Lab 3

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Lab 3

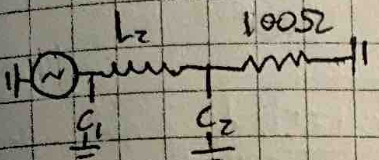
Pre-lab	5 +1
3.2	√5
3.3	√5

3.1
(a) Remeasured L_1 from lab 2: 2.887 ± 0.044 mH

↳ Predicted $\boxed{L_2 = L_1/25 = 115 \pm 1.8 \text{ mH}}$

(b) we want $Z_r \sim Z_L$, so if $L_2 = \frac{1}{5} L_1$, $Z_{L_2} = \frac{1}{5} Z_L$ →
$R_2 \sim \frac{1}{25} R_1$

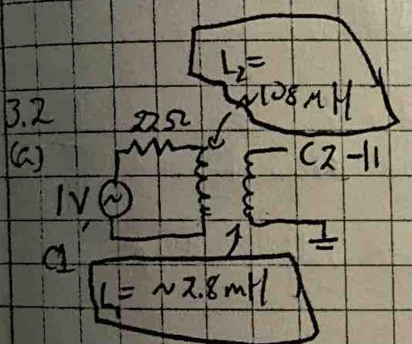
or 40Ω → 100Ω for the inductance measurement



$R_{measured} = 97.9 \pm 1$ Ω
↓
$\boxed{L_{measured} = 108.2 \pm 11.6 \text{ mH}}$

(c) the half-turns on both the "25-turn" and "5-turn" inductors messed things up - after recalculating, $(25.75/5.0)^2$ → predicted 108.8 ± 1.7 mH → agrees!

3.2
(a)



$Z_L = i\omega L$, $\omega = 2\pi \cdot 10^5$
↳ $Z_1 = 1.848 \pm 0.019$ kΩ, $Z_2 = 65.62 \pm 1.7$ Ω
$Z_1 >> 22$ Ω, so it won't affect much

(b) $V_{in} = 0.697 \pm 5e{-3}$ V, $V_{out} = 3.465 \pm 5e{-3}$ V, $\boxed{\frac{V_{out}}{V_{in}} = 4.97 \pm 0.04}$

agrees with 5.0!

$\sqrt{L_2/L_1} =$

also agrees with $N_{12} = 5.01 \pm 0.07$

(c) $V_{in} = 1.01 \pm 0.005$, $V_{out} = 0.20 \pm 0.005$ → $\boxed{\frac{V_{out}}{V_{in}} = 0.198 \pm 0.005}$

agrees with 0.2!
and with $N_{21} = 0.1995 \pm 0.0028$

(d) $N_{12} = (L_1/L_2)^{1/2} = \boxed{5.01 \pm 0.07}$, $k = \frac{V_1}{V_2} / N_{12} = \boxed{0.992 \pm 0.029}$

(e) $R = 21.7 \pm 0.27$, $\Delta V_1 = 14 \pm 0.05\,mV \rightarrow I = 0.65 \pm 0.08\ mA$

no one could figure this out

$V_{primary} = 1.01 \pm 0.005\ V \rightarrow$

$Z_{primary} = V_{primary}/I = \boxed{1970 \pm 90\ \Omega}$, does not agree w/ $1648 \pm 19\ \Omega$

(f) $R_2 \approx \underbrace{R_1\sqrt{Z_1/R_1}}\left(\frac{1}{N_{12}}\right)^2 = \boxed{8.24 \pm 0.32\ \Omega}$

↳ geometric mean to be as far as possible

(g) $\boxed{V_1 = 111\,mV}$, $\boxed{V_2 = 0.632\ V} \rightarrow \boxed{\frac{V_1}{V_2} = 0.175}$, does not agree w/ 0.2, 12% discrepancy

(h)

$I = \frac{0.117\ A}{22\ \Omega} = 5.08\,mA \longrightarrow Z_p = V/I = \frac{0.632}{5.08e-3} = \boxed{124.3\ \Omega}$

agrees w/ 117

it is lower than expectation, and it differs because

now that $R_L \neq \infty$, the 5-turn inductor can have much more current, and more energy can be transferred,

so the 25-turn inductor has a lower voltage drop for equal current → lower impedance

(i)

With 4.7 Ω: nearly in phase, slight lag in the resistor

with $R_L = \infty\ \Omega$: resistor lags behind inductor by about 90°

with 0.33 μF: there was a ~85° trail in the resistor

. when the load resistance increases, Z_L increases, which causes the circuit to act like a simple RL circuit, which is past its cutoff point.

when putting in a capacitor, the load becomes an LC circuit and the primary will transfer power based on the load cutoff points, meaning the phase will be impacted as with an RC circuit

(j) $V = 0.11060\,V$, $R = 4.7\,\Omega \rightarrow I = V/R = \boxed{23.53\,mA}$

compared to $I_{in} = 5.08\,mA$, $I_{out}/I_{in} = 4.63$, does not agree with expectation of 5.01, 7% discrepancy

3.3

(a) $R = 9.98 \pm 0.10\,k\Omega$, $C = 99.7 \pm 4\,nF$, $L = 2.588 \pm 0.094$ (remeasured)

$R_{big} = 222 \pm 2.7\,k\Omega$

$\omega_0 = (LC)^{-1/2} = (6.23 \pm 0.18) \cdot 10^4\,rad/s \rightarrow \boxed{f_0 = 9.91 \pm 0.29\,kHz}$

(b) $f_{measured} = \boxed{10.359 \pm 0.092\,kHz}$, does not agree with predicted - perhaps $10k\Omega \ll 220k\Omega$?

(c)

$-3 \pm 0.01\,dB$ @ $\Delta x = +158.323\,Hz$
$-3 \pm 0.02\,dB$ @ $\Delta x = -144.323\,Hz$
$\rightarrow Q = \dfrac{10.359}{(0.158 + 0.144)} = \boxed{34.23 \pm 0.32}$

(d)

R	f_{max}	3dB pos	3dB neg	Q
$984 \pm 10\,\Omega$	10.418 kHz	$+962 \pm 90$ Hz	-864 ± 90 Hz	5.7 ± 0.4
$2.95 \pm 0.034\,k\Omega$	10.401 kHz	$+336 \pm 6$ Hz	-347 ± 10 Hz	15.23 ± 0.26

(e) $Q_{ideal} = R(C/L)^{1/2} \rightarrow$

R=		Real	Agree?
10k:	$Q = 61.9 \pm 1.9$	34.23 ± 0.32	X
3k:	$Q = 18.2 \pm 0.6$	15.23 ± 0.26	X
1k:	$Q = 6.14 \pm 0.19$	5.7 ± 0.4	✓

(f) measured peak: 271 ± 5 mV $= V_C$

$V_R = 4.868 \pm 0.0005\,V \rightarrow I = V_R / 222\,k\Omega = \boxed{0.0219 \pm 0.03\,mA}$

$\cancel{I = I_c + I_L = V\left(\frac{1}{R_C} + \frac{1}{R_L}\right) \rightarrow R_c = V\left(I - \frac{V}{R_L}\right)^{-1} = \frac{V R_L}{(I R_L - V)}}$

$R_{L\|C} \approx R_c$ at $\omega_0 \rightarrow R_C = V_C / I = \boxed{12.36 \pm 0.3\,k\Omega}$

(g)

$\omega_0 = 10294 \pm 0.05\,kHz$, $\delta\omega_1 = 106 \pm 1.3\,kHz$, $\delta\omega_2 = -34.8 \pm 2.5\,kHz$

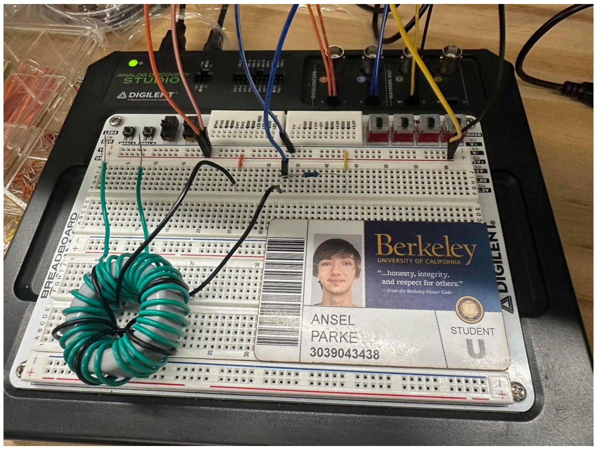
$\hookrightarrow \boxed{Q = 72.7 \pm 1.5}$ ideal $= 76.2 \pm 2.6$, almost agreed!

(h)

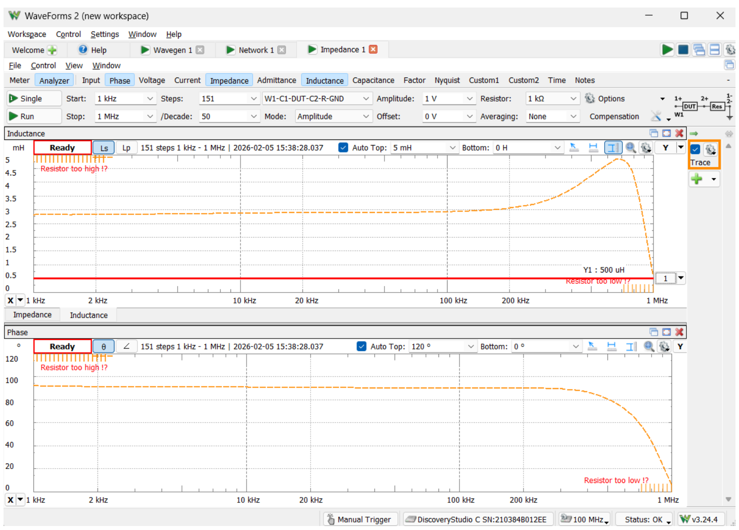
	Q ideal	measured	agree?
$10k\Omega$:	34.0 ± 0.9	34.23 ± 0.32	✓
$3k\Omega$:	14.6 ± 0.4	15.23 ± 0.26	x (almost!)
$1k\Omega$:	5.65 ± 0.14	5.7 ± 0.4	✓

3.1

The circuit:

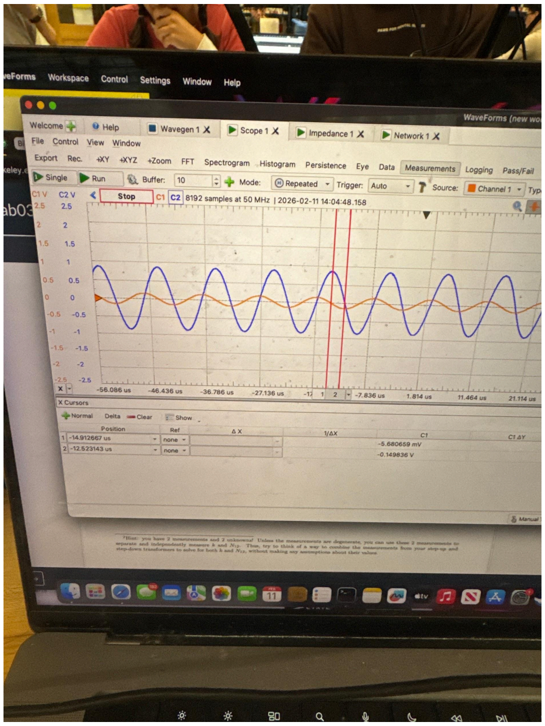


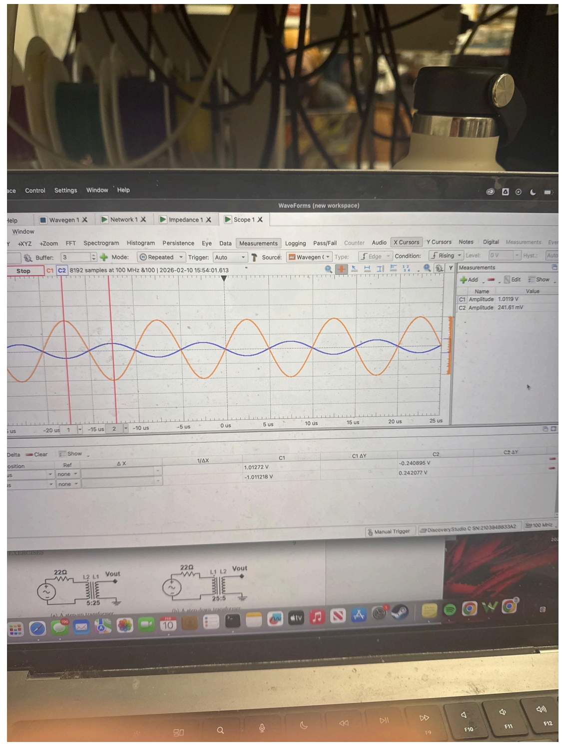
The inductance meter:



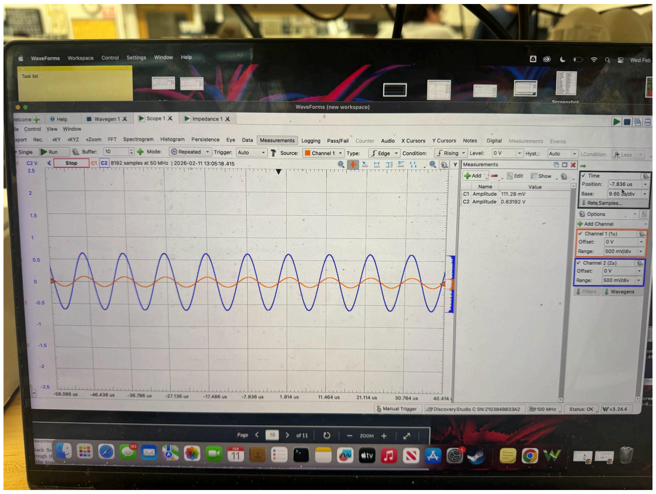
3.2

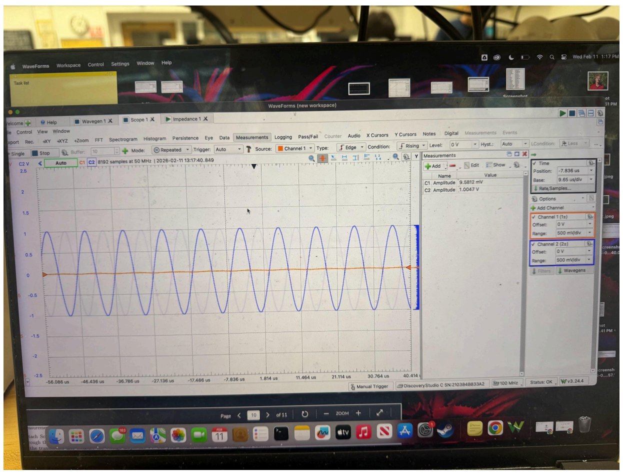
Step up and step down:


WaveForms (new wo
Welcome
Help
Wavegen 1
Scope 1
Impedance 1
Network 1
File Control View Window
Export Rec. +XY +XYZ +Zoom FFT Spectrogram Histogram Persistence Eye Data Measurements Logging Pass/Fail
Single Run Buffer: 10 Mode: Repeated Trigger: Auto Source: Channel 1
Stop C1 C2 8192 samples at 50 MHz | 2026-02-11 14:04:48.158
-56.086 us -46.436 us -36.786 us -27.136 us -7.836 us 1.814 us 11.464 us 21.114 us
X Cursors
Normal Delta Clear Show
Position Ref ΔX 1/ΔX C1 C1 ΔY
1 -14.912667 us none -5.680659 mV
2 -12.523143 us none -0.149836 V


WaveForms (new workspace)
Wavegen 1
Network 1
Impedance 1
Scope 1
+XYZ +Zoom FFT Spectrogram Histogram Persistence Eye Data Measurements Logging Pass/Fail Counter Audio X Cursors Y Cursors Notes Digital
Buffer: 3 Mode: Repeated Trigger: Auto Source: Wavegen Condition: Rising
Stop C1 C2 8192 samples at 100 MHz &100 | 2026-02-10 15:54:01.613
Measurements
Name Value
C1 Amplitude 1.0119 V
C2 Amplitude 241.61 mV
-20 us -15 us -10 us -5 us 0 us 5 us 10 us 15 us 20 us 25 us
Delta Clear Show
Ref ΔX 1/ΔX C1 C1 ΔY C2 C2 ΔY
none 1.01272 V -0.240895 V
none -1.011218 V 0.242077 V
Manual Trigger
22Ω
L2 L1
Vout
5:25
L1 L2
25:5

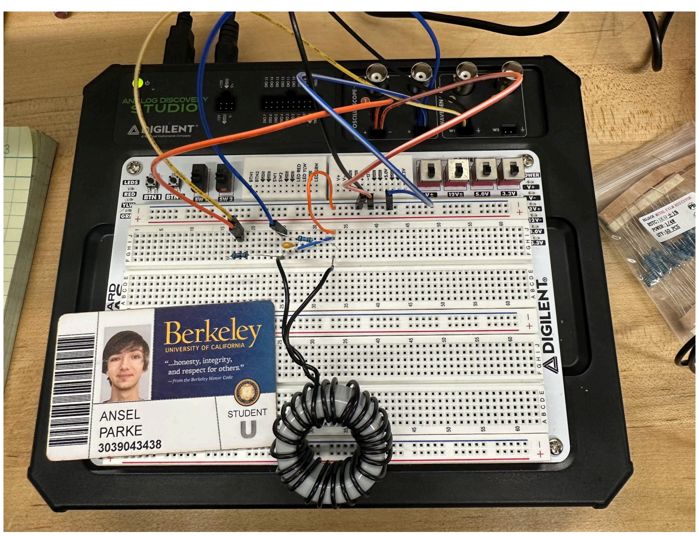
4.7Ω resistor (without and then with)



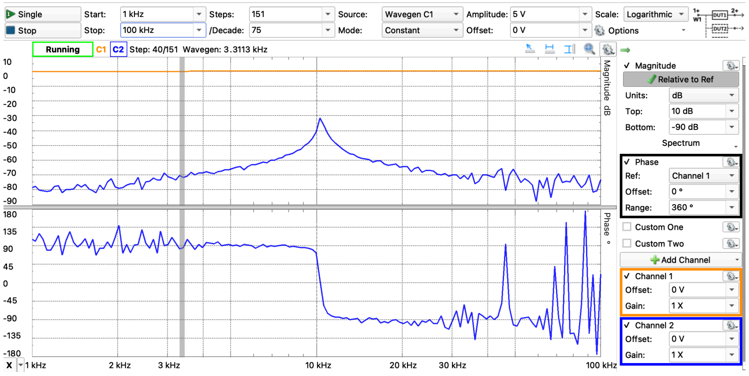


3.3

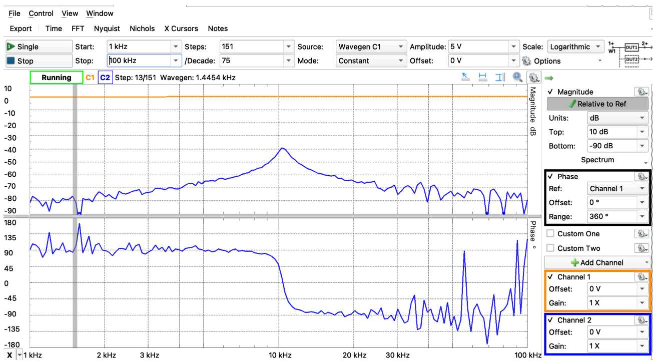
The circuit:



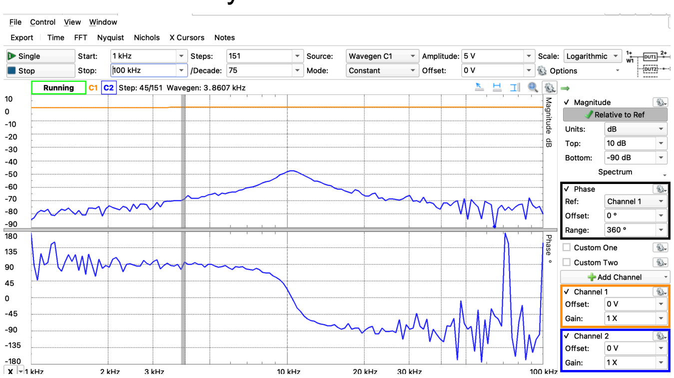
10kΩ network analyzer:



3kΩ network analyzer:



1kΩ network analyzer:



0kΩ network analyzer: