Ex. No.: 5 Date: 15/11/2021

Finding Resonance Frequency

Aim:

To find the resonance frequency in an RLC circuit, a circuit involving a resistance, capacitor, and inductor.

Apparatus:

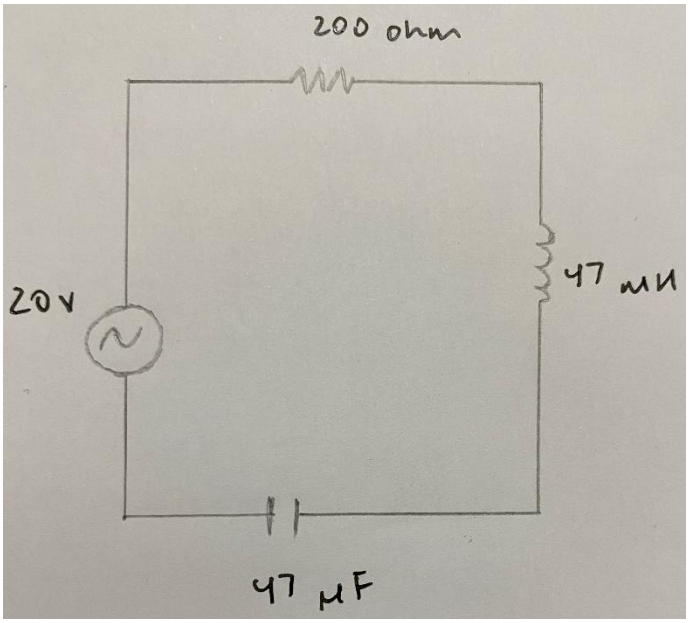
ORCAD / Capture CIS: Analog Library – R, L, C

Source Library – Vac

Ground (GND) – 0 (zero)

Simulation Settings: Analysis Type – AC Sweep

Circuit Diagram for Maximum Power Transfer Theorem:



Statement:

Resonance occurs when reactance of an inductor balances the reactance of a capacitor at some frequency. In this type of circuit, current is maximum and impedance is minimum.

Theory and Formula:

In an RLC circuit, the voltage difference between the capacitor and inductor lags and leads the resistive voltage respectively. While in resonance, the magnitudes of V_L and V_C are the same, but have a phase difference of 180°, making the cancel each other. This lowers the impedance, therefore increasing the current to its maximum value. This can be achieved when $X_L = X_C$, when inductive and capacitive reactances are equal.

$$\therefore X_L = X_C$$

$$\Rightarrow \omega L = \frac{1}{\omega C}$$

$$\Rightarrow \omega^2 = \frac{1}{LC}$$

For frequency: $\omega = 2\pi f$

$$4\pi f^2 = \frac{1}{LC}$$

$$\Rightarrow f = \frac{1}{2\pi\sqrt{LC}}$$

Manual Calculations:

$L = 47 \times 10^{-3}$ H

$C = 47 \times 10^{-6}$ F

$X_L = X_C$ for resonance frequency

$$\omega L = \frac{1}{\omega C}$$

$$\Rightarrow \omega^2 = \frac{1}{LC}$$

Since $\omega = 2\pi f$

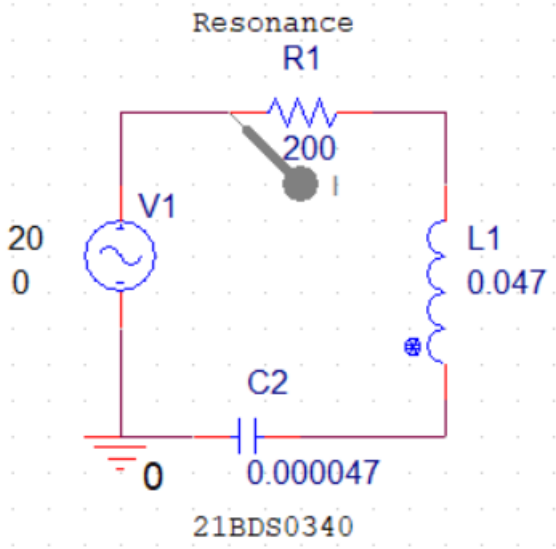
$$\therefore 4\pi^2 f^2 = \frac{1}{LC}$$

$$\Rightarrow f = \frac{1}{2\pi\sqrt{LC}}$$

$$\therefore f = \frac{1}{2\pi\sqrt{47^2 \times 10^{-9}}}$$

$$\Rightarrow f = 107.08 \text{ Hz}$$

Simulation Circuit:

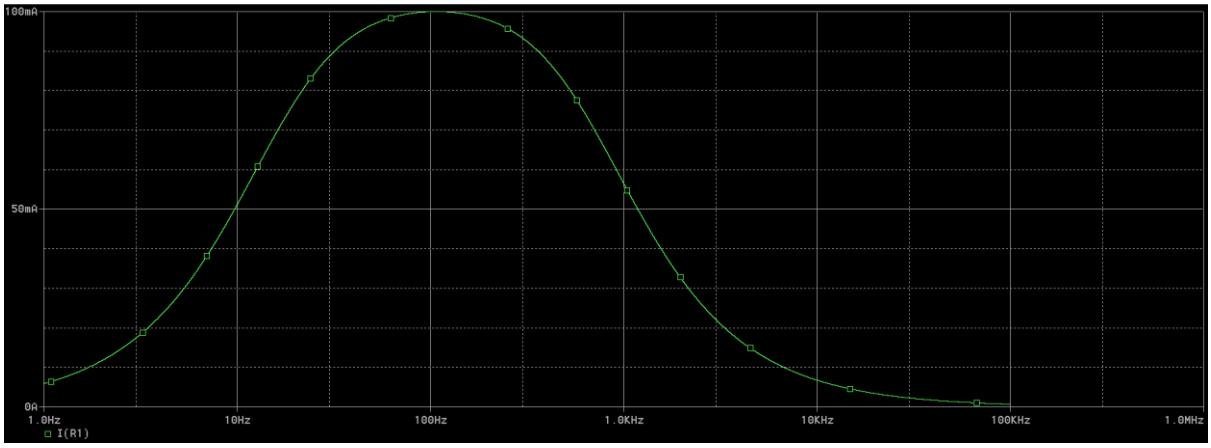


Procedure:

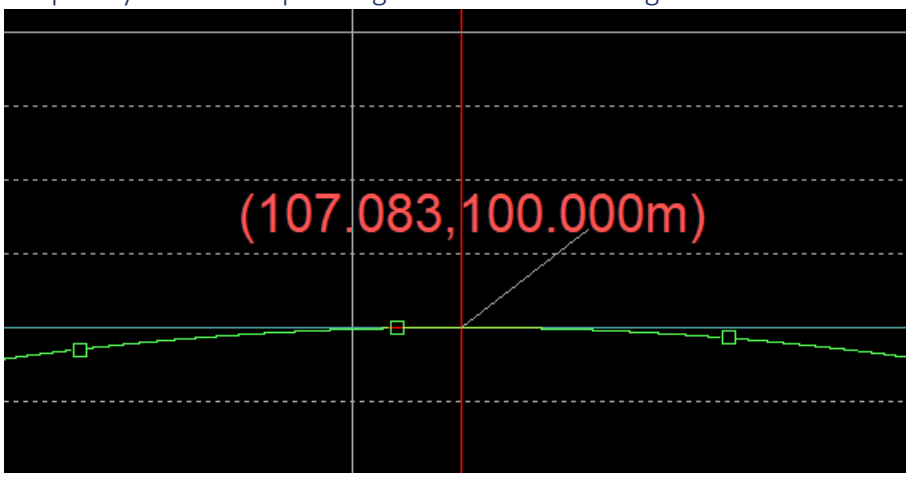
1. Press P to place a part
2. Press R and select to place a resistor
3. Press C for capacitor
4. Press L for inductor
5. Press vac for an alternating voltage source
6. Run the simulation on AC sweep
7. In the logarithmic pane, enter start frequency = 1, end frequency = 100000 and points/decade = 100000
8. Run the simulation and the peak is when the resonance frequency occurs.

Result:

Current vs Frequency Graph:



Resonance Frequency and Corresponding Current Value Enlarged:



Resonance Frequency

NOTATION	MANUAL CALCULATIONS	SIMULATED RESULT
F	107.08	107.083
P_{MAX}	0.1	0.1

Inference:

By comparing manual results to the simulation, we have found the maximum current and resonance frequency.

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