

Lab 03 Basic OPAMP Circuit: Gain and Bandwidth

【Purpose】

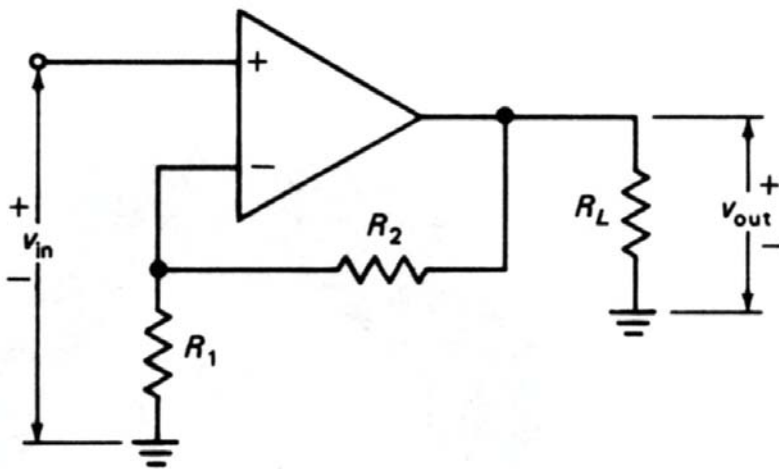
Understand the relation between the gain and bandwidth of basic negative feedback OP amplifier.

【Theory】

Linear OPAMP circuit: Voltage amplifier

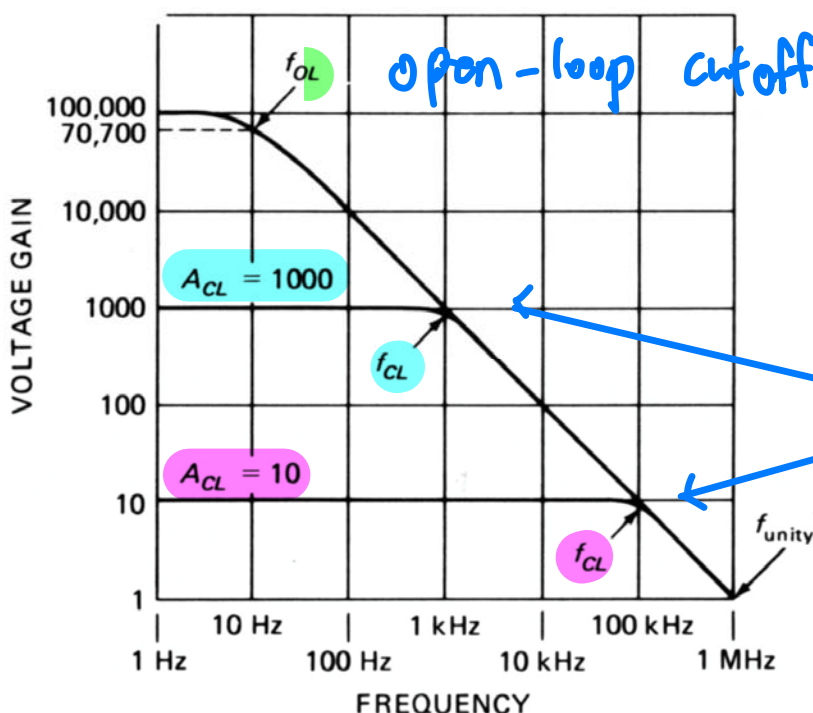
Voltage gain (A) of an amplifier is defined as the ratio of output to the input with values usually displayed in dB

$$A = \frac{v_{out}}{v_{in}} = \frac{R_2}{R_1} + 1 \text{ and } A_{dB} = 20 \log |A|$$



-3dB
↑

The upper cutoff frequency of the voltage gain (f_{CL}) is the frequency when gain drops to $1/\sqrt{2}$ (0.707) of its maximum value ($A/\sqrt{2}$). For OPAMP, the gain bandwidth product is a constant. For example, the 741C has gain bandwidth product around 1MHz, which means $f_{CL}A_{CL} = \text{constant} = 1\text{MHz}$. The plot of gain versus frequency is shown in the figure.



$$f_{CL} \times A_{CL} = \text{Gain - Bandwidth Product}$$

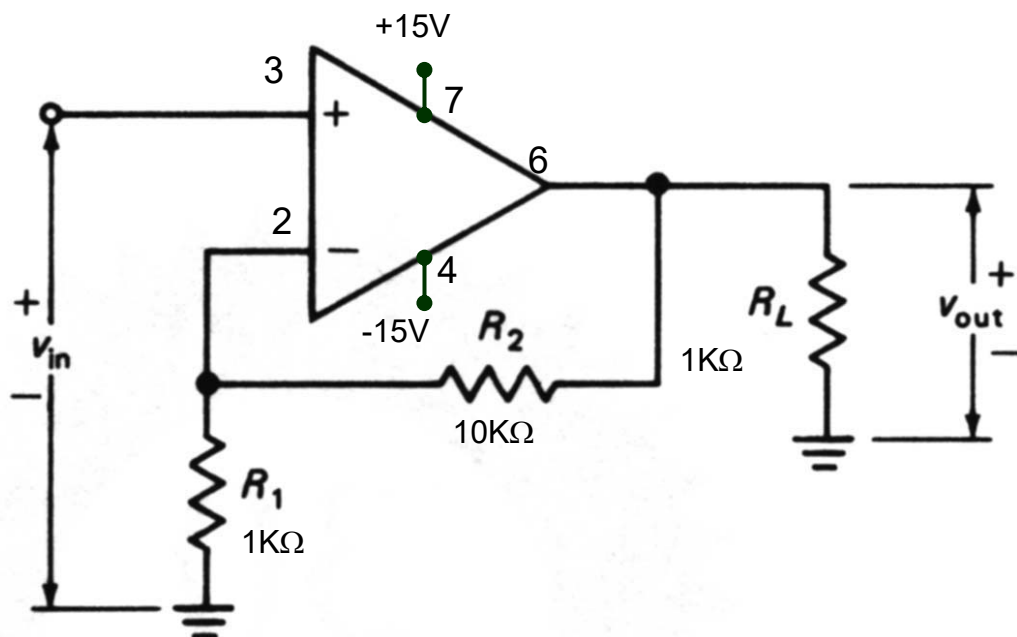
【Instruments】

Oscilloscope(示波器)、Function generator(訊號產生器)、Power supply(電源供應器)、resistor ($1\text{K}\Omega \times 2$, $10\text{K}\Omega$, $47\text{K}\Omega$, $100\text{K}\Omega$)、OPAMP (ua741C)

【Steps】

Voltage amplifier

1. Connect the circuit.
2. Set AC generator to sinusoid wave at 1000 Hz. Adjust signal level to get $V_{p-p} = 10.0\text{ V}$ at the output voltage (pin6).
3. Measure and record the peak-to-peak input voltage (pin3) in table
4. Increase the frequency until the output voltage decrease to $V_{p-p} = 7.0\text{ V}$. This is the cutoff frequency (f_{CL}) of this circuit. Record it in the table.
5. Repeat steps 2 and 3 for values listed in the table
6. Change another OPAMP (741C) and repeat steps 2 to 5. Record data in the table.
7. Calculate the close loop voltage gain (A), equivalent decibel gain (A_{db}) and gain bandwidth product ($A \cdot f_{CL}$) in the table.



【Questions】

1. What is the theoretical voltage gain (A) in this circuit? Does it match what you measure in the experiment?
2. Is the gain bandwidth product a constant in this experiment? Is it close to the theoretical value?
3. Are two OPAMP showing similar gain and the gain bandwidth product in your experiment?
4. If you change R_2 to $240\text{ K}\Omega$ in the circuit. What should be the voltage gain (A) and bandwidth (f_{CL}) of this circuit?

CL: closed loop

【Supplement】

Table

R2, K Ω	V _{out} , p-p	V _{in} , p-p	A	A _{db}	f _{CL}	A*f _{CL}
10	10	0.92	10.86	20.72	33kHz	358.38k
47	10	0.22	45.45	33.15	18kHz	818.1k
100	10	0.10	100	40.00	8kHz	800k