Resonance and Q in Electric Circuits

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# Summary

# Introduction

Electrical resonance occurs in electrical circuits at a specific input frequency at which the impedance is zero. At this frequency, the impedance of the capacitive and inductive components of the circuit are equal in magnitude but are 180 degrees out of phase with each other. Resonating circuits can generate higher peak voltages than the input and reach higher peak currents. Resonant RLC circuits are used commonly in wireless communications, as they are effective at selectively “blocking” frequencies other than the resonant frequency.

This report and experiments will be investigating RLC series circuits and their behaviour at different frequencies. Our aim is to estimate the resonant frequency using known measured values as well as finding it experimentally.

# Theory

# Resonance in RLC Circuits

# AC circuits and impedance

# Q Factor

# Method

# Frequency response of an RLC circuit

The capacitance of the 3.3uF capacitor and resistance of 33 ohm resistor are recorded with a Digital Multimeter (DMM) and are recorded for use in calculations. The resistor, capacitor, and a 0.1 ± 0.01 H are connected in a circuit as shown below.

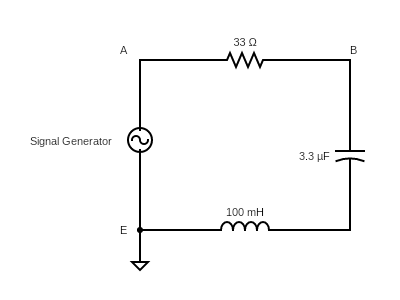


Figure : Circuit diagram for frequency response experiment.

The signal generator peak voltage was set to 0.57V. A digital multimeter was connected across the terminals temporarily to verify the RMS value of the AC signal is 0.4V. Channels 1 and 2 are connected to points A and B respectively, the oscilloscope was grounded at point E. To verify the setup, the frequency was quickly swept on the signal generator. Channel A was observed to be constant while Channel B was observed to change with frequency. Two DMMs are connected to the circuit in figure 1; one between point A and point B to measure VR ; and one between A and E to measure V0. Measurements are taken at a range of frequencies from 100Hz to 500Hz, including at the expected resonant frequency. Results are recorded in [REFERENCE]

# Determining resonance using an oscilloscope

The experimental setup remains unchanged from the previous experiment. Channel A was adjusted such that the waveform crosses zero on the centre line of the display, and the volts/division was turned down such that the lines appear nearly vertical. Channel B was shifted until the peaks of the waveform are close to the centre line. The frequency on the signal generator was adjusted until peaks of channel B line up with the points channel A crosses zero. This indicates a phase difference of between the voltage at the input and the voltage over the inductor. The frequency on the signal generator was recorded and contributes to the previous exercise. Results are recorded [REFERENCE]

# Measuring Quality Factor

The 33 ohm resistor was removed from the circuit, the new circuit setup is shown below.

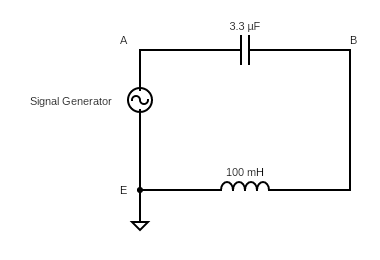


Figure : Circuit diagram for Quality Factor experiment.

Using the oscilloscope method described above, the resonant frequency of the circuit was measured and recorded. Voltage measurements were taken using a DMM across the capacitor, inductor, and signal generator at the resonant frequency and recorded. The frequency on the signal generator was lowered until . This frequency was recorded as . The frequency was raised above the resonant frequency until the same relationship was true, this frequency was recorded as . The difference between and was recorded as . All frequency measurements were taken using the reading on the signal generator.

# Measurement of Equivalent Resistance

Using the same experimental setup as in Figure 2, a DMM was used to measure the DC resistance across the inductor. The value of each denomination of capacitor was measured using the DMM and recorded. Using the signal generator and oscilloscope method described previously, the resonant frequency was found for each denomination of capacitor. Due to time constraints, the remainder of tasks for this portion of the experiment were left unfinished.

# Results and Uncertainty

# Frequency response of an RLC circuit

# Determining resonance using an oscilloscope

# Measuring Quality Factor

# Measurement of Equivalent Resistance

# Analysis of Results

# Conclusion

# Acknowledgements

# References