Comparison Bridge: Capacitance

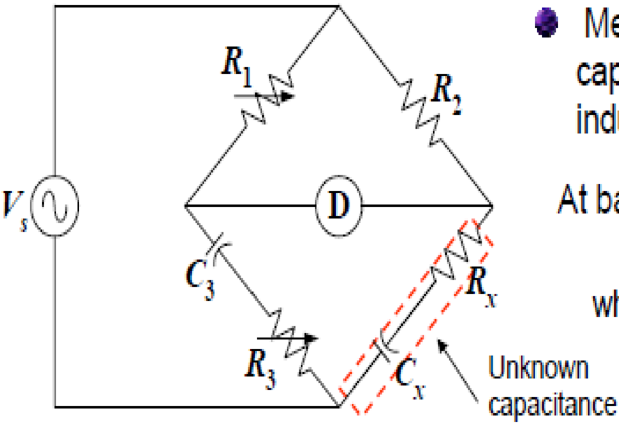


Diagram of Capacitance Comparison Bridge

- Measure an unknown inductance or capacitance by comparing with it with a known inductance or capacitance.

At balance point: $\mathbf{Z}_1\mathbf{Z}_x = \mathbf{Z}_2\mathbf{Z}_3$

where $\mathbf{Z}_1 = R_1$; $\mathbf{Z}_2 = R_2$; and $\mathbf{Z}_3 = R_3 + \frac{1}{j\omega C_3}$

$$R_1\left(R_x + \frac{1}{j\omega C_x}\right) = R_2\left(R_3 + \frac{1}{j\omega C_3}\right)$$

Separation of the real and imaginary terms yields: $R_x = \frac{R_2 R_3}{R_1}$ and $C_x = C_3 \frac{R_1}{R_2}$

- Frequency independent
- To satisfy both balance conditions, the bridge must contain two variable elements in its configuration.

Comparison Bridge: Inductance

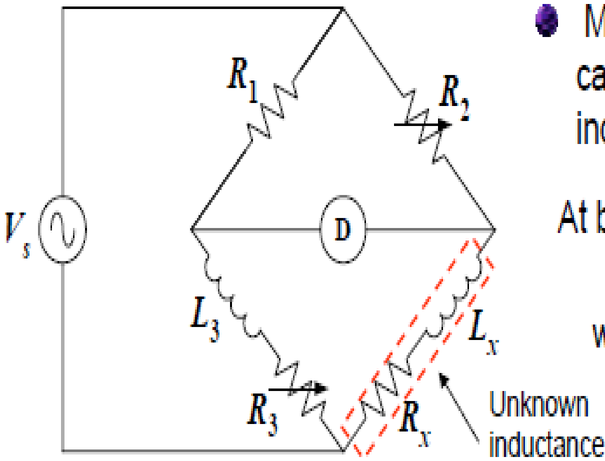


Diagram of Inductance Comparison Bridge

- Measure an unknown inductance or capacitance by comparing with it with a known inductance or capacitance.

At balance point: $\mathbf{Z}_1\mathbf{Z}_x = \mathbf{Z}_2\mathbf{Z}_3$

where $\mathbf{Z}_1 = R_1; \mathbf{Z}_2 = R_2;$ and $\mathbf{Z}_3 = R_3 + j\omega L_3$

$$R_1\left(R_x + j\omega L_x\right) = R_2\left(R_S + j\omega L_S\right)$$

Separation of the real and imaginary terms yields: $R_x = \frac{R_2 R_3}{R_1}$ and $L_x = L_3 \frac{R_2}{R_1}$

- Frequency independent
- To satisfy both balance conditions, the bridge must contain two variable elements in its configuration.

Maxwell Bridge

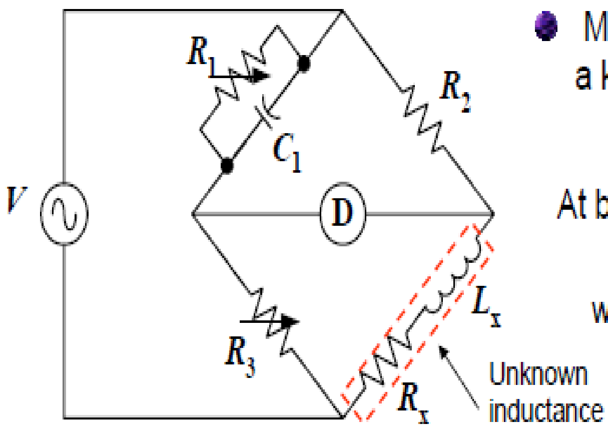


Diagram of Maxwell Bridge

- Measure an unknown inductance in terms of a known capacitance

At balance point: $\mathbf{Z}_x = \mathbf{Z}_2\mathbf{Z}_3\mathbf{Y}_1$

where $\mathbf{Z}_2 = R_2$; $\mathbf{Z}_3 = R_3$; and $\mathbf{Y}_1 = \frac{1}{R_1} + j\omega C_1$

$$\mathbf{Z}_x = R_x + j\omega L_x = R_2R_3\left(\frac{1}{R_1} + j\omega C_1\right)$$

Separation of the real and imaginary terms yields: $R_x = \frac{R_2R_3}{R_1}$ and $L_x = R_2R_3C_1$

- Frequency independent
- Suitable for Medium Q coil (1-10), impractical for high Q coil: since R_1 will be very large.

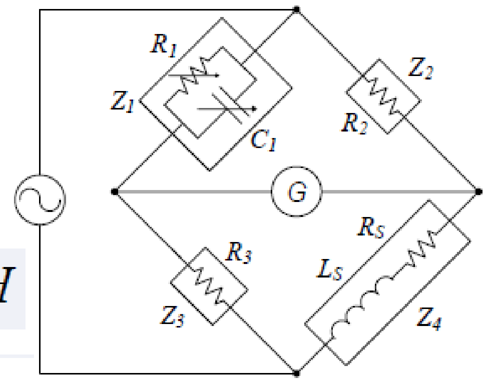
EXAMPLE

A Maxwell-Wien bridge as shown in below operates at a supply frequency of 100Hz used to measure inductive impedance. The bridge

balanced at the following values:

$$C_1 = 0.01\mu F,\ R_1 = 470\Omega\ ,\ \ R_2 = 2.2k\Omega\ \text{ and } R_3 = 100\Omega$$

Find the series resistance and inductance and determine its *Q-factor*.



SOLUTION

$$R_S = \frac{R_2 R_3}{R_1} = \frac{2.2\text{k}\times 100}{470} = 468.1\Omega$$

$$L_S = C_1 R_2 R_3 = 0.01\mu \times 2.2k \times 100 = 2.2mH$$