Lab 05 Active Filter

【Purpose】

Build active filter using op amps and reactive elements

【Theory】

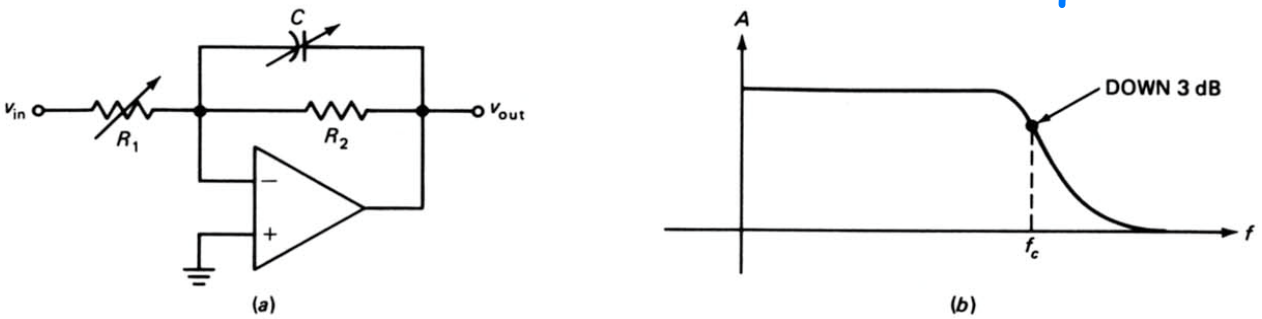
Frequency response of Filter

Voltage gain (A) of a filter is defined as:

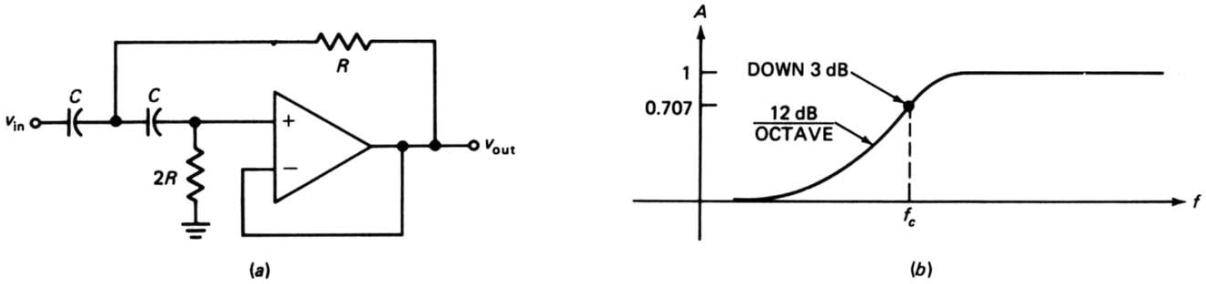
$$A = \frac{v_{out}}{v_{in}} \quad A_{dB} = 20log|A|$$

Ideally, A=1 for pass band. Frequency response is plot of frequency (f) vs A_{dB}. Cutoff frequency (fc) is where voltage gain equals 0.707 (AdB= -3 dB).

Example of low pass filter and frequency response with $f_c = \frac{1}{2\pi R_2 C}$ 1592.4



Example of high pass filter and frequency response with $f_c = \frac{0.707}{2\pi RC}$ 1125.8



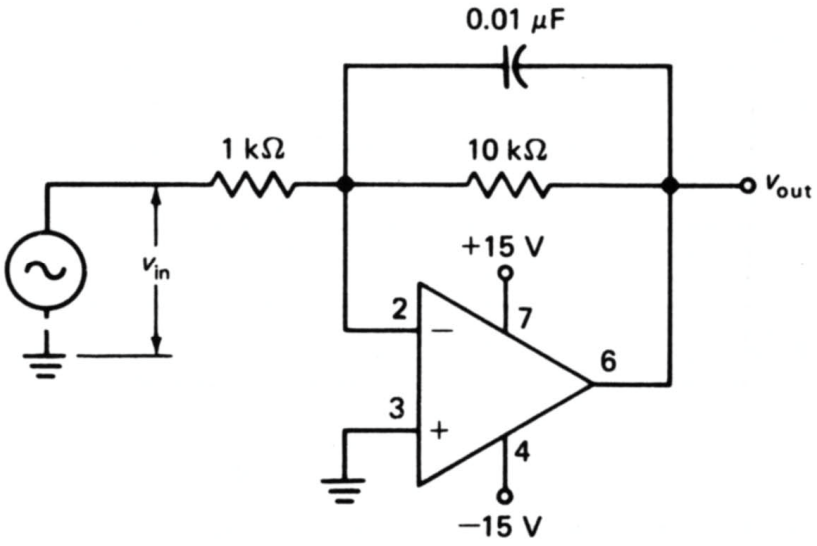
【Instrument】

Oscilloscope(示波器)、Function generator(訊號產生器)、Power supply(電源供應器)、Resistor (1KΩ,10KΩ, 22KΩ)、Capacitor (0.01 uF x2 -103p)、OPAMP (ua741C)

【Steps】

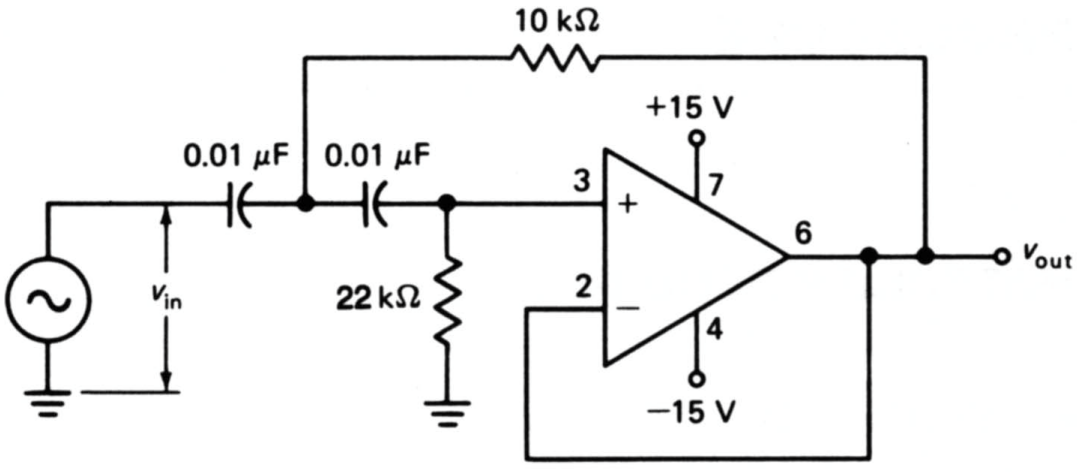
1st order low pass filter

1. Connect the circuit.
2. Set function generator to 100 Hz. Adjust signal level to get a 1 V peak-to-peak at the output voltage. Measure and recode peak-to-peak input voltage in the table. $V_{pp\text{-}in} = 3.4\,(V)$
3. Change the frequency (200Hz to 10 KHz) and measure the input/output voltages. Record the data in table.
4. Calculate the voltage gain (A) and equivalent decibel gain (A_{dB})
5. Measure the cutoff frequency fc.



2nd order high pass filter

1. Connect the circuit.
2. Set function generator at 10 kHz. Adjust signal level to get a 1 V peak-to-peak at the output voltage. Measure and recode peak-to-peak input voltage in table. 0.96 V
3. Change the frequency (10 KHz to 100 Hz) and measure the input/output voltages. Record the data in table.
4. Calculate the voltage gain (A) and equivalent decibel gain (A_{dB})
5. Measure the cutoff frequency fc.



【Questions】

For 1st order low-pass filter

1. What is the theoretical voltage gain at 100 Hz and cutoff frequency? Why this value differ from the recorded values?
2. How fast should the voltage gain decrease? How much decrease is there between 5 and 10 kHz?

For 2nd order high-pass filter

3. What is the theoretical cutoff frequency?
4. How fast should the voltage gain decrease above the cutoff frequency? Compare this to the recorded data.
5. How fast should the voltage gain decrease below the cutoff frequency? Compare this to the recorded data.

【Supplement】

Table 1

(p-p) (p-p)

f	V_{in}	V_{out}	A	A_{db}
100 hz	0.1	1	10	
200 hz	0.1	1	10	
500 hz	0.1	1	10	
1 khz	0.1	0.85	8.5	
2 khz	0.1	0.6	6	
5 khz	0.1	0.32	3.2	
10 khz	0.1	0.17	1.7	

【Questions】

For 1st order low-pass filter

1. What is the theoretical voltage gain at 100 Hz and cutoff frequency? Why this value differ from the recorded values?
2. How fast should the voltage gain decrease? How much decrease is there between 5 and 10 kHz?

For 2nd order high-pass filter

3. What is the theoretical cutoff frequency?
4. How fast should the voltage gain decrease above the cutoff frequency? Compare this to the recorded data.
5. How fast should the voltage gain decrease below the cutoff frequency? Compare this to the recorded data.

【Supplement】

Table X 2

f	V_{in}	V_{out}	A	A_{db}
100 hz		0.012		
200 hz		0.035		
500 hz		0.19		
1 khz	0.96	0.76		
2 khz		0.92		
5 khz		1		
10 khz		1		