Measurements and Electronic Instruments Lab

Experiment – 1

LabReport

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Objective:

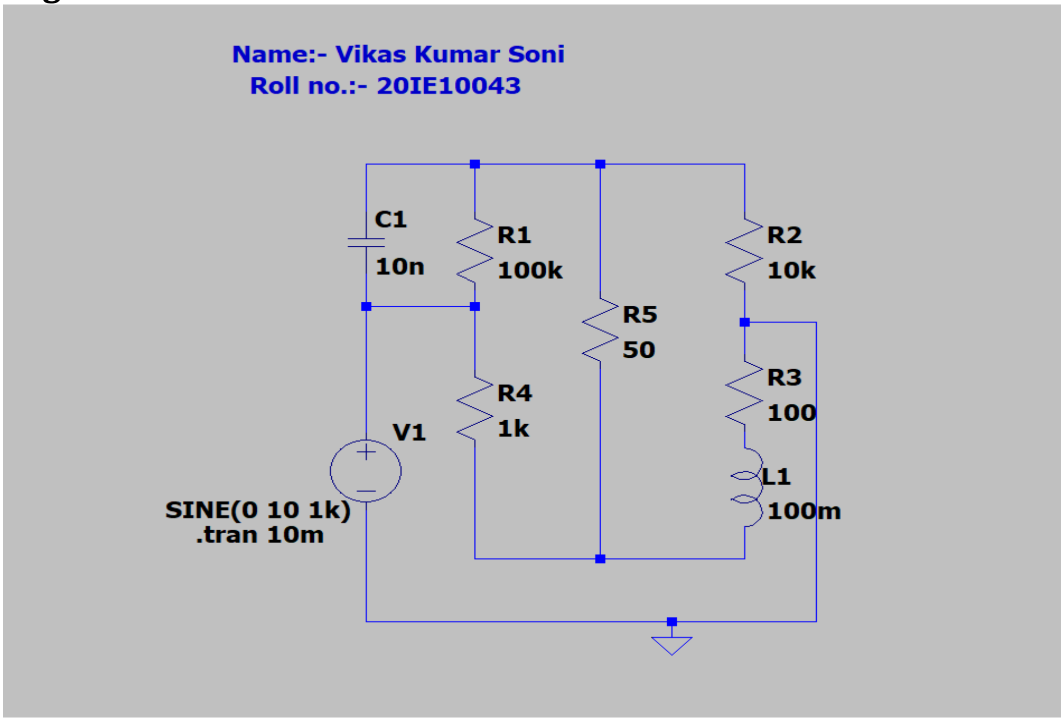
To determine the self-inductance of a coil.

Experimental Procedure:

For the detector in all the cases, a resistance of 50 Ω is used.

Part – I:

Circuit Diagram:



L_1=100 mH, R_1= 100 kΩ, C_1=10 nF and R_2=10 kΩ

Equipment Used:

- Variable Resistors
- Known Capacitor
- Voltage Source
- Unknown Inductor
- Ground
- Wires

Theory:

A Maxwell Inductance Capacitance Bridge (known as a Maxwell Bridge) is a modified version of a Wheatstone bridge which is used to measure the self-inductance of a circuit. A Maxwell bridge uses the null deflection method (also known as the "bridge method") to calculate an unknown inductance in a circuit. When the calibrated components are a parallel capacitor and resistor, the bridge is known as a Maxwell-Wien bridge. The working principle is that the positive phase angle of an inductive impedance can be compensated by the negative phase angle of a capacitive impedance when put in the opposite arm and the circuit is at resonance (i.e., no potential difference across the detector and hence no current flowing through it). The unknown inductance then becomes known in terms of this capacitance.

Equations:

$L1 = R2*R4*C1$,

$R3 = R2*R4/R1$,

$Q = 2\pi f*L1/R3 = 2\pi f*C1*R1$

PART- II

Initial Conditions: L1 = 100mH, R1 = 100kΩ, C1 = 10nF and R2 = 10kΩ

Calculations:

$$L_1 = R_2 R_4 C_1$$

$$R_4 = \frac{100m}{10k \times 10n}$$

$$= 1k$$

$$\boxed{R_4 = 1k\Omega}$$

$$R_3 = \frac{R_2 R_4}{R_1}$$

$$= \frac{10k \times 1k}{100k}$$

$$= 100$$

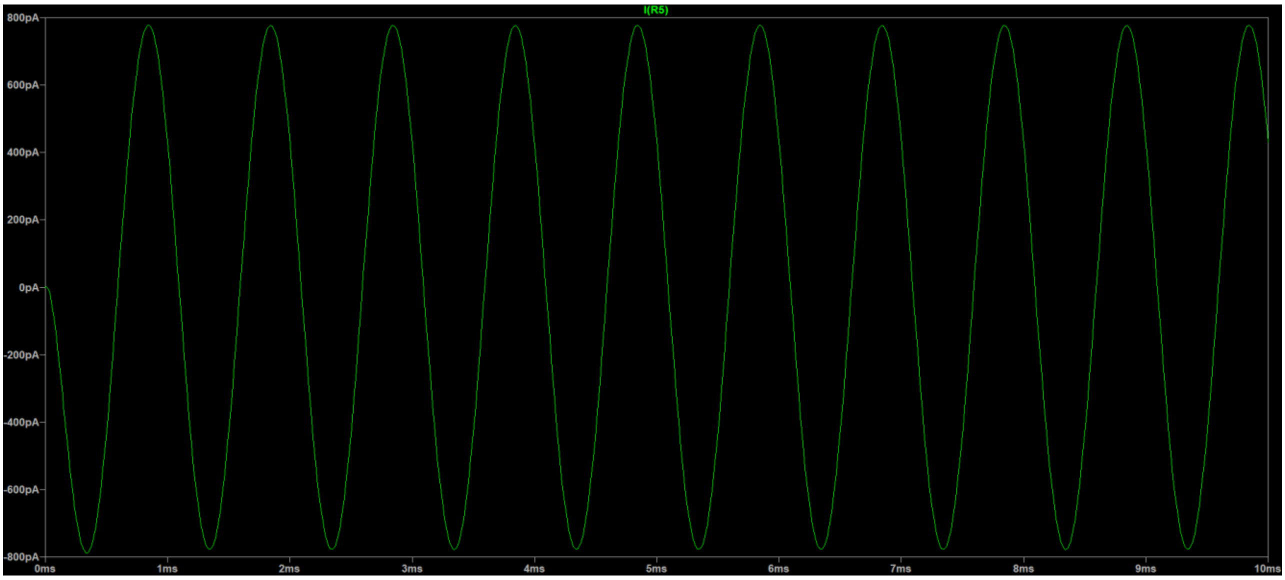
$$\boxed{R_3 = 100\Omega}$$

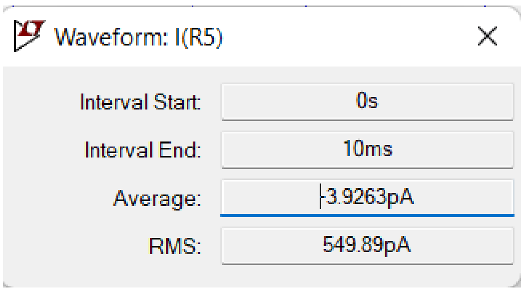
$$Q = 2\pi f C_1 R_1$$

$$= 2\pi \times 1k \times 10n \times 100k$$

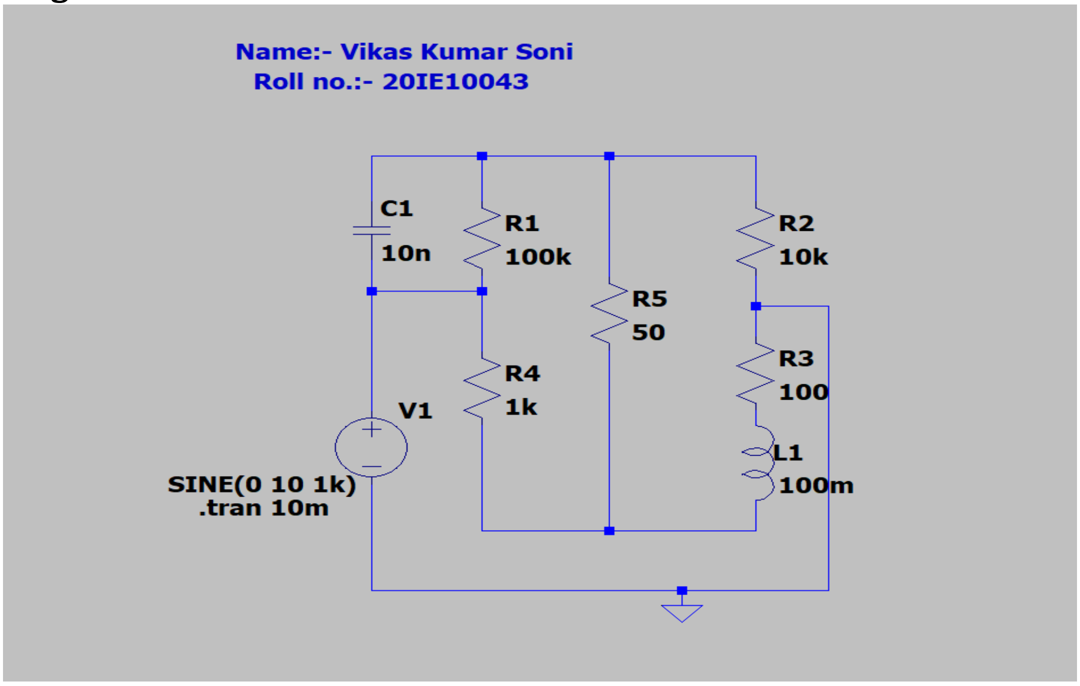
$$\boxed{Q = 2\pi}$$

Observations:





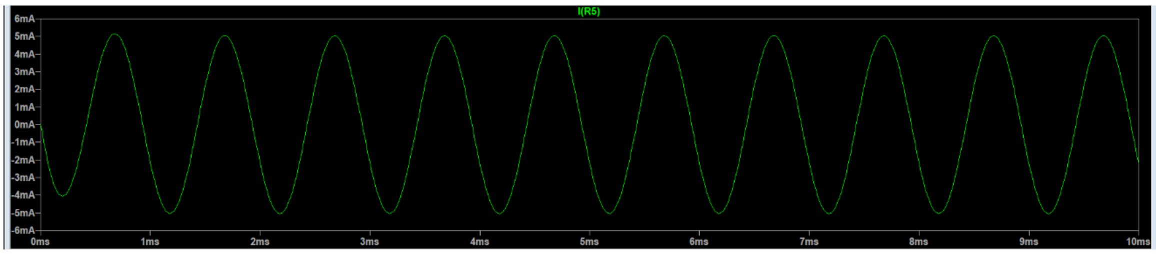
Circuit Diagram:



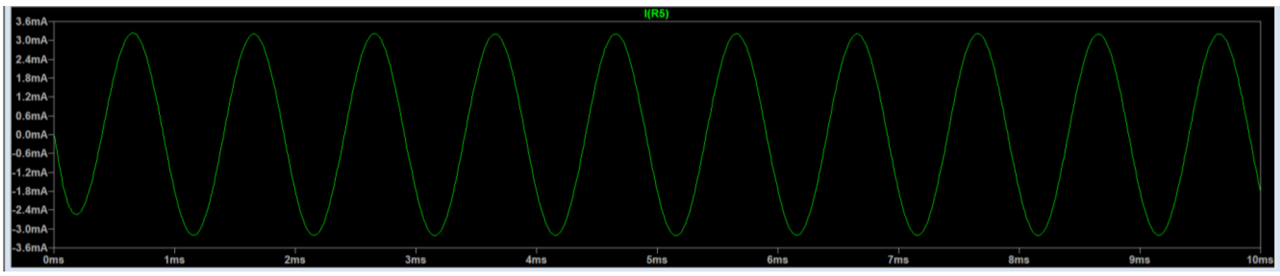
Observations:

When the resistance R_2 is varied from 500 to 50kΩ:

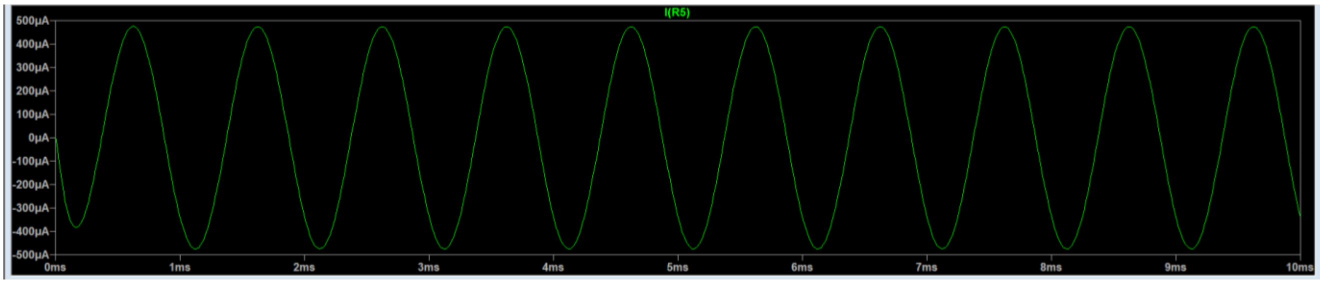
R2=500 ohm



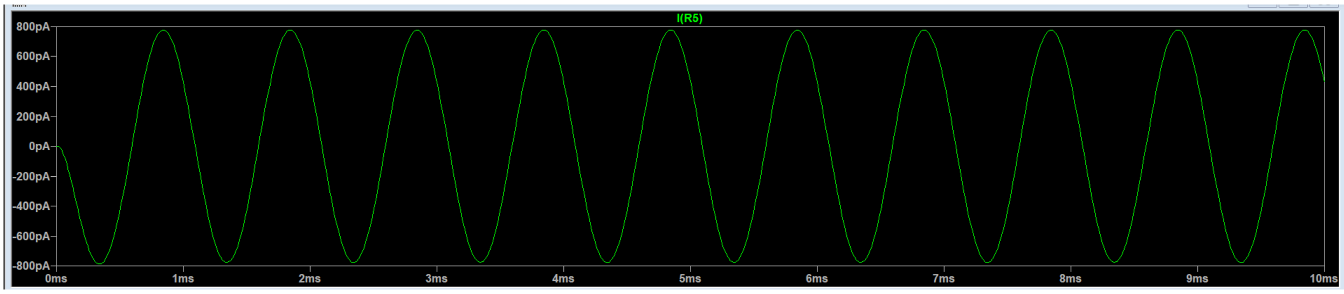
R2=1000 ohm



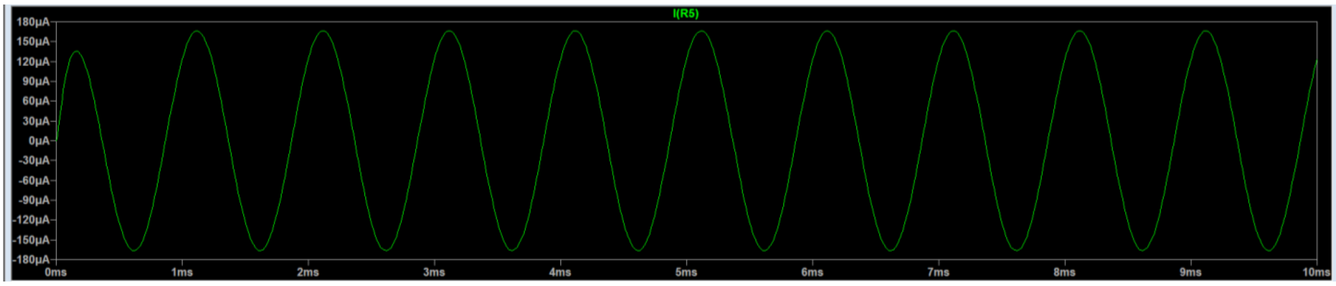
R2=5k ohm



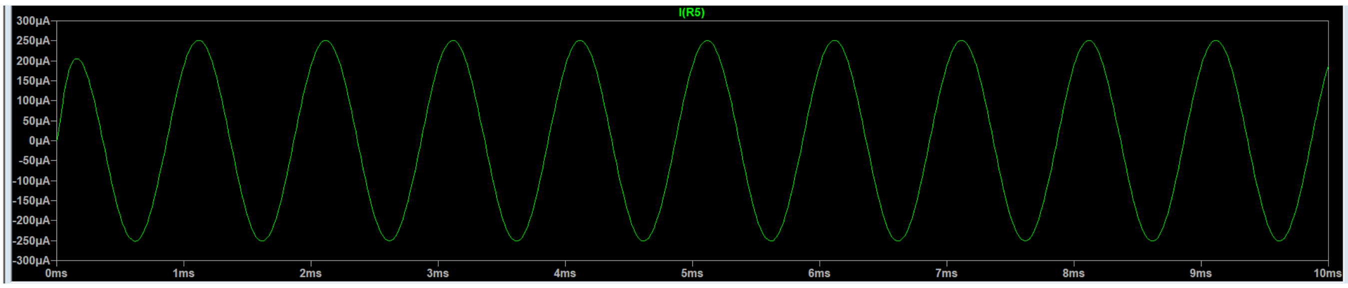
R2=10k ohm



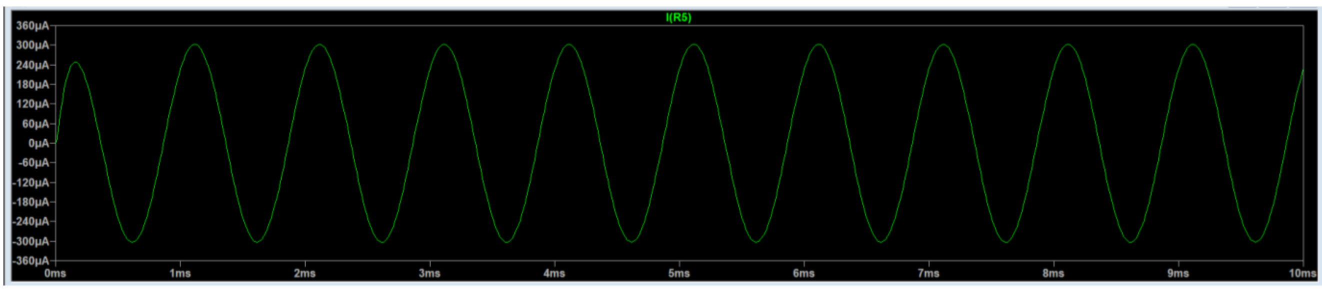
R2=15k ohm



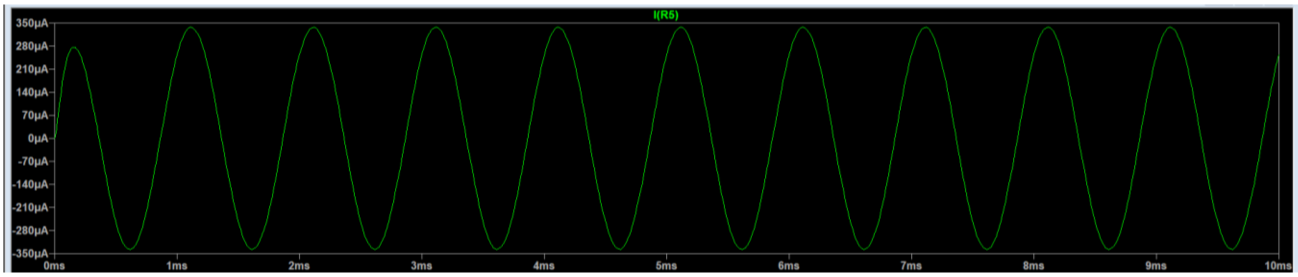
R2=20k ohm



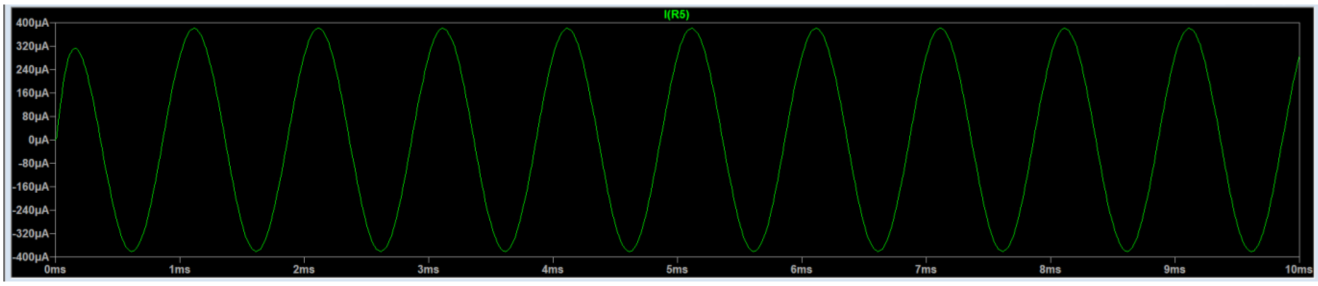
R2=25k ohm



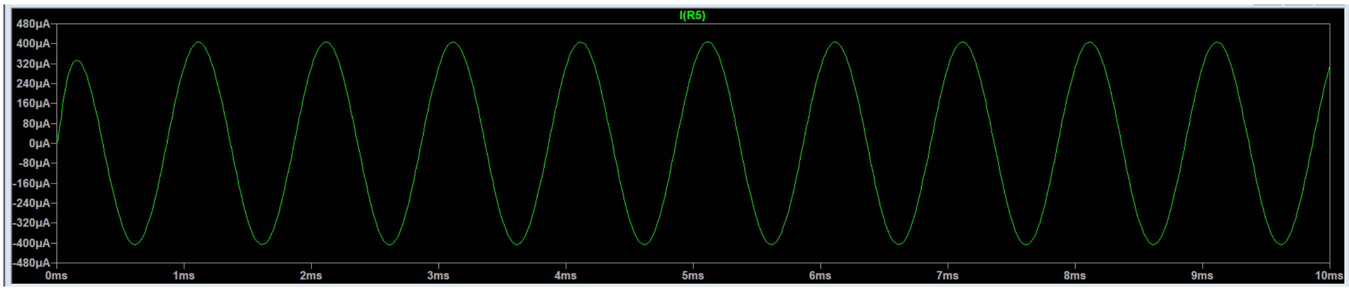
R2=30k ohm



R2=40k ohm



R2=50k



Conclusion:

From this, we see that our observations and calculations are in sync. We see the least current passing across the detector in this case comes at the 10,000-ohm case.

Part – III:

Replacing the coil with an inductance of L_X = 45 mH, and Q = 2,

Calculation:

$Q = 2\pi f * L1/R3 = 2\pi f * C1 * R1$ R1 is fixed to maintain Q.

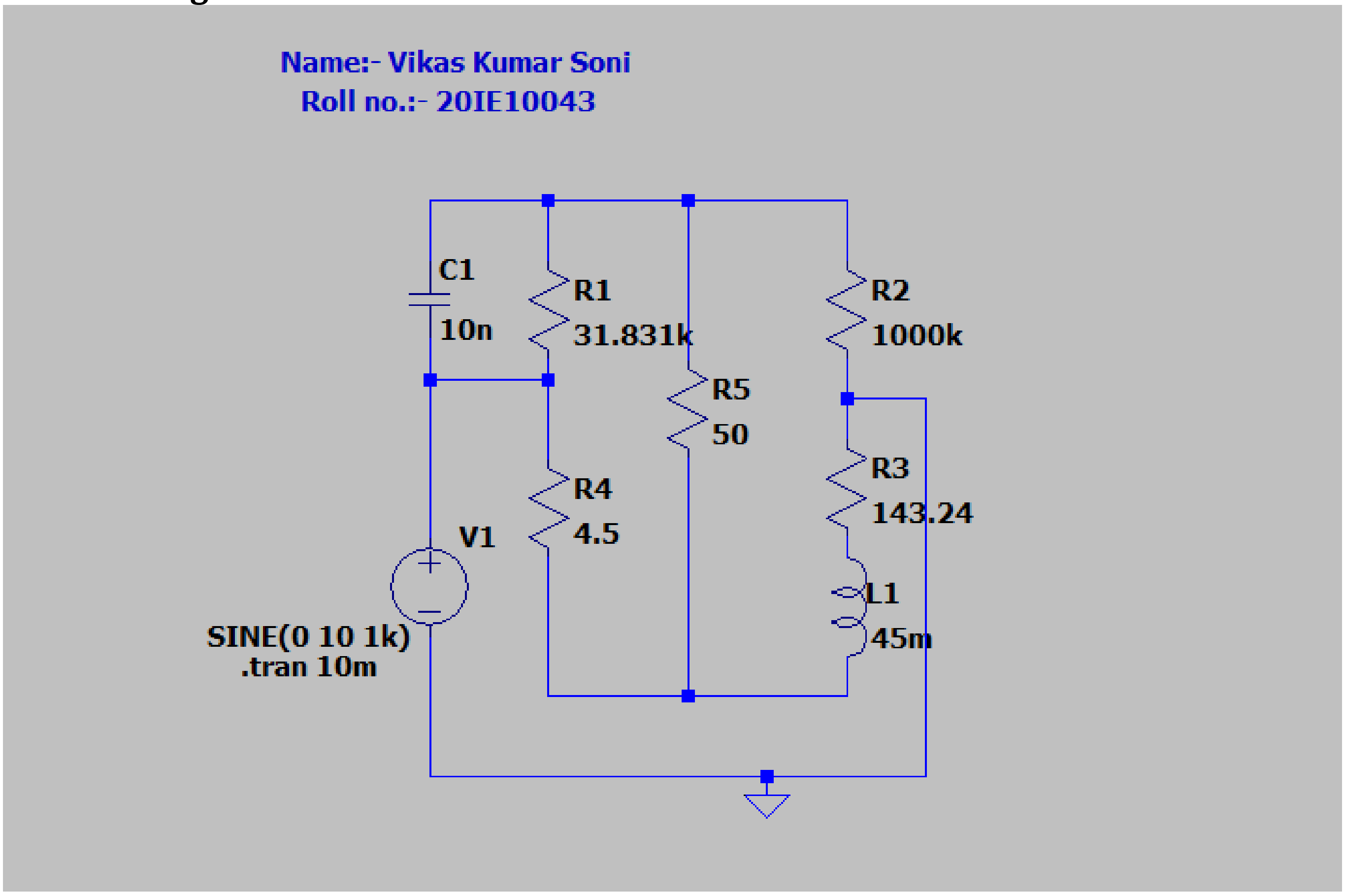
R1 = Q/($2\pi f * C1$) = 2/(2π*1000*10nF) = 31.83k ohm.

R3 = L1/(C1*R1) = 143.24 ohm.

$R3 = R2 * R4/R1$

From the above, for balance case, R2*R4 = 4.5 M ohm square.

Circuit Diagram:

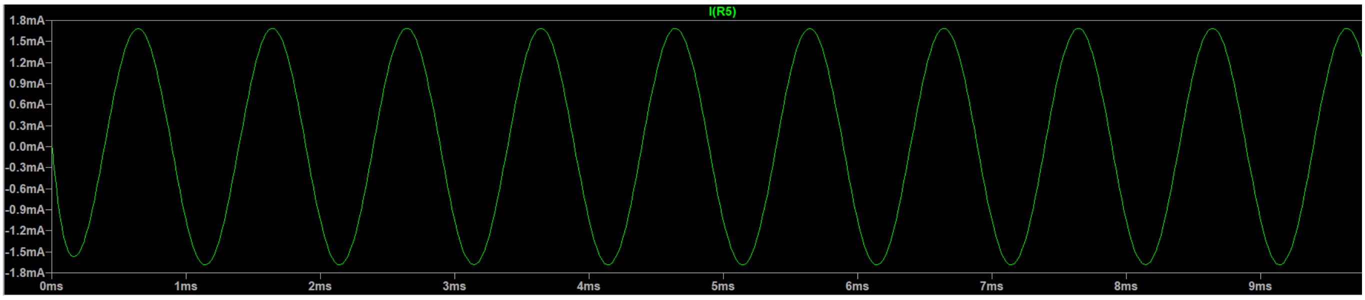


Observation & Plot:

Checking Current Across R5

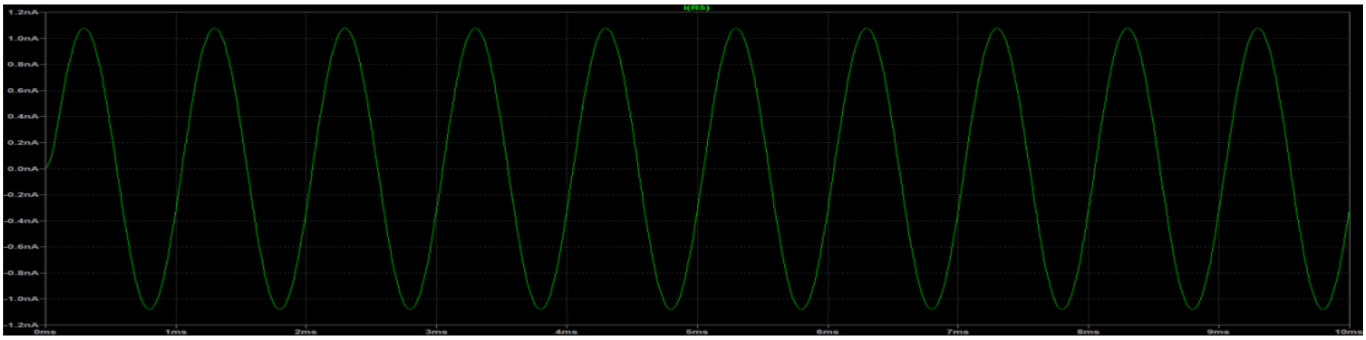
Let's take R2= 1000 ohm

Case 1. R4 = 1000 ohm



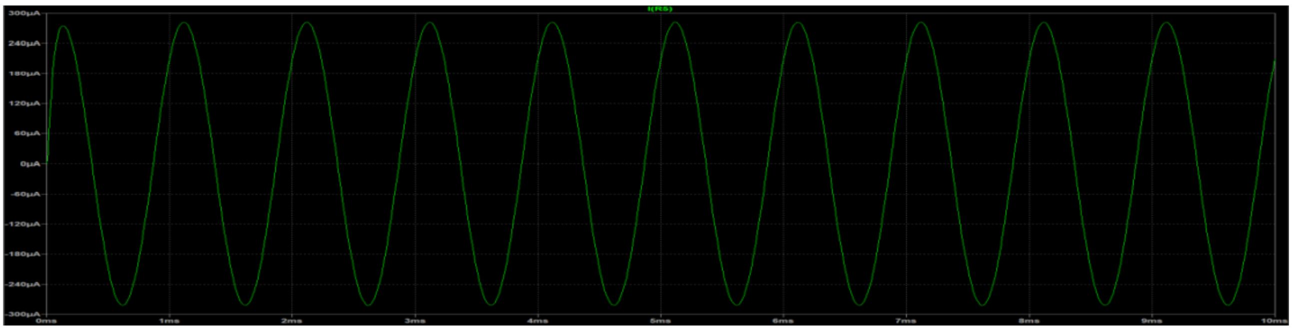
Interval Start:	0s
Interval End:	10ms
Average:	7.7815µA
RMS:	1.1847mA

Case 2. R4 = 4500 ohm



Interval Start:	0s
Interval End:	10ms
Average:	1.334pA
RMS:	763.3pA

Case 3. R4 = 9000 ohm



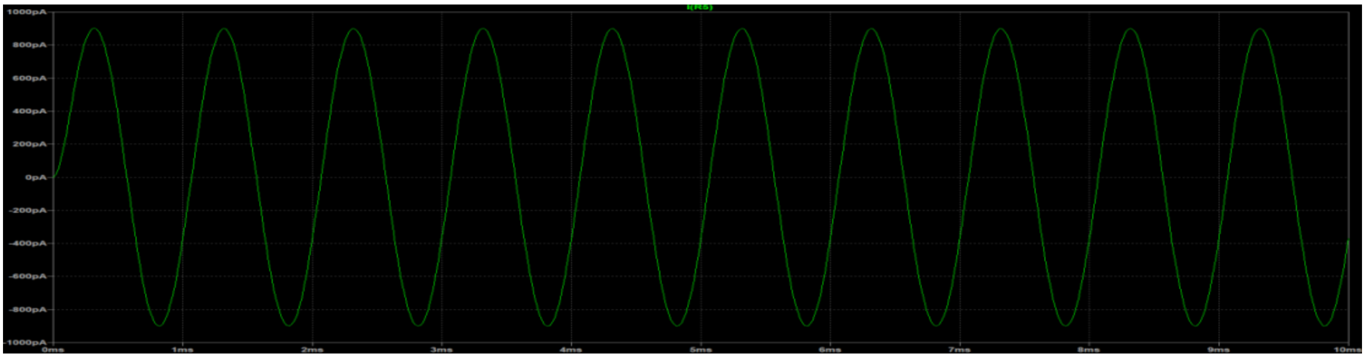
Interval Start:	0s
Interval End:	10ms
Average:	971.44nA
RMS:	198.63µA

Conclusion:

From the above 3 cases, we can confirm that on keeping R2 fixed, the balance condition is attained on varying R4 in a case where their product is 4.5 M ohm square.

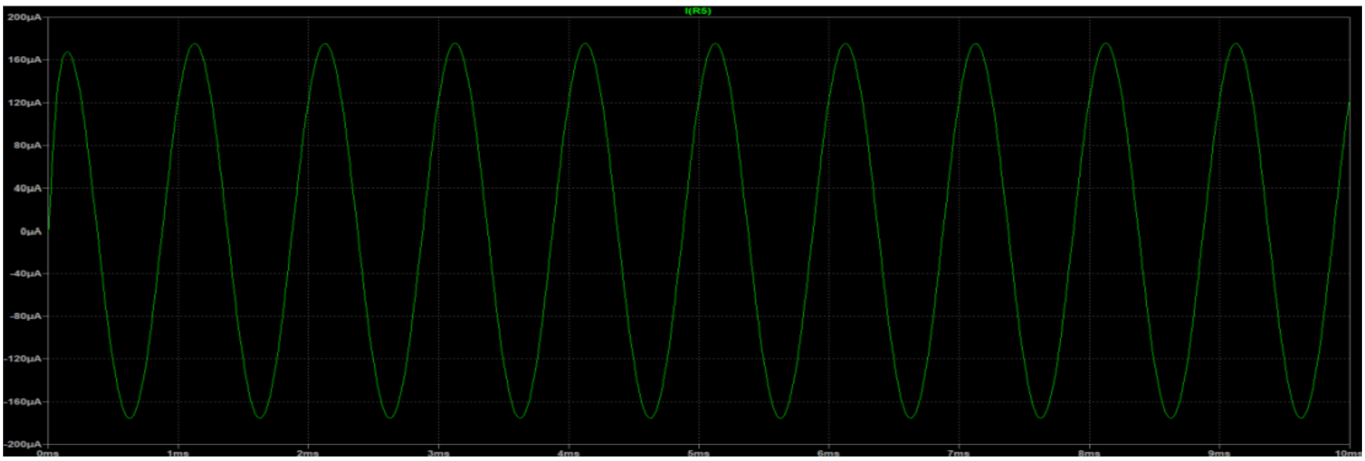
Let's take R4 = 9000 ohm

Case 1. R2 = 500 ohm



Interval Start:	0s
Interval End:	10ms
Average:	2.4821pA
RMS:	636.44pA

Case 2: R2 = 750 ohm



Interval Start:	0s
Interval End:	10ms
Average:	-691.86nA
RMS:	123.44µA

Conclusion:

From the above cases, we can confirm that on keeping R4 fixed, the balance condition is attained on varying R2 in a case where their product is 4.5 M ohm square.

Discussion:

1. The unknown Inductor's self-inductance was determined
2. The Maxwell Bridge balancing conditions were verified