

MAXWELL BRIDGE

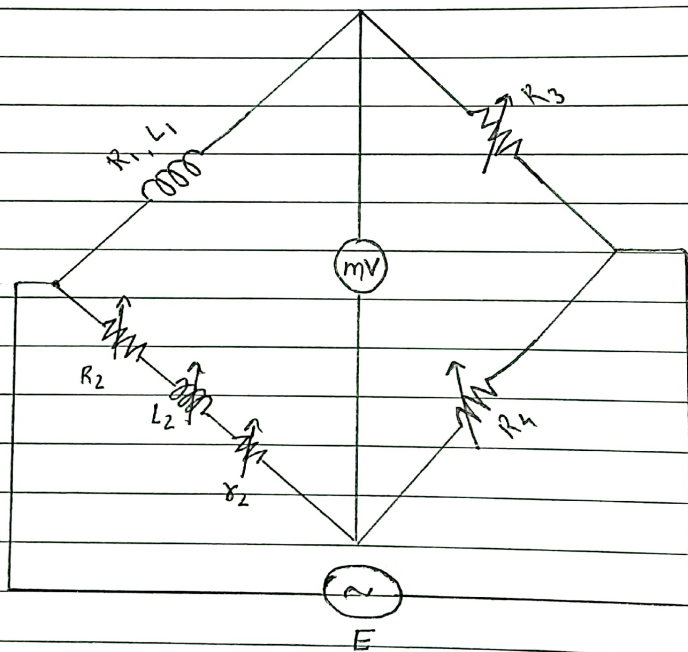
AIM

To study the Maxwell Bridge and determine the self inductance of an unknown coil.

THEORY

The bridge used for the measurement of self-inductance of the circuit is known as the Maxwell bridge. It is the advanced form of the Wheatstone Bridge. The Maxwell Bridge works on the principle of the comparison i.e. the value of unknown inductance is determined by comparing it with the known value or standard value.

Circuit Diagram:



Let,

L_1 = unknown self inductance of resistance R_1 ,

L_2 = variable inductance of fixed resistance r_2

R_2 = variable resistance connected in series with inductor of L_2 .

R_3, R_4 = known non-inductive resistance

At balance condition,

$$(R_1 + j\omega L_1) (R_4) = (R_2 + r_2 + j\omega L_2) R_3 \quad \text{--- (i)}$$

Equating both the real and imaginary parts in eq (i) and separating them,

$$L_1 = \left(\frac{R_3}{R_4} \right) L_2 \quad \text{--- (ii)}$$

$$R_1 = \left(\frac{R_3}{R_4} \right) (R_2 + r_2) \quad \text{--- (iii)}$$

PROCEDURE

- 1) Apply Supply voltage from the signal generator with arbitrary frequency. ($V = 3V$). Also set the unknown Inductance value from 'Set Inductor Value' tab.
- 2) Then switch on the supply to get millivoltmeter deflection.
- 3) Choose the values of L_2 , r_2 , R_2 , R_3 and R_4 from the inductance and resistance box. Vary the values to some particular values to achieve "NULL".
- 4) Observe the millivoltmeter pointer to achieve "NULL".
- 5) If "NULL" is achieved, switch to 'Measure Inductor Value' tab and click on 'Simulate'. Observe the calculated values of unknown inductance (L_1) and its internal resistance (R_1) of the inductor.

SIMULATION

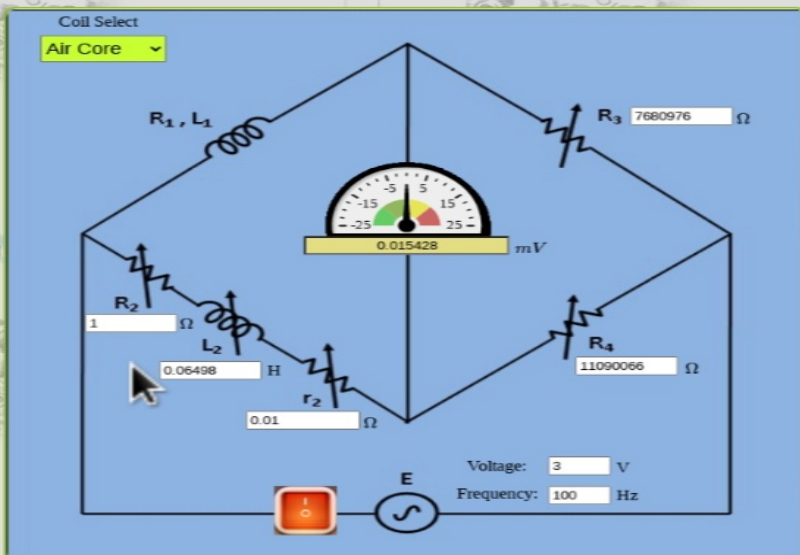
• For Air core

Measurement of Self Inductance by Maxwell Bridge

Procedure:

1. Apply Supply voltage (3V) from the signal generator with arbitrary frequency.
2. Select the type of the unknown Inductor (Air Core or Iron Core) from 'Set Inductor Value' tab by clicking on 'Set' button.
3. Then switch on the supply to get millivoltmeter deflection.
4. For Air Core experiment: Choose the values of R_2 , L_2 , r_2 , R_3 and R_4 from the control box below or directly put the values in the boxes of respective elements.
5. Observe the millivoltmeter pointer to achieve "Null" or closest to "Null".
6. If "Null" is achieved, switch to 'Measure Inductor Value' tab and click on 'Simulate'. Observe calculated values of unknown Inductor (L_1) and unknown Internal Resistance (R_1) of the Coil. Also observe the Quality factor (or Q-factor) of the coil, which is defined as $\frac{\omega L}{r}$, where, $\omega = 2 \cdot \pi \cdot f$.
7. For Iron Core experiment: Follow the same procedure from step 2 to step 6.

N.B.:- Range of $L_2 = 10\mu\text{H}$ to 111.1mH (in steps of $10\mu\text{H}$).
Range of R_2 , R_3 and R_4 is 1Ω to $11.11111\text{M}\Omega$ (in steps of 1Ω).
Range of $r_2 = 0.01\Omega$ to $11.11111\text{M}\Omega$ (in steps of 0.01Ω).



Set Inductor Value

Measure Inductor Value

The current voltmeter reading is: 0.015428 mv.

Now click on simulate to get:

Inductor value (in mH): 45.00512625263001

Resistance value (in Ohm): 0.69952566197532.

Quality Factor: 40.403

Simulate

CONTROLS

R2 : 1 Ohm 11.11111 MΩ
L2 : 10 uH 111.1mH
r2 : 1 Ohm 11.11111 MΩ
R3 : 1 Ohm 11.11111 MΩ
R4 : 1 Ohm 11.11111 MΩ

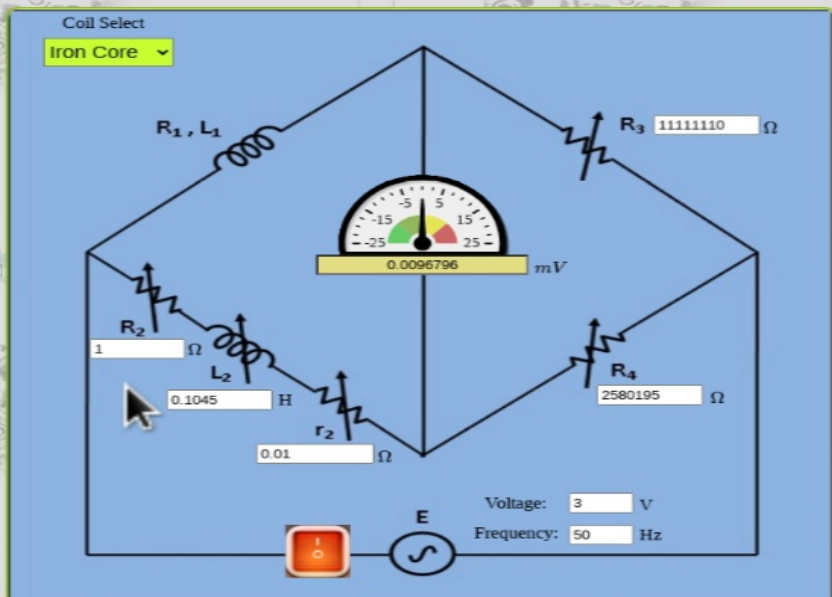
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Set Inductor Value

Measure Inductor Value

The current voltmeter reading is: 0.0096796 mv.

Now click on simulate to get:

Inductor value (in mH): 450.00900900900081

Resistance value (in Ohm): 4.34936936936937

Quality Factor: 32.488

Simulate

CONTROLS

R2 : 1 Ohm 11.11111 MΩ
L2 : 10 uH 111.1mH
r2 : 1 Ohm 11.11111 MΩ
R3 : 1 Ohm 11.11111 MΩ
R4 : 1 Ohm 11.11111 MΩ

OBSERVATION TABLE:

Voltage = 3V										
Sr	Core	R_1	R_2	γ_2	R_3	R_4	L_2	$L_1 (H)$	$L_1 (H)$	% Error
No		(Ω)	(Ω)	(Ω)	(Ω)	(Ω)	(H)	(Measured)	(True)	
1.	Air	40.2	1	0.01	7.68M	11.09M	64.98m	45.005m	45m	0.01
2.	Iron	40.2	1	0.01	11.11M	2.58M	104.5m	450.009m	450m	0.001
Average % Error = 0.005										
Result: The accuracy of the bridge is 99.995%.										

CONCLUSION

In this experiment we studied about the working of Maxwell Bridge to determine the self inductance of an unknown coil by comparing it with standard value and verified the results with the help of simulation.