A PYTHON-BASED STUDY OF RESONANT PROCESSES IN ELECTRIC CIRCUITS

AUTHORS: **NIKOLAY HINOV – TECHNICAL UNIVERSITY OF SOFIA, BULGARIA**

STOYAN POPOV – TECHNICAL UNIVERSITY OF SOFIA, BULGARIA

Content

Introduction

Generally, for the study of electrical and electronic circuits, Spise-based simulators are used. Circuit simulators based on SPICE (Simulation Program with Integrated Circuit Emphasis) are widely used software for modeling and analyzing electrical circuits and electronic devices. SPICE is a program that allows engineers and designers to perform virtual experiments with electrical circuits before their actual implementation. Based on SPICE, various software tools have been created that provide a graphical interface and an easier way to create, simulate, and analyze electrical circuits.

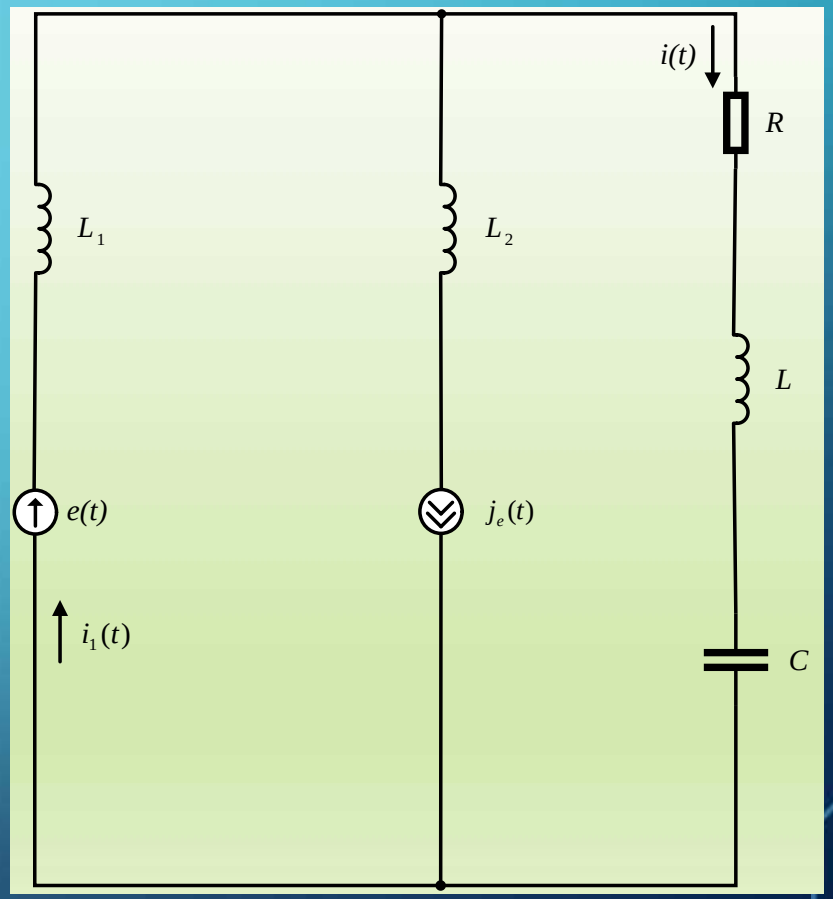
Computational examples

A. Investigation of voltage resonance in a circuit with non-ideal elements

$$e(t) = 200.\sqrt{2}.\sin(10^4\ t + 90°)$$

$$j_e\ (t) = 2.\sqrt{2}.\sin(10^4\ t + 90°)$$

$$R = 100\,\Omega,\ L_1 = 10\,\text{mH},\ L_2 = 15\,\text{mH},\ L = 5\,\text{mH},\ C = 2\ «F$$



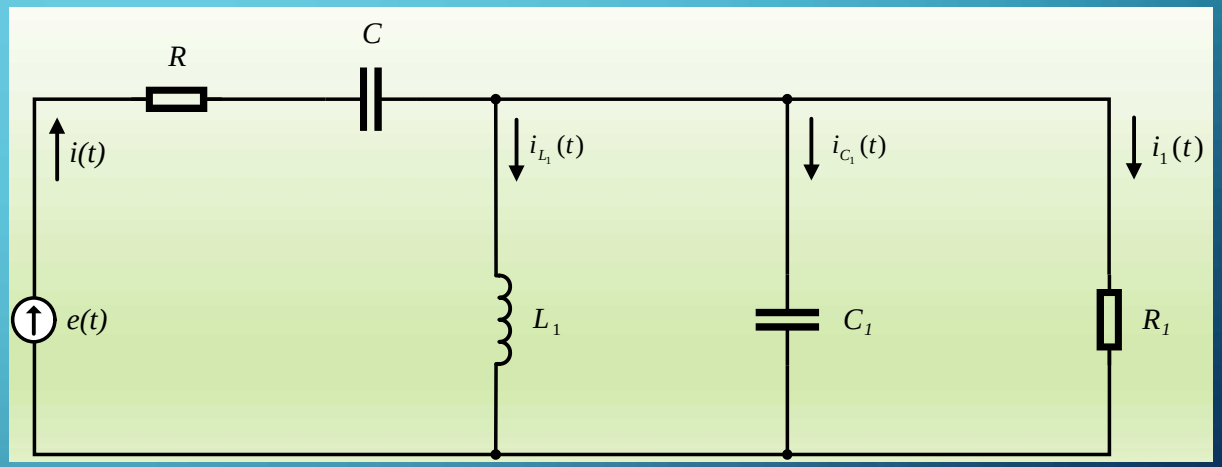
Computational examples

B. Investigation of current resonance in a circuit with non-ideal elements

$e(t) = 200.\sqrt{2}.\sin(10^4\ t - 90°)$

$R = 40\,\Omega, \quad C = 2\ «F, \quad L_1 = 10\,mH,$

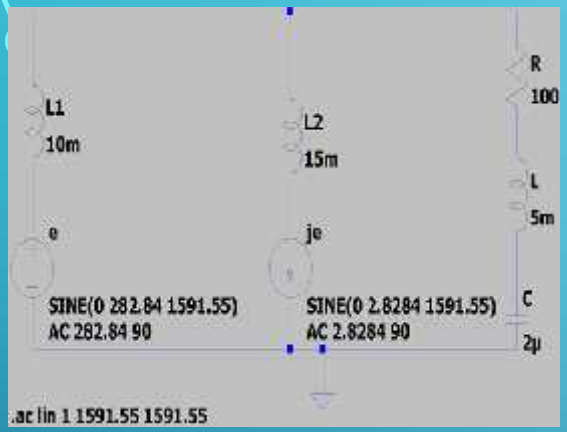
$C_1 = 2\ «F, \quad R_1 = 10\,\Omega$



Results

A. Investigation of voltage resonance in a circuit with non-ideal elements

Ltspice:

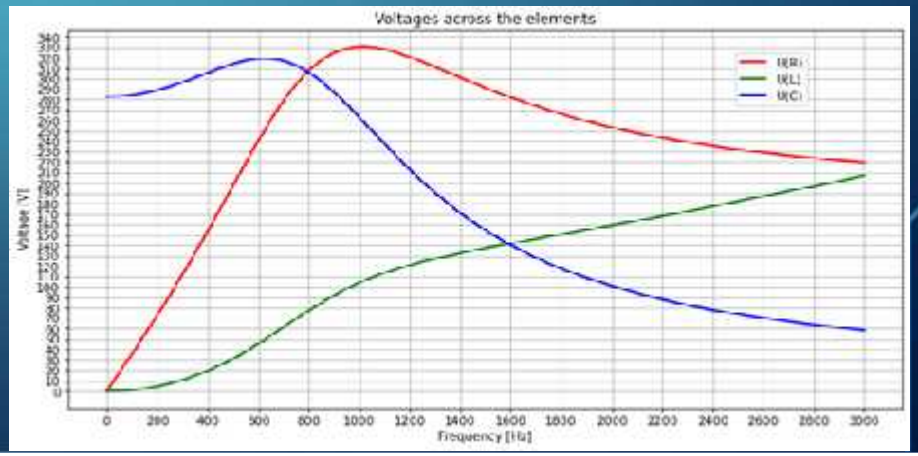



```
       --- AC Analysis ---

frequency:     1591.55        Hz
V(n003):       mag:      282.84 phase:          90°          voltage
V(n004):       mag:     707.099 phase: -0.000118693°         voltage
V(n001):       mag:     282.839 phase: 0.000276228°          voltage
V(n002):       mag: 0.00283016 phase:     2.04807°           voltage
V(n005):       mag:     141.418 phase:    -89.9997°           voltage
I(C):          mag:     2.82836 phase: 0.000255741°          device_current
I(L1):         mag:     3.99994 phase:    -134.999°           device_current
I(L2):         mag:      2.8284 phase:          90°          device_current
I(L):          mag:     2.02036 phase: 0.000255741°          device_current
I(Je):         mag:      2.8284 phase:          90°          device_current
I(R):          mag:     2.82836 phase: 0.000255741°          device_current
I(E):          mag:     3.99994 phase:    -134.999°           device_current
```

PySpice:

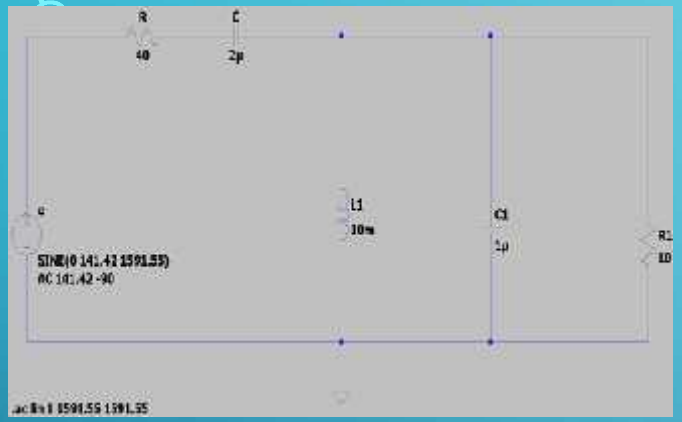
```
Node 5 :  magnitude: 141.4199241 V;  phase: 89.9999693 degrees
Node 2 :  magnitude: 0.0001011 V;  phase: 89.9999693 degrees
Node 1 : magnitude: 282.8399494 V;  phase:-0.0000102 degrees
Node 4 :  magnitude: 707.1001011 V;  phase:-0.0000041 degrees
Node 3 :  magnitude: 282.8400000 V;  phase: 90.0000000 degrees
IC :  magnitude: 2.8283985 A phase:-0.0000307 degrees
IL :  magnitude:2.8284005 A;  phase:-0.0000307 degrees
IL1 :  magnitude: 3.9999616 A;  phase: 44.9999898 degrees
IL2 :  magnitude: 2.8284010 A;  phase: 90.0000000 degrees
Ije :  magnitude: 2.8284 A; phase: 90 degrees
IR :  magnitude: 2.8283995 A;  phase:-0.0000307 degrees
Ie :  magnitude: 3.9999602 A;  phase: 44.9999898 degrees
```



Results

B. Investigation of current resonance in a circuit with non-ideal elements

Ltspice:

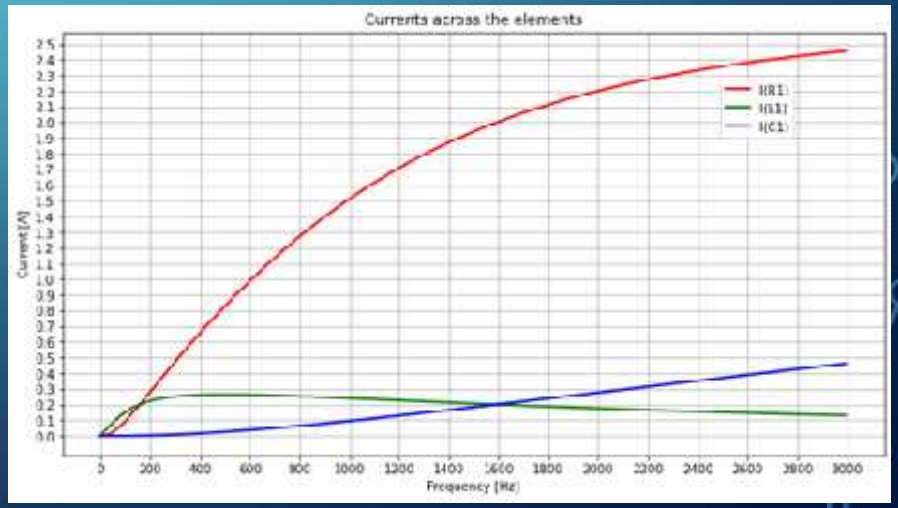



```
       --- AC Analysis ---

frequency:     1591.55        Hz
V(n001):       mag:      141.42 phase:        -90°          voltage
V(n003):       mag:     19.9998 phase:        -45°          voltage
V(n002):       mag:     101.979 phase:    -123.69°          voltage
I(C1):         mag:    0.199998 phase:         45°          device_current
I(C):          mag:     1.99998 phase:        -45°          device_current
I(L1):         mag:    0.199998 phase:   -134.999°          device_current
I(R1):         mag:     1.99998 phase:        -45°          device_current
I(R):          mag:     1.99998 phase:        -45°          device_current
I(E):          mag:     1.99998 phase:        135°          device_current
```

PySpice:

```
Node 2 :  magnitude: 101.9793961 V;  phase: 56.3099264 degrees
Node 3 :  magnitude: 19.9998116 V;  phase: -45.0000139 degrees
Node 1 :  magnitude: 141.4200000 V;  phase: -90.0000000 degrees
IC :  magnitude: 1.9999804 A;  phase: -45.0000098 degrees
IC1 :  magnitude: 0.1999981 A;  phase: 44.9999861 degrees
IL1 :  magnitude: 0.1999981 A;  phase: 44.9999861 degrees
IR1 :  magnitude: 1.9999812 A;  phase: -45.0000139 degrees
IR :  magnitude: 1.9999812 A;  phase: -45.0000098 degrees
Ie :  magnitude: 1.9999812 A;  phase: -45.0000098 degrees
```



Conclusion

The work proposes the implementation of modern information and communication technologies in scientific research, as well as for the improvement of training in fundamental disciplines such as theoretical electrical engineering. Broadly speaking, computer-based methods of electrical engineering education involve the use of technology and software tools that help students and professionals understand and learn electrical engineering concepts and principles.

ACKNOWLEDGMENT

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Thank you very much for your attention!