MULTISIMM: A CIRCUIT SIMULATOR

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T.O.C.

INTRODUCTION

- Multisim integrates industry-standard SPICE code simulation with an interactive schematic environment to instantly visualize and analyze electronic circuit behavior.
- In this presentation Multisim is used to validate the theoretical model of a small signal electronic circuit, governed by a second order ODE.

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THEORETICAL BACKGROUND

The subject series RLC circuit consists of an alternating current voltage source of $1V_{peak}$, at a frequency of 1kHz [more specifically, V(t) = sin(6283.185t)], a 50Ohm resistor, a 10mH inductor and a 1μF capacitor.

While this circuit is characterized by a damping factor of 0.25, similar analyses hold true for overdamped and/or critically damped response setup.

The characteristic differential equation of the circuit featured, can be written as [4]:

$$L(d^2I/dt^2) + R(dI/dt) + (1/C)I = dV/dt \qquad (1)$$

Solving the SUBJECT boundary problem (using the method of undetermined coefficients), while considering the initial conditions $I(0) = I'(0) = 0A$, the general solution for current $I(t)$ is given by:

$$I(t) = I_h(t) + I_p(t) \quad (3),$$

where:

$$I_h(t) = e^{(-2500t)}[-0.005\sin(9682.458t) - 0.008\cos(9682.458t)] \quad (4),$$

and

$$I_p(t) = 0.004\sin(6283.185t) + 0.008\cos(6283.185t) \quad (5).$$

More specifically, $I_h(t)$ from (3) and (4), respectively, is a transient current that tends to zero as time approaches infinity whereas, $I_p(t)$ [from (3) and (5), respectively] is a sinusoidal steady-state current that remains (time to infinity) [4].

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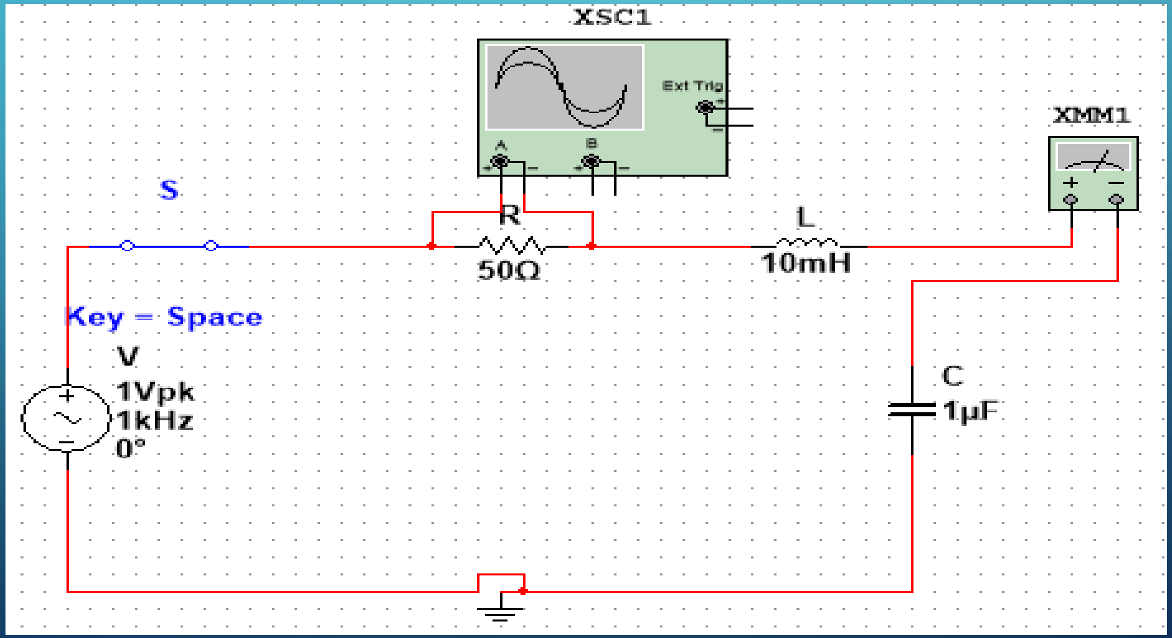
SIMULATION

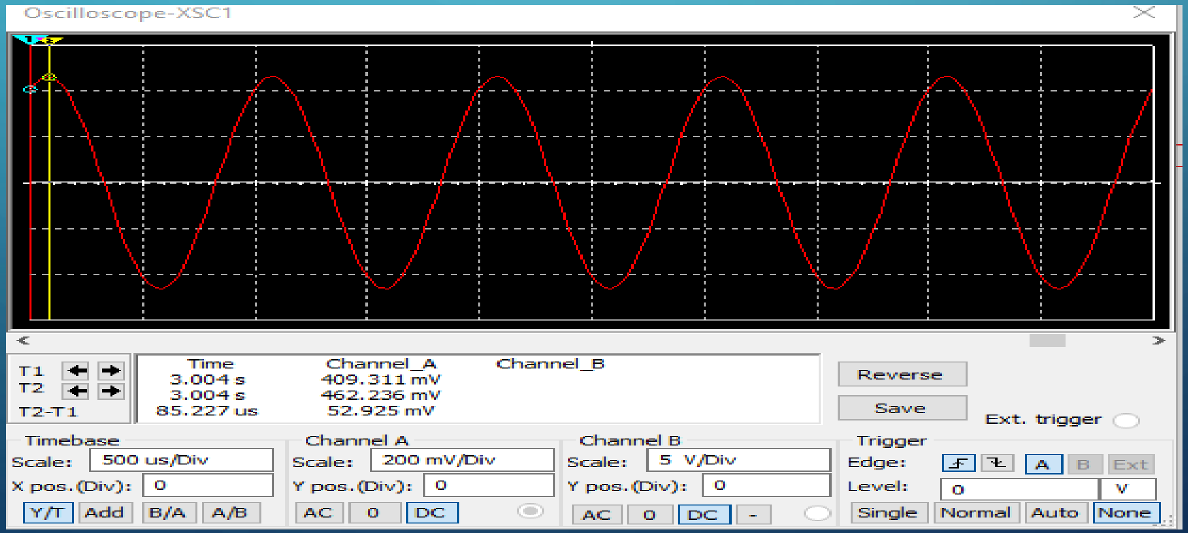
The RLC circuit is built in Multisim [3], with typical measuring equipment, also used.

Observations are recorded for several similar configurations.



Several simulations were carried out, all generating similar results, under the following common consideration: 0^0 initial phase shift for the sinusoidal input voltage V(t), 0% tolerance for the components, 0Ω internal resistance of the source, and constant operating temperature.

Naturally, configurations involving different value input signals and various component values resulted in data consistent with the observations presented herein (similar measurements were recorded by analyzing a physical setup).



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- ~~Introduction~~
- ~~“Theory”~~
- ~~Simulation~~
- Results and Discussion
- Summary and Conclusions

RESULTS AND DISCUSSION

Focusing on instances where the voltage across resistor R peaks (hence, moments in time when the instantaneous current through the circuit also reaches peak values), (3), (4) and (5) are used to "analytically" compute (peak, while instantaneous) a current value of 8.701mA. At the same time, for cross-reference purposes, multimeter XMM1 captures a peak current of 9.267mA.

The consistent - approx. 0.5mA - gap between the analytical computations [time value/s plugged in (4) and (5) to yield I(t) in (3)] and the numerical values observed in Multisim is attributed to the conceptual (implemented) difference between the two procedures used to calculate the currents in the circuit (analytical vs. numerical), and also, to the fact that the analytical computations from (3), (4) and (5) were truncated to 0.001 order of magnitude, throughout the process.

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SUMMARY AND CONCLUSIONS

Steady state current values through a small signal RLC alternating current circuit are calculated analytically (from the circuit's characteristic differential equation) and compared with the results generated in the numerical model implemented by Multisim. Measurements are also contrasted, and matched, the values acquired from a physical prototype.

Because of the ease of use, convenience, low processing time, cost effectiveness and accuracy of the results obtained, even, and specifically, for the transient regime (when currents temporarily surge), Multisim represents an optimum design and analysis tool.

Additionally, due to the added features present in the simulator, research, as well as prototypes can be virtually modeled for various operating conditions (e.g., temperature, tolerances, phase shifts, etc.) and circumstances.

THANK YOU!

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