

# **2CJ4 LAB Report**

## **Set 5**

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Cooperate with:

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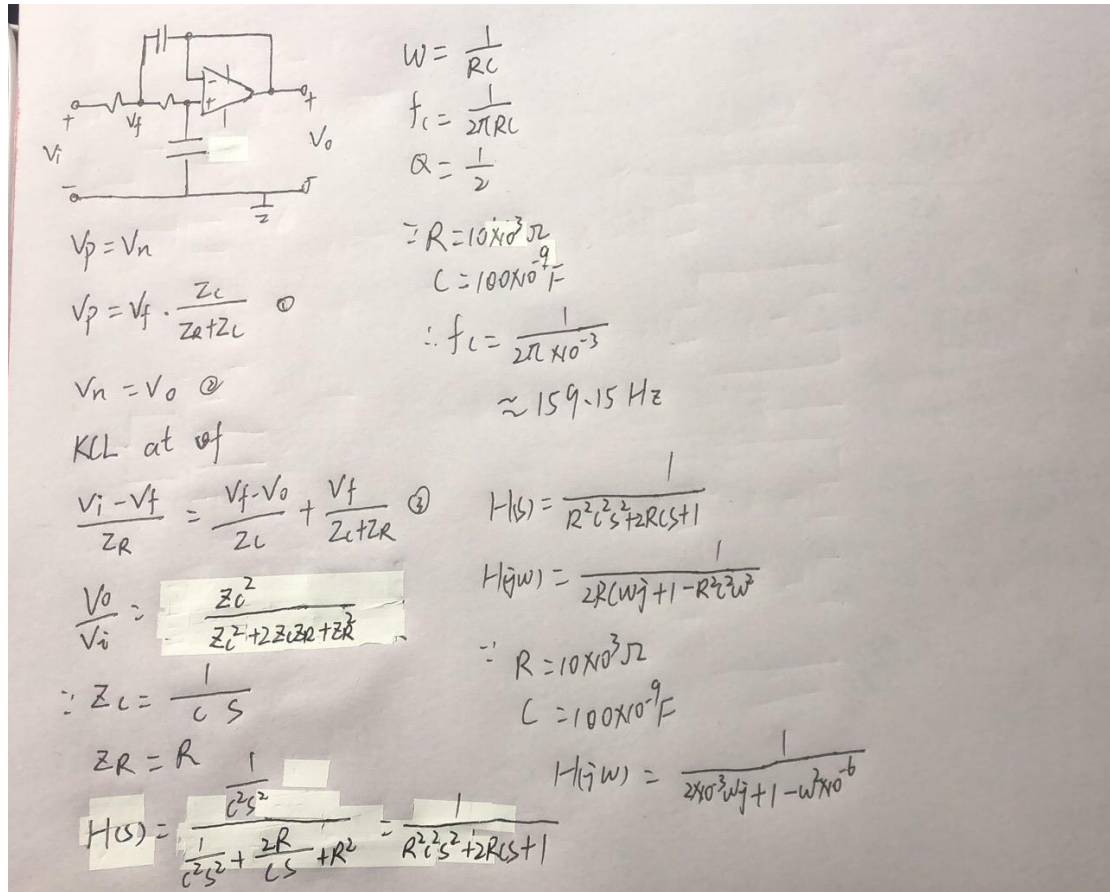
Jishen Wang (400228352)

As a future member of the engineering profession, the student is responsible for performing the required work in an honest manner, without plagiarism and cheating. Submitting this work with my name and student number is a statement and understanding that this work is our own and adheres to the Academic Integrity Policy of McMaster University and the Code of Conduct of the Professional Engineers of Ontario.

1. The expression for the transfer function:

$$H(j\omega) = 1 / (1 - \omega^2 \cdot 10^{-6} + 0.002j\omega)$$

The calculation:



Handwritten calculations and circuit diagram for an active filter. The circuit diagram shows an op-amp configured as a voltage follower with a feedback network consisting of a resistor R and a capacitor C in parallel. The input is  $V_i$  and the output is  $V_o$ . The calculations include:

- $V_p = V_n$
- $V_p = V_f \cdot \frac{Z_c}{Z_r + Z_c}$  (1)
- $V_n = V_o$  (2)
- KCL at  $V_f$
- $\frac{V_i - V_f}{Z_r} = \frac{V_f \cdot V_o}{Z_c} + \frac{V_f}{Z_c + Z_r}$  (3)
- $\frac{V_o}{V_i} = \frac{Z_c^2}{Z_c^2 + 2Z_c Z_r + Z_r^2}$
- $Z_c = \frac{1}{C s}$
- $Z_r = R$
- $H(s) = \frac{1}{C^2 s^2 + \frac{2R}{C} s + R^2}$
- $W = \frac{1}{RC}$
- $f_c = \frac{1}{2\pi RC}$
- $\alpha = \frac{1}{2}$
- $R = 10 \times 10^3 \Omega$
- $C = 100 \times 10^{-9} F$
- $f_c = \frac{1}{2\pi \times 10^{-3}} \approx 159.15 \text{ Hz}$
- $H(s) = \frac{1}{R^2 C^2 s^2 + 2RCs + 1}$
- $H(j\omega) = \frac{1}{2RC(j\omega) + 1 - R^2 C^2 \omega^2}$
- $R = 10 \times 10^3 \Omega$
- $C = 100 \times 10^{-9} F$
- $H(j\omega) = \frac{1}{2 \times 10^{-3} j\omega + 1 - \omega^2 \times 10^{-6}}$

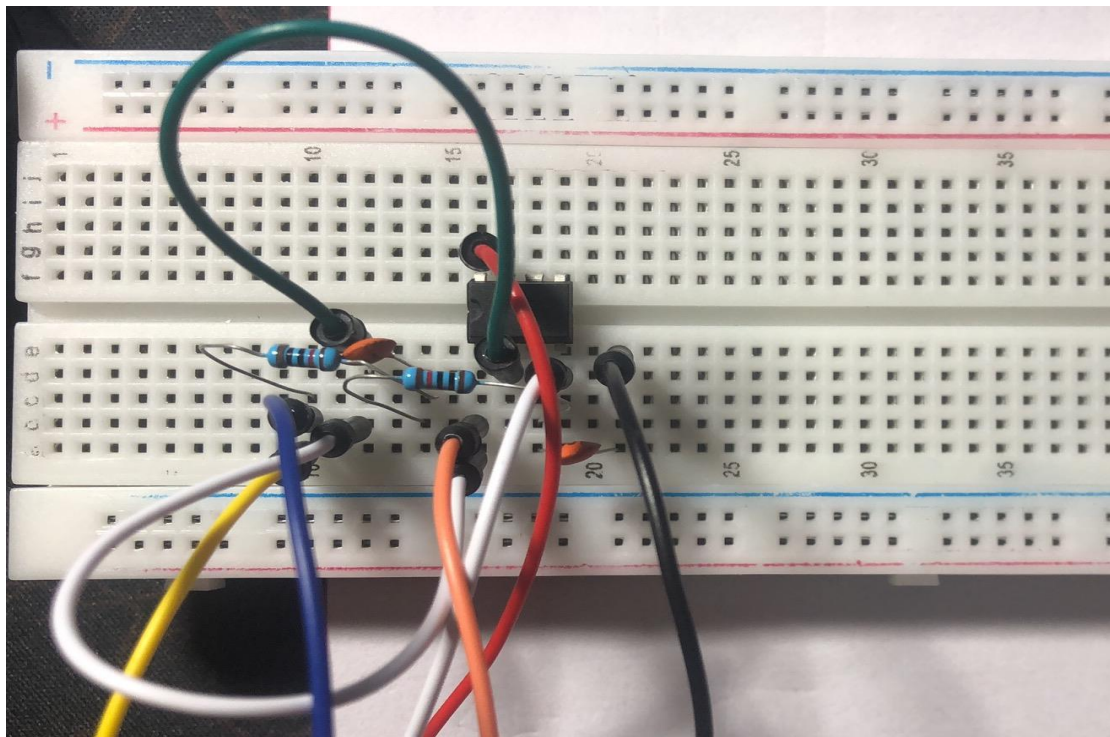
2. The cut-off frequency of this filter is 159.15Hz.

3. The table:

Frequency	Angular velocity ( $\omega$ )	abs( $V_o/V_i$ ) analytical	abs( $V_o/V_i$ ) measured
50Hz	100pi	9.10E-01	9.81E-01
100Hz	200pi	7.17E-01	9.40E-01
200Hz	400pi	3.88E-01	8.11E-01
500Hz	1000pi	9.20E-02	4.51E-01

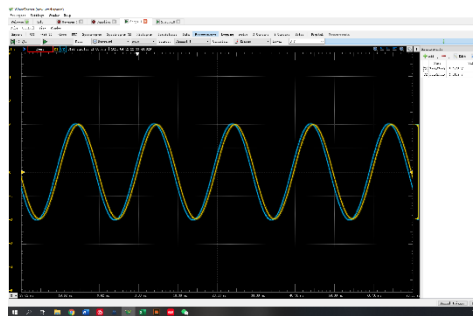
1kHz	2000pi	2.47E-02	2.02E-01
1.1kHz	2200pi	2.05E-02	1.75E-01
1.2kHz	2400pi	1.73E-02	1.56E-01
1.3kHz	2600pi	1.48E-02	1.38E-01
1.4kHz	2800pi	1.28E-02	1.26E-01
1.5kHz	3000pi	1.11E-02	1.13E-01
1.6kHz	3200pi	9.80E-03	1.03E-01
1.7kHz	3400pi	8.69E-03	9.43E-02
1.8kHz	3600pi	7.76E-03	8.80E-02
1.9kHz	3800pi	6.97E-03	8.07E-02
2kHz	4000pi	6.29E-03	7.33E-02
5kHz	10000pi	1.01E-03	4.85E-02

4. The circuit:

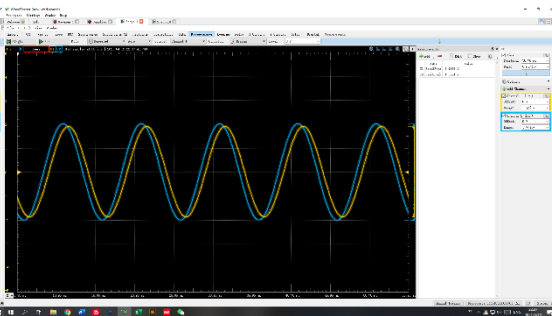


## 5. The measurement:

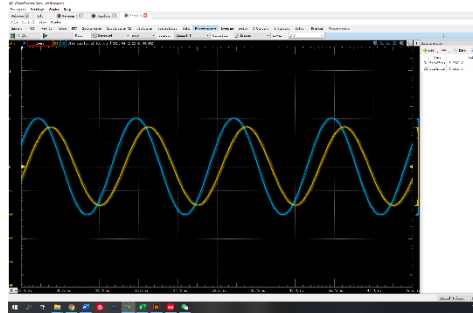
50Hz



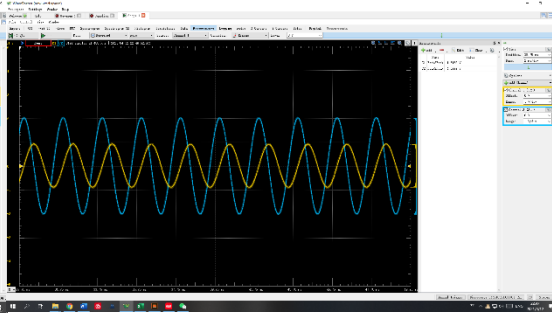
100Hz



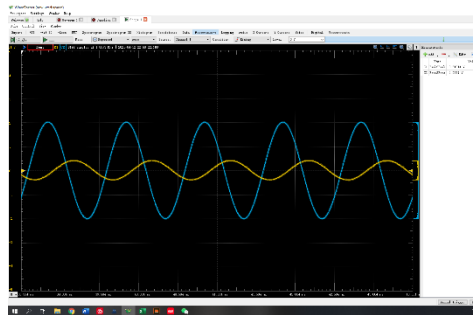
200Hz



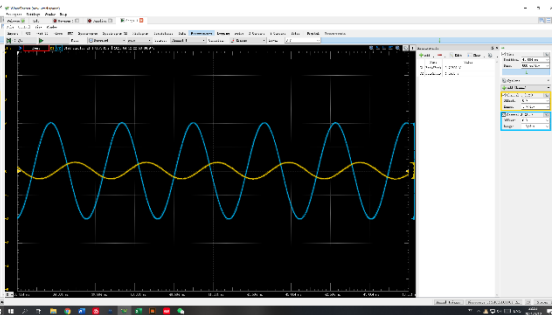
500Hz



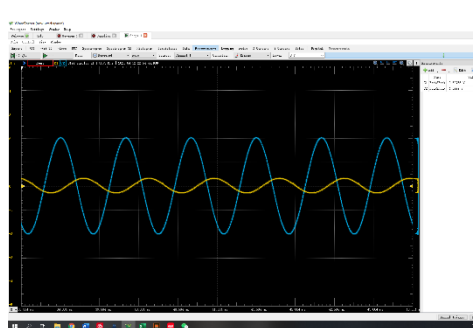
1kHz



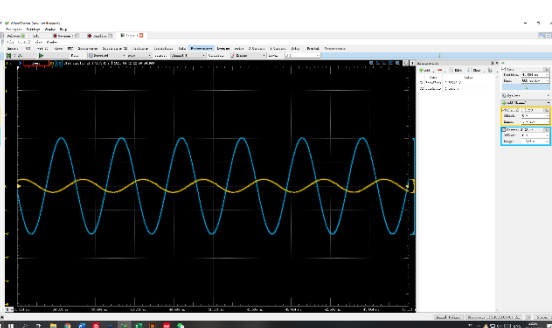
1.1kHz



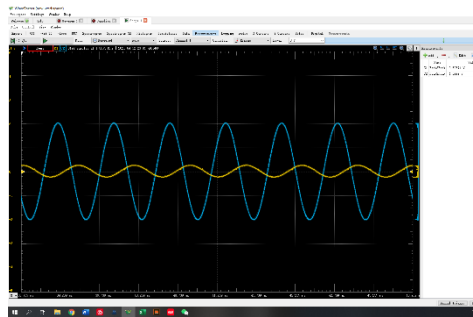
1.2kHz



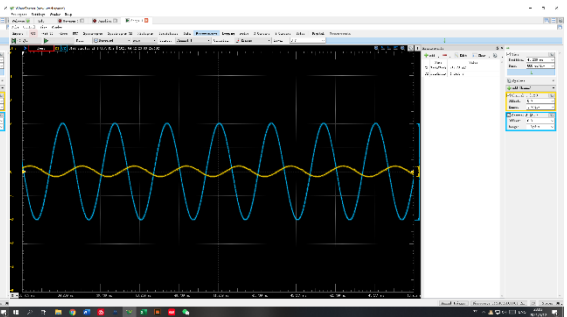
1.3kHz



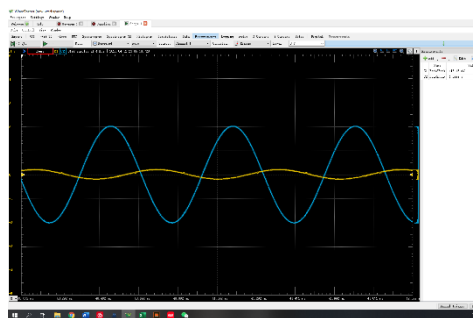
1.4kHz



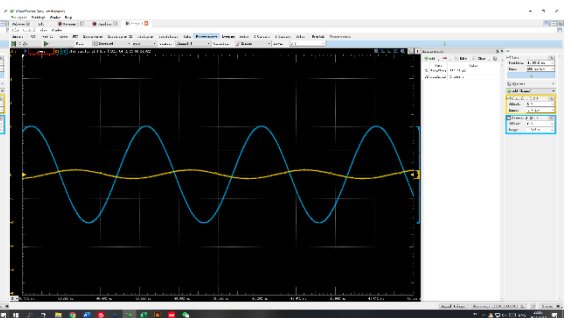
1.5kHz



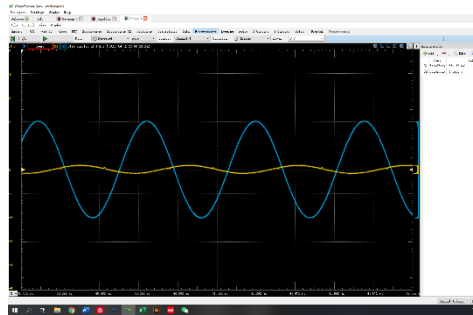
1.6kHz



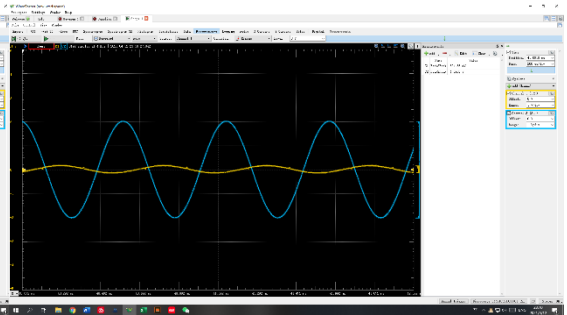
1.7kHz



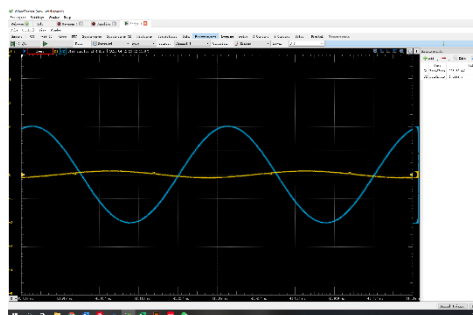
1.8kHz



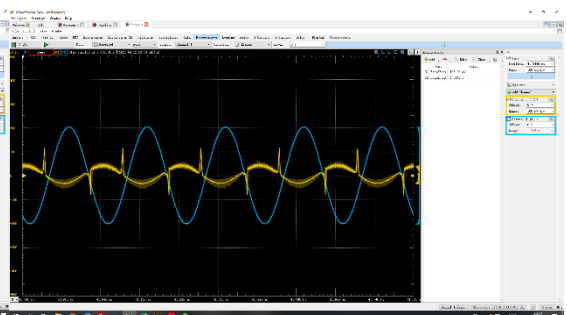
1.9kHz



2kHz



5kHz



6.