverting amplifier. The voltage gain (A) of this circuit is

$$A \ \ (Gain) = \frac{v_O}{v_I} = -\frac{R_2}{R_1}$$

− : inverting input

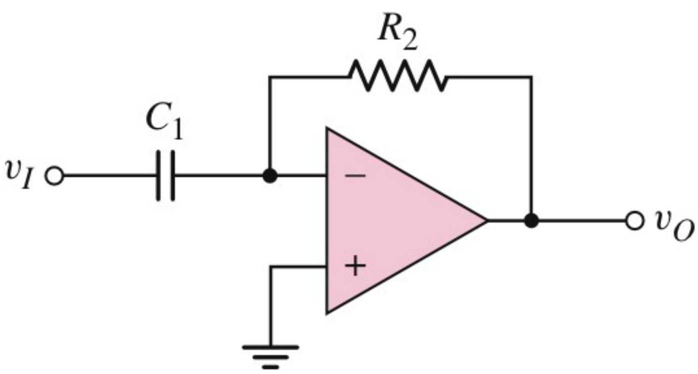
+ : non-inverting input



Integrator and differentiator

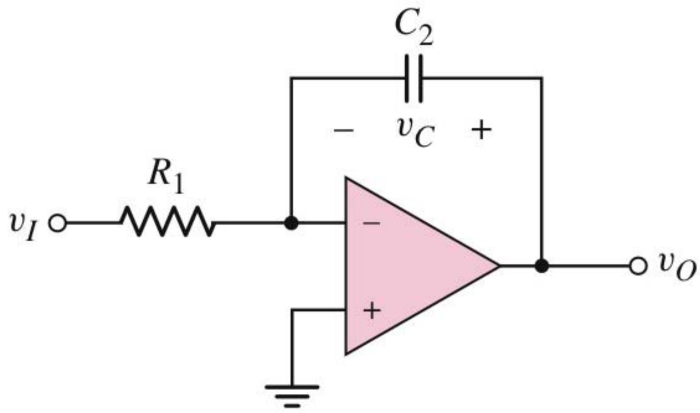
The relation of output and input of the OPAMP circuit can be integrating or differentiating with the resistor replaced by capacitor. The circuit of differentiator is shown here and formula for output and input is

$$v_O = -R_2 C_1 \frac{dv_I}{dt}$$



The circuit of integrator is shown here and formula for output and input is

$$v_O = -\frac{1}{R_1 C_2}\int v_I dt$$



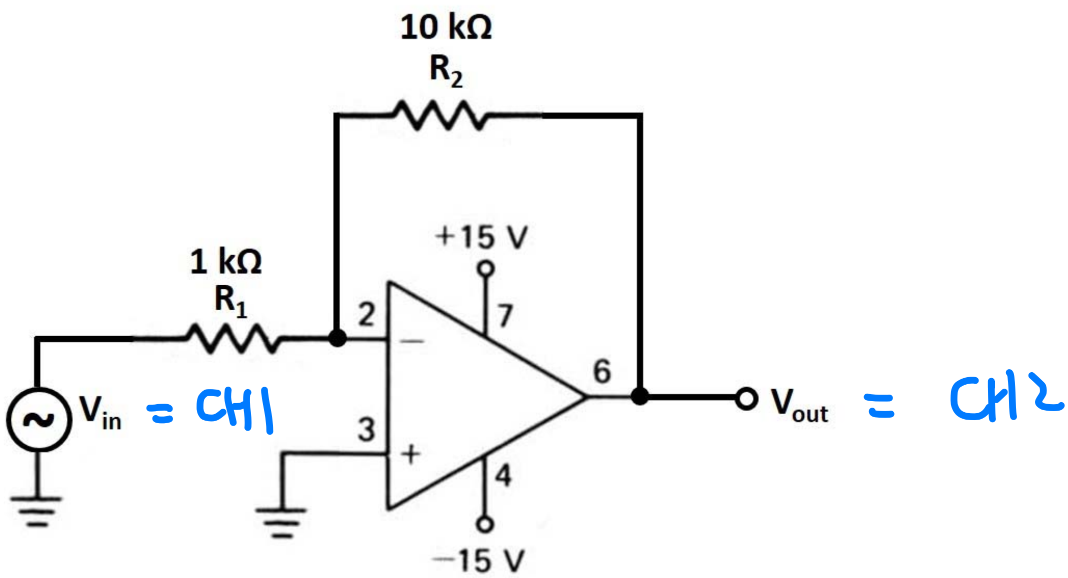
【儀器】

Oscilloscope (示波器)、Function generator (訊號產生器)、Power supply (電源供應器)、resistor (1KΩ, 10KΩ, 47KΩ, 100KΩ)、capacitor (0.1 uF)、OPAMP (ua741C)

【步驟】

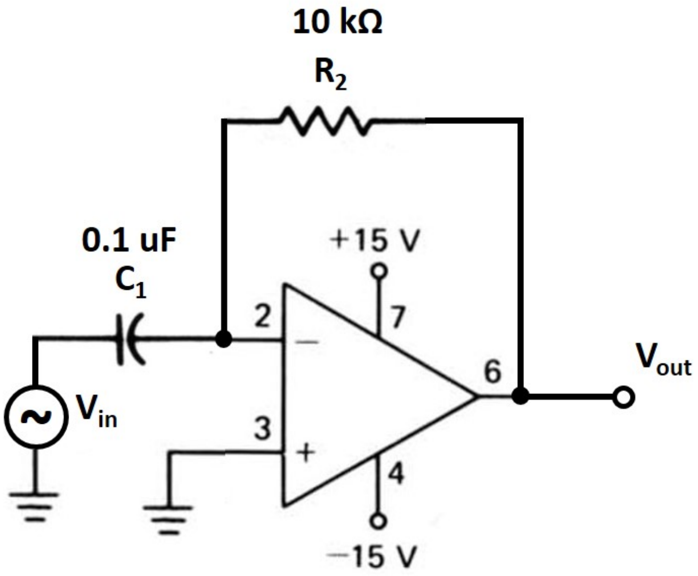
Inverting amplifier

1. Connect the circuit.
2. Set AC generator to sinusoid wave at 1000 Hz. Adjust signal level to get a 10.0 V peak-to-peak ($V_{p\text{-}p}$) at the output voltage (pin6).
3. Measure and record the $V_{p\text{-}p}$ of the input voltage in table.
4. Compare the waveform of the input and output signals. Are they in phase or 180° out of phase? o.p
5. Repeat steps 2 and 4 for values listed in the table



Differentiator

1. Connect the circuit.
2. Set AC generator to triangle wave at 100 Hz with $V_{p\text{-}p}$= 2.0 V.
3. Measure and record the $V_{p\text{-}p}$ of the out voltage (pin6) in table.
4. Draw the waveform of the output signals.
5. Repeat steps 2 and 4 for values listed in the table



【Questions】

1. For the inverting amplifier, what is the relationship between the polarity of the output and input voltages in your experiment?
2. For the inverting amplifier, what is the relationship between gain and R1 and R2 according to the data you record? Dose it bear out the gain formula (R2/R1)?
3. If you want to sum up two signal, where should you put the 2^{nd} input in the inverting amplifier?
4. For the differentiator, what waveform do you see in the output? Why?
5. For the differentiator, what is the relationship between voltage of input and output in your experiment? Dose it bear out the formula?
6. For the differentiator, will be output voltage change when you change the frequency of the input triangle wave.

【Supplement】

Table 1

R2, KΩ	$V_{out, p-p}$	$V_{in, p-p}$	Gain (A, V_{out}/V_{in})	Gain (Theory)	Phase
10	10	1	10	10	π
47	10	0.22	45.45	47	π
100	10	0.1	100	100	π

Table 2

R2, KΩ	$V_{in, p-p}$	$V_{out, p-p}$	Waveform (V_{out})
10	2	1	square wave
47	2	4	
100	2	10	

6.

① $R_2 = 100\,k\Omega$

f_c

f	50	100	500	1000	2200
$V_{o, p-p}$	5	10	27.5	27.5	27.5

② $R_2 = 1\,k\Omega$

f	50	100	500	1K	2K	4K	8K
$V_{o, p-p}$	0.05	0.1	0.5	0.85	1.7	3.4	≈6.8