Report on resonant circuit

Environment, Electricity

[Date (May 26, 2013)]

Objective

Theory overview

A resonant circuit which is in series consists of a capacitor, a resistor and an indicator connected in a loop. At some frequency the inductive and capacitive reactances magnitudes becomes equal and since they are opposite each other they effectively cancel each other. This makes the circuit to be purely resistive as it only ‘ sees’ the resistor. Therefore at the resonance frequency the current becomes maximum. At any lower or higher frequency, the net difference between XC and XL should be summed with the value of the resistor; this produces higher impedance and hence lowers the circuit current. Since this is a simple loop the voltage across the resistor will be directly proportional to the circuit current. Subsequently, the voltage across the resistor must be maximum at the circuit resonant frequency and reduces with the increase or decrease of frequency. The resistor rating at resonance sets the highest/maximum current and subsequently has a big voltage effect that is developed across the inductor and capacitor. The circuit Q is given by Q= X/R, i. e. the ratio of circuit resistance and resonant reactance.

Apparatus

Signal generator, capacitor, inductor, resistance box, and oscilloscope.

Circuit

Figure 1: Circuit 1, L in series with R

Figure 2: Circuit 2, L in parallel with R

Procedure

- Circuit one was set up as shown the in the above diagram.

- Voltage readings at Y were taken in steps of 1, 2, 5 starting from frequency of 100Hz to 1MHz

- Extra readings around the resonance point were taken (where Y1 is a maximum)

- Voltage across the capacitor at resonance was measured.

- Repeat was done with the resistance reduced by a half.

- Circuit 2 was also set as shown in diagram 2 above.

- Voltage at Y1 at 1, 2, 5 steps from 100Hz to 1MHz were taken.

- Extra readings around the resonance point were taken (where Y1 is a minimum)

Results

The following results were obtained from the experiments.

Plot graphs of voltage at Y1 against frequency on a log/linear scale.

Figure 3: Graph of Voltage against frequency for parallel connection

Calculation of Q of circuit 1 with each resistance

Calculations for parallel connection

For R = 100 Ω

Q = 12π xfresonance x RC where R = 100 and c = 0. 22

Q R 100 = 12π x 300 x 100 x 0. 22 = 22. 1 x 10-6 Coulombs

For R = 800 Ω

Since from the graph f resonance = 300 Hz.

Q = 12π xfresonance x RC where R = 800 and c = 0. 22

Q R 800 = 12π x 800 x 100 x 0. 22 = 3. 01 x 10-6 Coulombs

At resonance in a RLC circuit voltage is at the minimum value

Figure 4: Graph of Voltage against frequency for series connection

Parallel connection calculations

For R = 100 Ω

Q = 12π xfresonance x RC where R = 100 and c = 0. 22

Q R 100 = 12π x 300 x 100 x 0. 22 = 22. 1 x 10-6 Coulombs

For R = 700 Ω

Since from the graph f resonance = 300 Hz.

Q = 12π xfresonance x RC where R = 800 and c = 0. 22

Q R 800 = 12π x 700 x 100 x 0. 22 = 3. 44 x 10-6 Coulombs

At resonance the voltage in RLC series circuit is maximum depending on the kind of resistors used, the larger the resistor the larger the value of voltage at resonance and vice versa. In the graph above it can be seen that resonance frequency is 300Hz. The circuit accepts a signal at the frequency of 300Hz and rejects all other frequencies.

Conclusion

References

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