PH2255 Course:
Introduction to Statistical Methods
Exercise 4

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0.1 Question 1

Using Kirchoff's first law to sum the voltages around the LCR circuit:

$$V = IZ = I\,(R + i\omega L + frac1i\omega C) \tag{1}$$

We can rewrite this in differential form:

$$L\ddot{q} + r\dot{q} + \frac{1}{C}q = 0 \tag{2}$$

This is in the same form as a damped mechanical oscillator $\ddot{q} + \gamma\dot{q} + \omega_0^2 q = 0$ Therefore $\omega_0 = \sqrt{1/LC}$ From definition $\omega = \frac{2\pi}{T} = 2\pi f$

$$f_0 = \frac{1}{2\pi}\sqrt{\frac{1}{LC}} \tag{3}$$

0.2 Question 2

Using values of $L = 5mH = 5 \times 10^{-3}H$ and $C = 1nF = 1 \times 10^{-9}F$:
$f_0 = 71,176.25Hz$

0.3 Question 3

For $\Delta\phi = 0,\ f = 71.18kHz$
Peak-to-peak voltages:
CH1: $1.463V$
CH2: $1.082V$
$\therefore V_2/V_1 = 0.7395$
This small

$$\sim 10Hz$$

discrepancy comes from additional impedance from the connections/wires in the circuit.

0.4 Question 4

Starting frequency $f_{\min} = 60kHz$, at $V_2/V_1 = 0.1296$
Ending frequency $f_{\max} = 82kHz$, at $V_2/V_1 = 0.1357$

0.5 Question 6

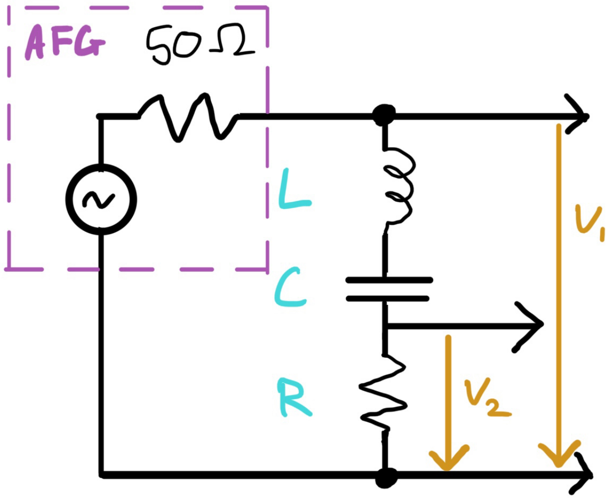
$$|Z| = \sqrt{R^2 + (\omega L - 1/\omega C)^2} \tag{4}$$

At resonance, $\omega L - 1/\omega C = 0$, therefore that term drops out of the equation, giving us a minimum value $|Z| = R$.

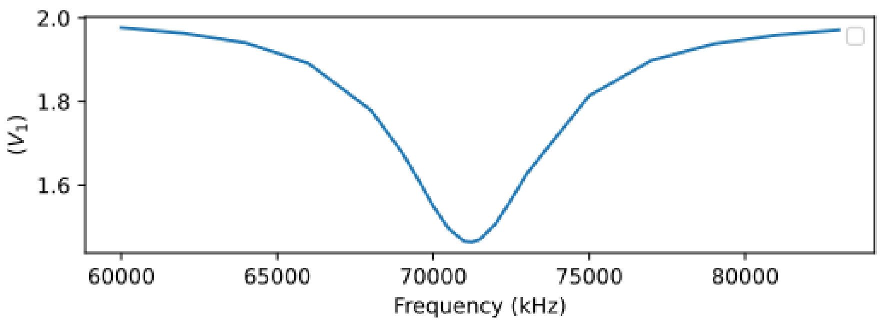
At high frequencies, the Inductor term ωL dominates.

At low frequencies, the Capacitor term $1/\omega C$ dominates.

0.6 Question 7



0.7 Question 8



A Python Code