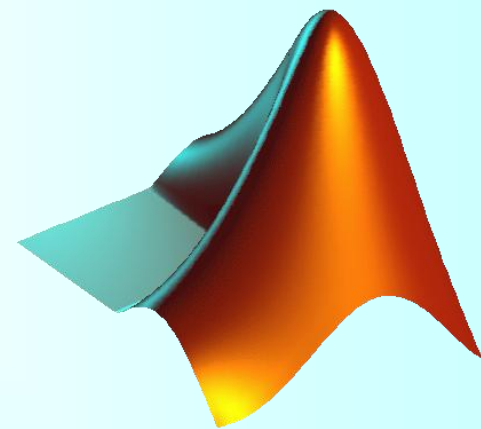
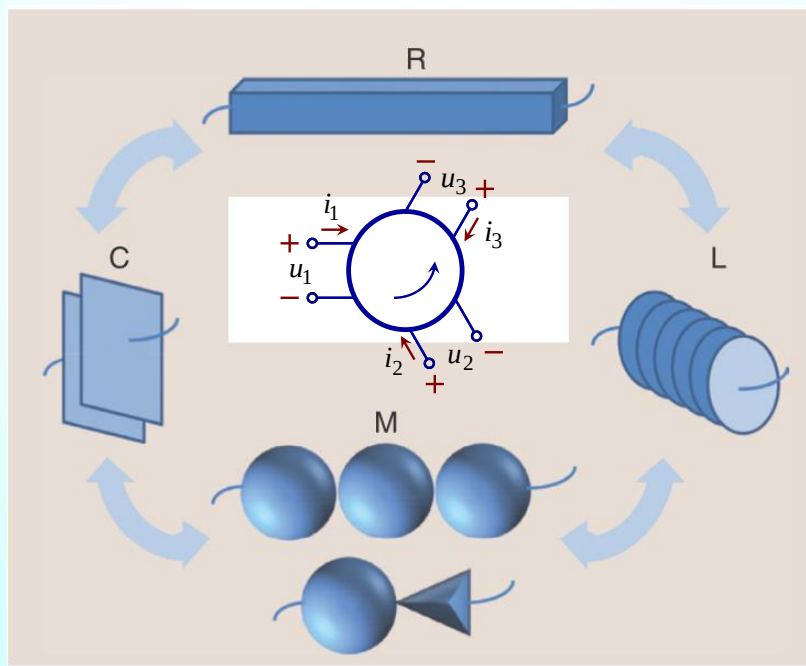


Практикум из рачунарске анализе кола



Милка Потребих
Никола Баста

Рачунарски (софтверски) алати

- *Mathematica*, WolframAlpha, MuPAD, Maxima, SymPy, SymPy Live, SymPy Gamma
- MATLAB, Scilab, Octave, FreeMat, Julia
- LTspice, QucsStudio, ngspice, Xyce, XCircuit
- Python, MathCAD, MAPLE, GeoGebra, Sage
- Symbolab, SpeQ Mathematics, meta-calculator, Desmos, ...
- Android apk: NCalc+, CalcES, SymJa CAS, Scientific Calculator Pro, CYZSoft Scientific Calculator Plus

Free/Libre Open Source Software (FLOSS)

Моделовање електричних кола

- PSpice, ngSpice, Xcos, SciLab, TINA-TI, Micro-Cap, Plexim, 5Spice...
- **Online Circuit Simulator:** DoCircuits, Circuit Lab, PartSim, EasyEda, Multisim, PartQuest (SystemVision Cloud)...
- **Android circuit simulator:** Electric Circuit Studio, Circuit Safari SPICE Simulator...

Mathematica

<https://www.wolfram.com/mathematica/>

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WOLFRAM MATHEMATICA

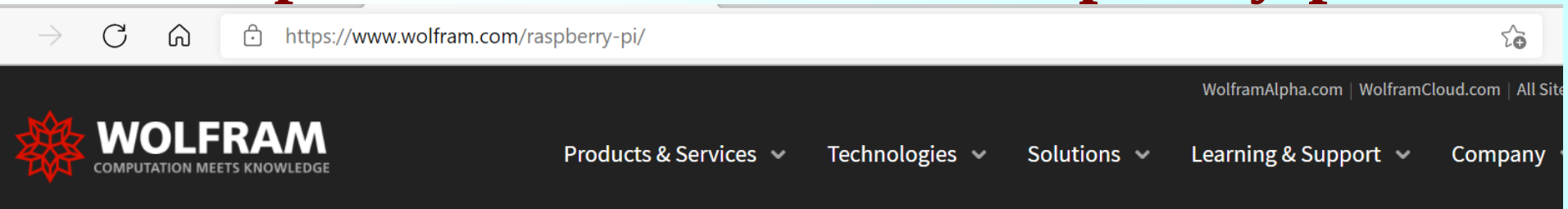
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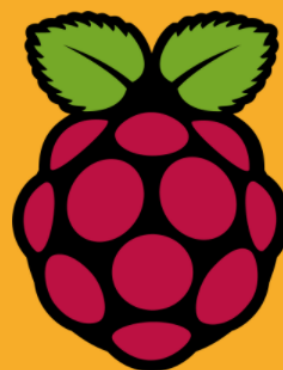
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Give your brain a quick workout with Wolfram Problem Generator.



$y' + 1000 * y = 10000, y(0) = -10$



Examples Random

Input:

$$\{y'(x) + 1000 y(x) = 10\,000, y(0) = -10\}$$

ODE classification:

first-order linear ordinary differential equation

Alternate forms:

$$\{y'(x) = 10\,000 - 1000 y(x), y(0) = -10\}$$

$$\{y'(x) + 1000 (y(x) - 10) = 0, y(0) = -10\}$$

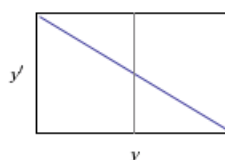
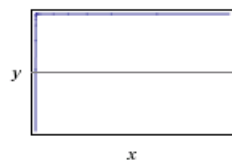
Differential equation solution:

Approximate form

Step-by-step solution

$$y(x) = 10 - 20 e^{-1000 x}$$

Plots of the solution:



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Need a hint?



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 <http://www.mathworks.com/>

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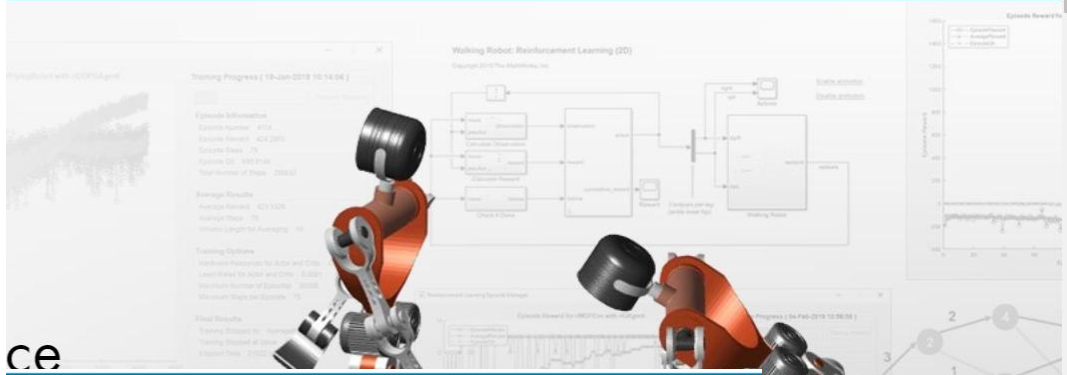
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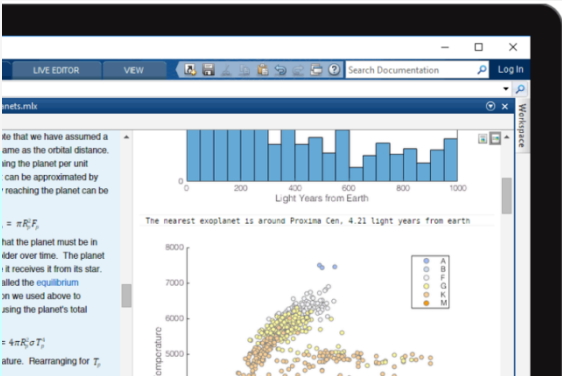
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MATLAB® combines a desktop environment tuned for iterative analysis and design processes with a programming language that expresses matrix and array mathematics directly. It includes the [Live Editor](#) for creating scripts that combine code, output, and formatted text in an executable notebook.



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Maxima

<http://maxima.sourceforge.net/>

Maxima, a Computer Algebra System

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 Downloads Documentation Project Page Top

(%i3) integrate (1 / (1 + x^4), x);

$$\frac{\log(x^2 + \sqrt{2}x + 1) - \log(x^2 - \sqrt{2}x + 1)}{4\sqrt{2}} + \frac{\operatorname{atan}\left(\frac{\sqrt{2}x + \sqrt{2}}{\sqrt{2}}\right) - \operatorname{atan}\left(\frac{\sqrt{2}x - \sqrt{2}}{\sqrt{2}}\right)}{2\sqrt{2}}$$

◀ ▶

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Maxima, a Computer Algebra System

Maxima is a system for the manipulation of symbolic and numerical expressions, including differentiation, integration, Taylor series, Laplace transforms, ordinary differential equations, systems of linear equations, polynomials, sets, lists, vectors, matrices and tensors. Maxima yields high precision numerical results by using exact fractions, arbitrary-precision integers and variable-precision floating-point numbers. Maxima can plot functions and data in two and three dimensions.

The Maxima source code can be compiled on many systems, including Windows, Linux, and MacOS X. The source code for all systems and precompiled binaries for Windows and Linux are available at the [SourceForge file manager](#).

Maxima is a descendant of Macsyma, the legendary computer algebra system developed in the late 1960s at the [Massachusetts Institute of Technology](#). It is the only system based on that effort still publicly available and with an active user community, thanks to its open source nature. Macsyma was revolutionary in its day, and many later systems, such as Maple and Mathematica, were

Recent Releases

Click on a version number to see the list of main changes.

[5.44.0: June 8, 2020](#)

[5.43.2: Jan 27, 2020](#)

[5.43.1: Jan 20, 2020](#)

[5.43.0: May 31, 2019](#)

[5.42.2: January 22, 2019](#)

Microsoft Store

Maxima on line

<http://maxima.cesga.es/>

Servicio proporcionado por  CESGA

Maxima on line

Help: [Español](#), [English](#), [Galego](#)

```
expand((x-2)^3*(x+1/3)^2);  
  
solve(x^2-x+2=0);  
  
invert(matrix([2,3,1], [a,0,0], [1,4,8]));  
  
integrate(x * sin(x), x);  
  
draw3d(explicit(x^2+y^2,x,-1,1,y,-1,1));
```

Clic

Clear

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(%i1) `expand((x-2)^3*(x+1/3)^2);`

(%o1) $x^5 - \frac{16x^4}{3} + \frac{73x^3}{9} - \frac{2x^2}{3} - 4x - \frac{8}{9}$

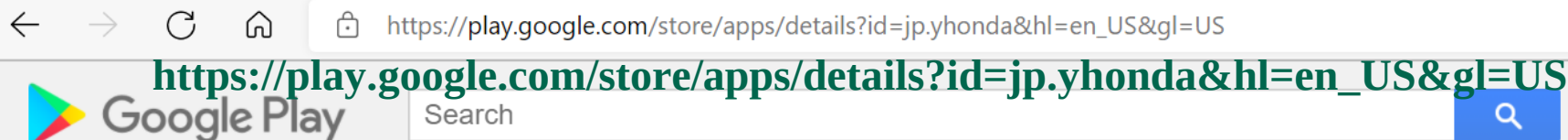
(%i2) `solve(x^2-x+2=0);`

(%o2) $\left[x = -\frac{\sqrt{7}i-1}{2}, x = \frac{\sqrt{7}i+1}{2} \right]$

(%i3) `invert(matrix([2,3,1], [a,0,0], [1,4,8]));`

(%o3) $\begin{pmatrix} 0 & \frac{1}{a} & 0 \\ \frac{2}{5} & -\frac{3}{4a} & -\frac{1}{20} \\ -\frac{1}{5} & \frac{1}{4a} & \frac{3}{20} \end{pmatrix}$

Maxima on Android



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Maxima on Android

Yasuaki Honda Education

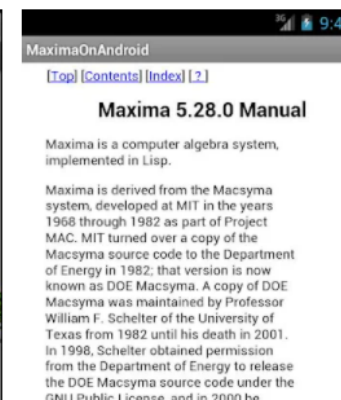
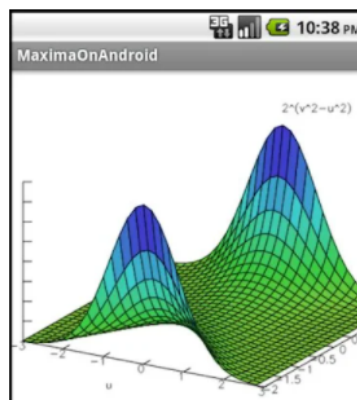
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Everyone

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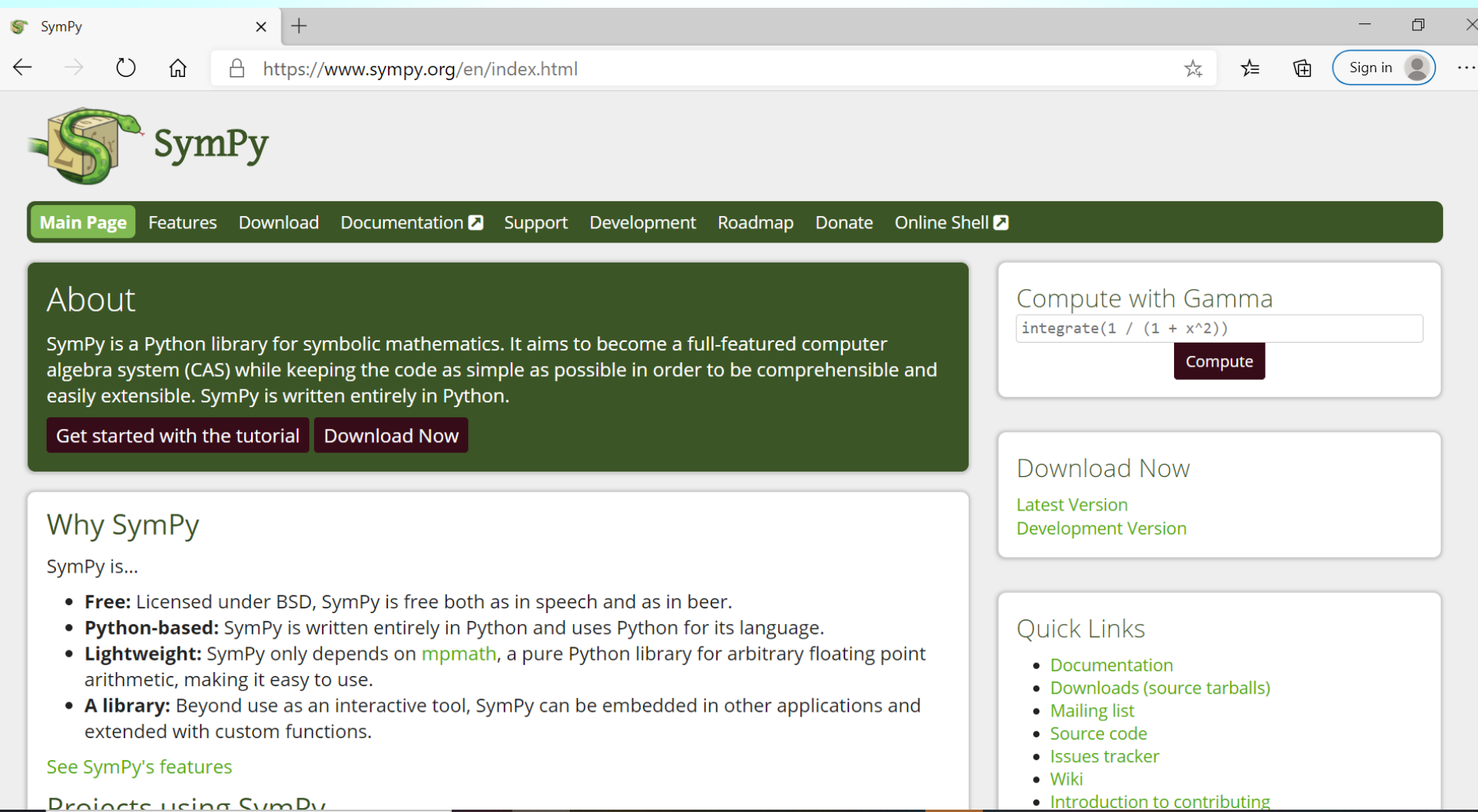
➕ Add to Wishlist

Install



SymPy

www.sympy.org/



The screenshot shows the SymPy website homepage. At the top, there is a navigation bar with links: Main Page, Features, Download, Documentation, Support, Development, Roadmap, Donate, and Online Shell. The main content area is divided into several sections. On the left, there is an 'About' section with a description of SymPy as a Python library for symbolic mathematics, followed by 'Why SymPy' and 'SymPy is...'. On the right, there is a 'Compute with Gamma' section with a text input field containing the code `integrate(1 / (1 + x^2))` and a 'Compute' button. Below this is a 'Download Now' section with links for 'Latest Version' and 'Development Version'. At the bottom right, there is a 'Quick Links' section with a list of links: Documentation, Downloads (source tarballs), Mailing list, Source code, Issues tracker, Wiki, and Introduction to contributing.

SymPy

[Main Page](#) [Features](#) [Download](#) [Documentation](#) [Support](#) [Development](#) [Roadmap](#) [Donate](#) [Online Shell](#)

About

SymPy is a Python library for symbolic mathematics. It aims to become a full-featured computer algebra system (CAS) while keeping the code as simple as possible in order to be comprehensible and easily extensible. SymPy is written entirely in Python.

[Get started with the tutorial](#) [Download Now](#)

Why SymPy

SymPy is...

- **Free:** Licensed under BSD, SymPy is free both as in speech and as in beer.
- **Python-based:** SymPy is written entirely in Python and uses Python for its language.
- **Lightweight:** SymPy only depends on `mpmath`, a pure Python library for arbitrary floating point arithmetic, making it easy to use.
- **A library:** Beyond use as an interactive tool, SymPy can be embedded in other applications and extended with custom functions.

[See SymPy's features](#)

[Projects using SymPy](#)

Compute with Gamma

`integrate(1 / (1 + x^2))`

[Compute](#)

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- [Downloads \(source tarballs\)](#)
- [Mailing list](#)
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- [Wiki](#)
- [Introduction to contributing](#)

SymPy live

live.sympy.org

live.sympy.org



Main Page Download Documentation Support Development Donate **Online Shell**

These commands were executed:

```
>>> from __future__ import division
>>> from sympy import *
>>> x, y, z, t = symbols('x y z t')
>>> k, m, n = symbols('k m n', integer=True)
>>> f, g, h = symbols('f g h', cls=Function)
```

Documentation can be found at <http://docs.sympy.org/>.

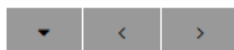
```
>>> diffeq = Eq(f(x).diff(x) + 1000*f(x), 10000)
>>> diffeq
```

$$1000f(x) + \frac{d}{dx} f(x) = 10000$$

```
>>> dsolve(diffeq, f(x))
```

$$f(x) = C_1 e^{-1000x} + 10$$

```
>>>
```



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About this page

SymPy Live is SymPy running on the SymPy Engine.

This is just a regular Python shell with the following commands executed:

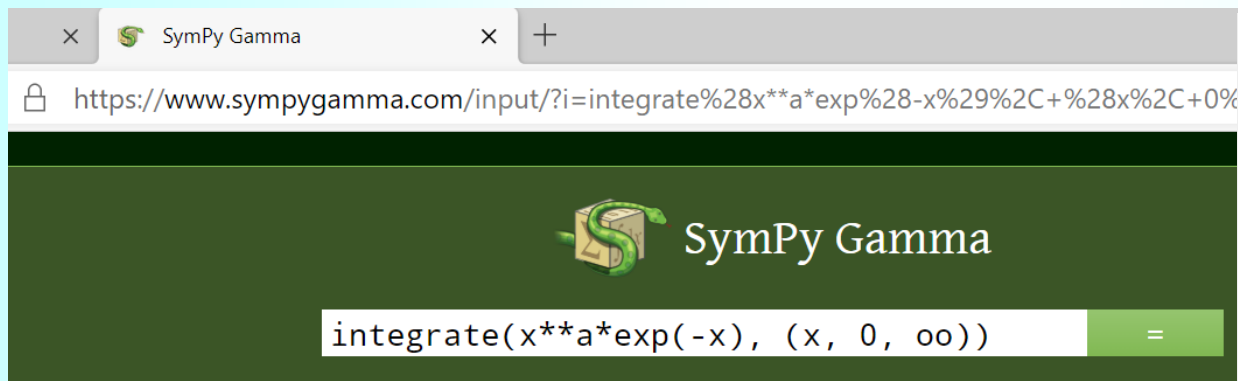
```
>>> from __future__ import division
>>> from sympy import *
>>> x, y, z, t = symbols('x y z t')
>>> k, m, n = symbols('k m n', integer=True)
>>> f, g, h = symbols('f g h', cls=Function)
```

Please note that the Google App Engine has a timeout of 60 seconds for computation due to a quirk in Safari on iOS, which is 58 seconds.

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SymPy Gamma

<https://www.sympygamma.com/>



SymPy:

`integrate (x**a*exp (-x),(x,0,oo ))`

$$\int_0^{\infty} x^a e^{-x} dx$$

Antiderivative forms:

`integrate(x**a*exp(-x), (x, 0, oo))`

$$\begin{cases} \Gamma(a+1) & \text{for } \operatorname{re}(a) > -1 \\ \int_0^{\infty} x^a e^{-x} dx & \text{otherwise} \end{cases}$$

`sympy.integrals.manualintegrate(x**a*exp(-x), (x, 0, oo))`

$$-\Gamma(a+1, x)$$

Examples

Random Example

Arithmetic

Algebra

Trigonometry

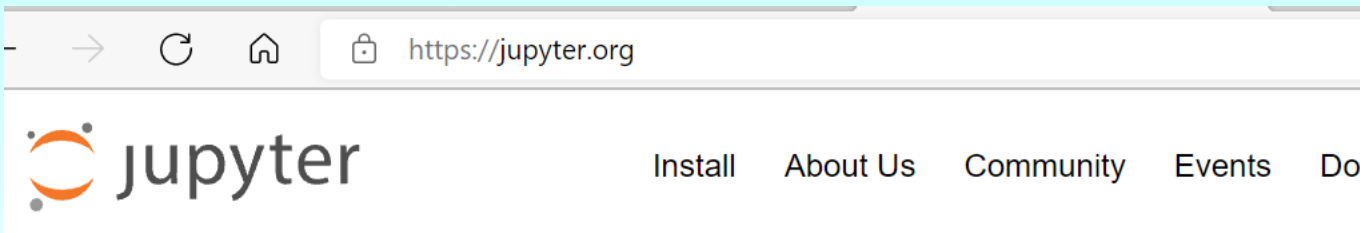
Calculus

Number Theory

Discrete Mathematics

Plotting

Miscellaneous



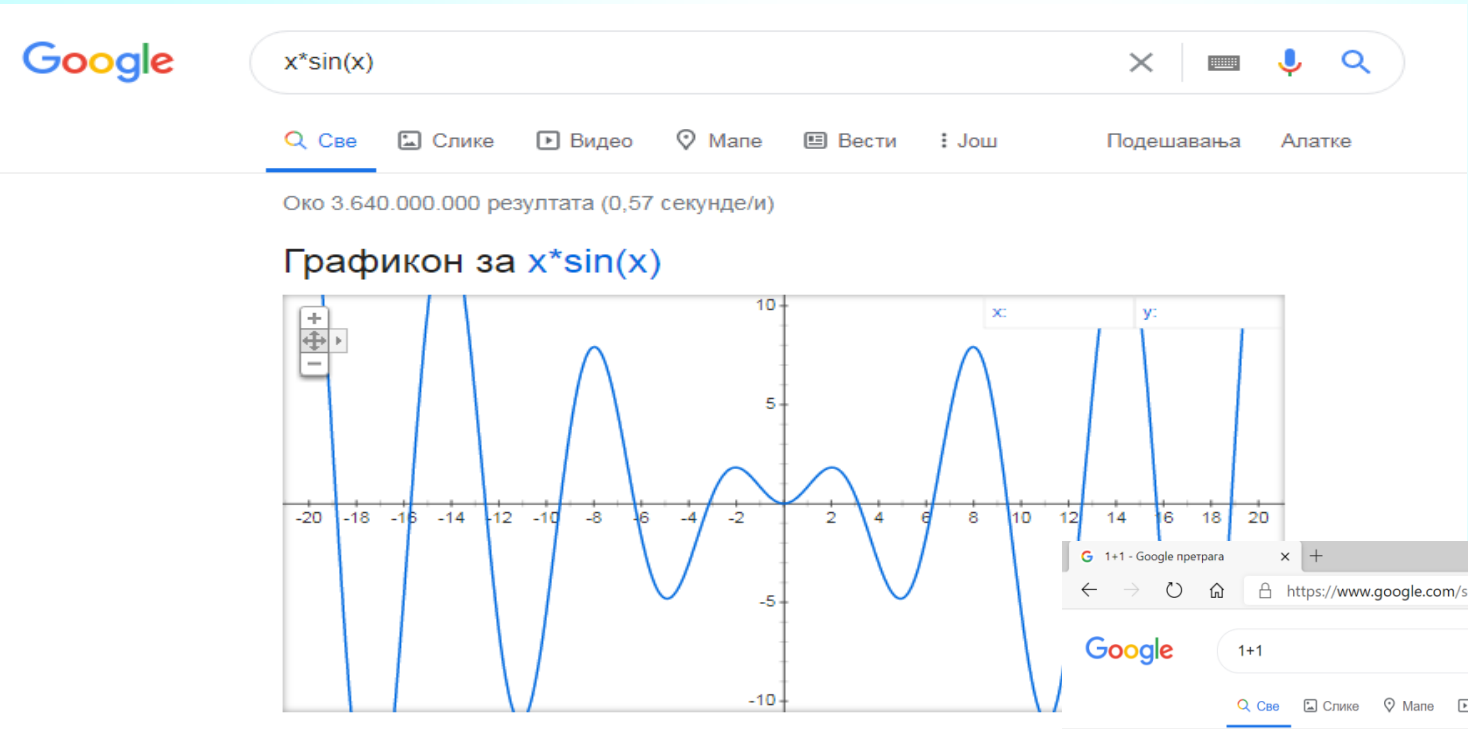
Sympy and the Jupyter Notebook for engineering calculations



```
[1]: from sympy import *  
x = symbols('x')  
import sympy; sympy.__version__  
  
[1]: '1.4'  
  
[2]: Integral(exp(-x**2), (x, -oo, oo))  
[2]:  $\int_{-\infty}^{\infty} e^{-x^2} dx$   
  
[3]: _.doit()  
[3]:  $\sqrt{\pi}$ 
```

Project Jupyter exists to develop open-source software, open-standards, and services
interactive computing across dozens of programming languages.

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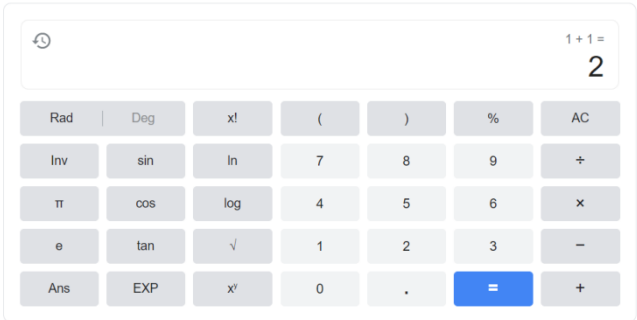
What is the integral of $x \sin(x) dx$? | MyTutor

Find the following integral: $\int x \sin(x) dx$ This question is a good candidate for parts method, as it is the product of two different 'parts'. R...

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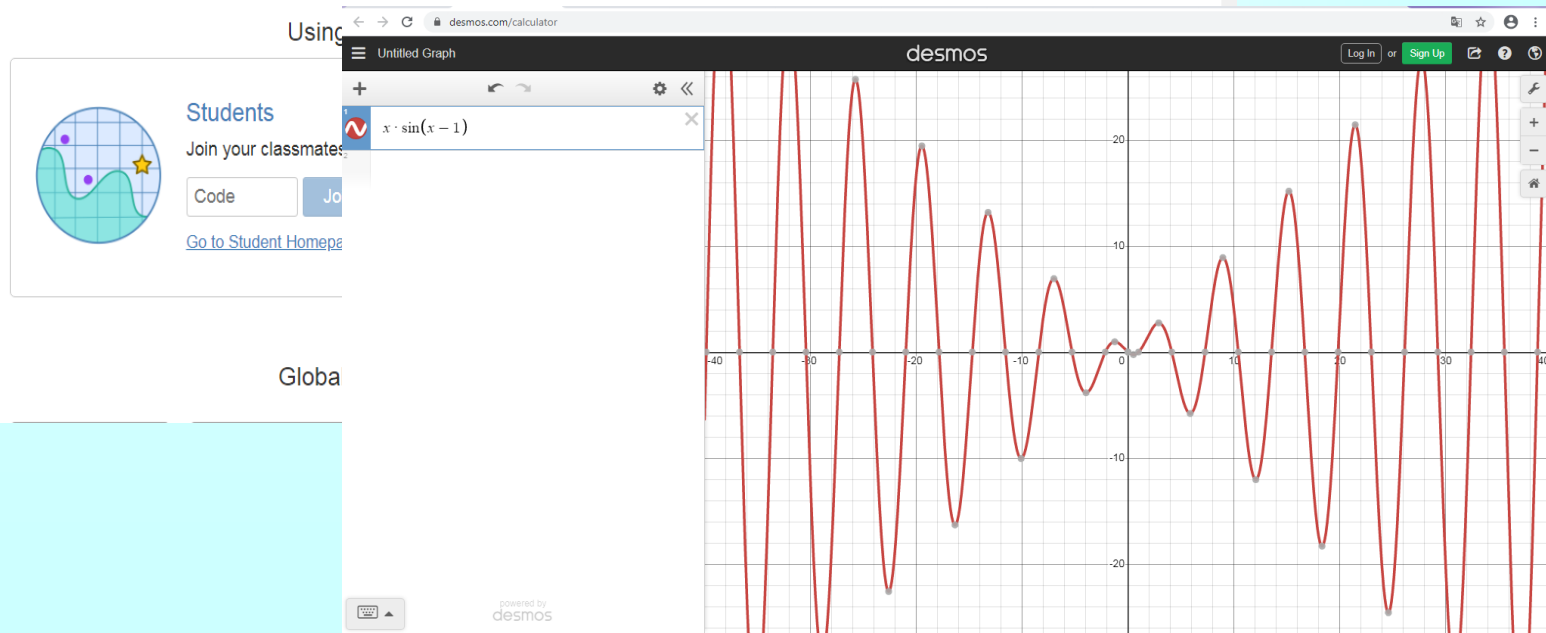
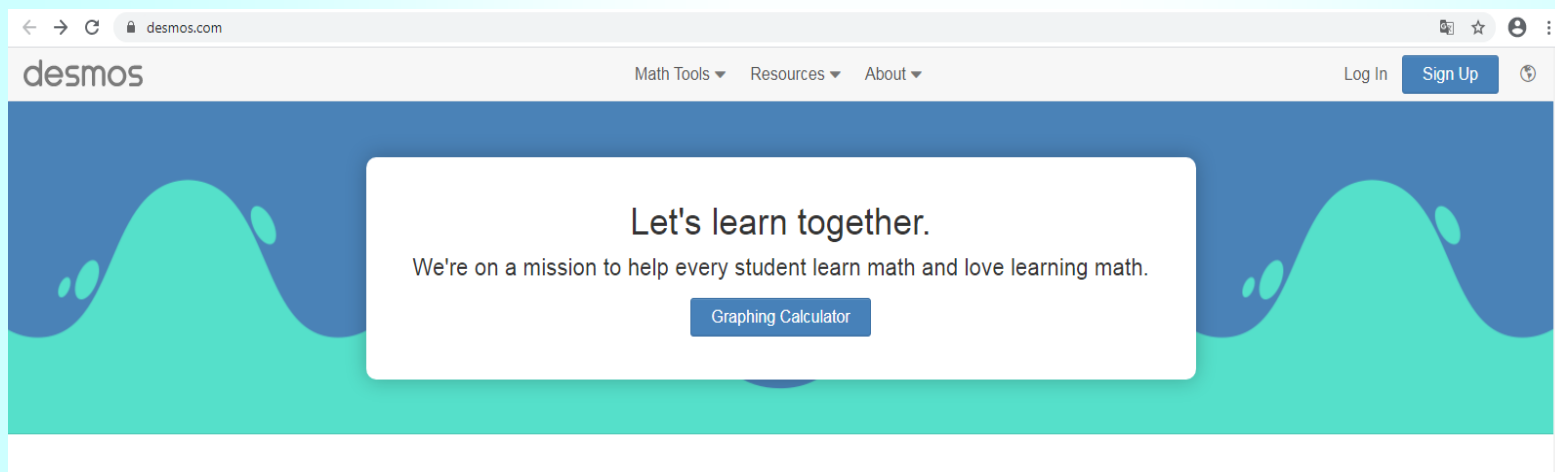
Ex 7.6, 1 - Find integration of $x \sin x$ - Chapter 7 Clas

25.09.2018. - Ex 7.6, $1x \sin x \int 1 \cdot [x \sin x] dx$ || Algebraic Trigonometric V
 $g(x) \int dx = f(x) \int 1 \cdot g(x) \dots$



Graphing Calculator – Desmos

<https://www.desmos.com/calculator>



Symbolab Math Solver - Step by Step calculator

<https://www.symbolab.com/>

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$\int_0^T x \sin(x) dx = \sin(T) - T \cos(T)$

Steps

$\int_0^T x \sin(x) dx$

Apply Integration By Parts: $u = x, v' = \sin(x)$ [Show Steps](#)

$= [-x \cos(x) - \int -\cos(x) dx]_0^T$

$\int -\cos(x) dx = -\sin(x)$ [Show Steps](#)

$= [-x \cos(x) - (-\sin(x))]_0^T$

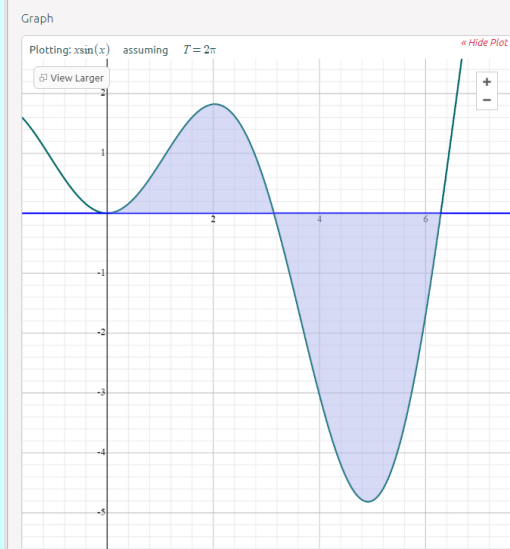
Simplify

$= [-x \cos(x) + \sin(x)]_0^T$

Compute the boundaries: $[-x \cos(x) + \sin(x)]_0^T = \sin(T) - T \cos(T)$ [Show Steps](#)

$= \sin(T) - T \cos(T)$

[Got a different answer? Check if it's correct](#) [Verify](#)



SciLab

<https://www.scilab.org/>

The image displays the SciLab website homepage and a collage of its software interface. The website header includes the SciLab logo, navigation links (Download, Software, Tutorials, Applications, Services, Cloud, About), and a search bar. The main content area features the text "Download Scilab 6.1.0" and "Windows, Linux and Mac OS X". Below this, it states "Open source software for numerical computation". The collage includes a screenshot of the SciLab 6.1.0 console showing a script execution, a 3D surface plot, and a list of toolboxes: Numerical Analysis, Data visualization, Algorithm development, and Application development. The bottom right corner lists various SciLab applications: Image Processing & Computer Vision, Model Order Reduction, Scilab Code Generator, Signal acquisition & instrument control, and Functional Mock-Up Interface (FMI) for Model-Exchange & Co-Simulation.

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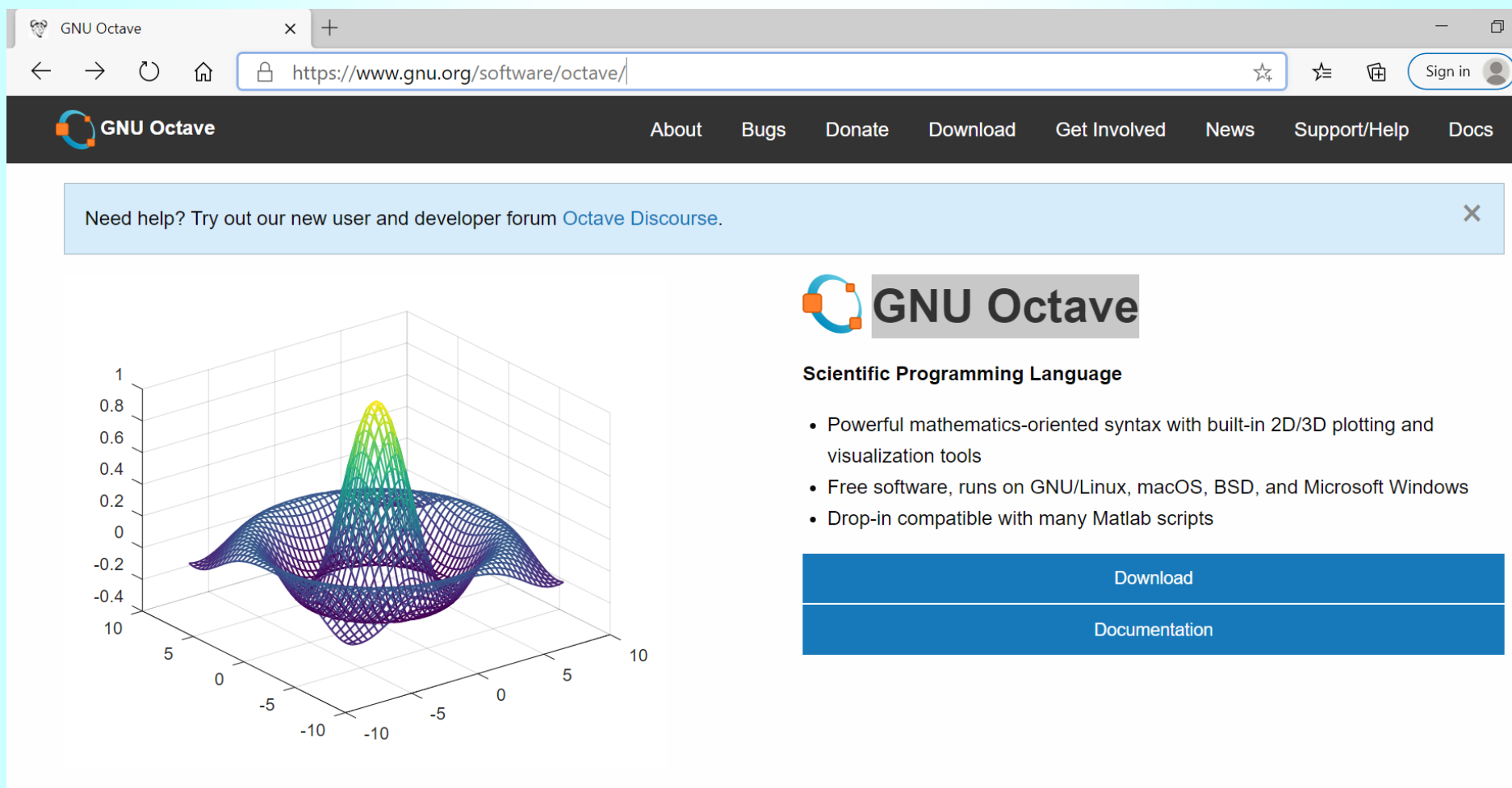
<https://www.scilab.org/software/xcos>

The screenshot displays the Xcos website interface. At the top, the Scilab logo is visible on the left, and a navigation menu includes links for Download, Software (selected), Tutorials, Applications, Services, Cloud, and About. A search bar is located on the right. Below the navigation bar, the word "Xcos" is prominently displayed in a large, white font on a blue background. Underneath, four example diagrams are shown, each representing a different application area:

- Signal Processing:** A diagram showing three "Signal Builder" blocks connected to a "Scope" block. A note below states: "blocks can also emit continuous or discrete activation signals".
- Control Systems:** A diagram illustrating a "Water-Tank System" with a "Controller" and a "Robot-Tank System". It includes a "Water Level" input and a "PID" controller block.
- Mechanics/Thermodynamics:** A diagram showing a series of interconnected mechanical or thermal components, including valves and tanks.
- Electronics:** A diagram showing an electronic circuit with various components like resistors, capacitors, and a "MUX" (multiplexer) block.

GNU Octave

<https://www.gnu.org/software/octave/>

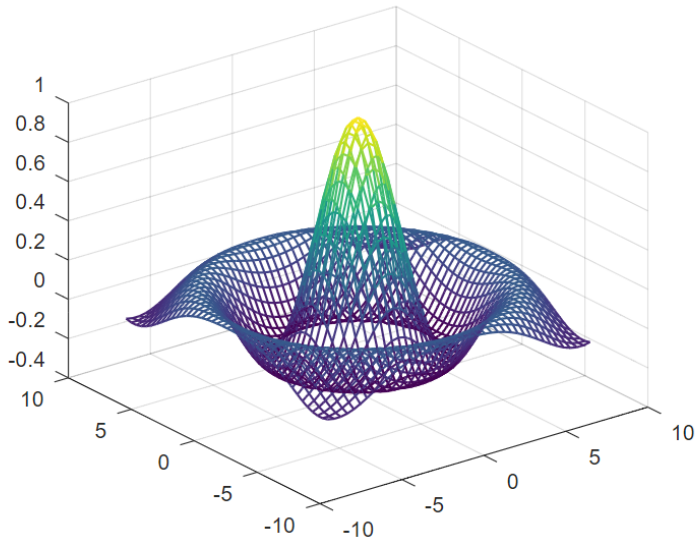


The screenshot shows the GNU Octave website homepage. At the top is a navigation bar with the GNU Octave logo and links for About, Bugs, Donate, Download, Get Involved, News, Support/Help, and Docs. Below the navigation bar is a light blue banner with the text "Need help? Try out our new user and developer forum [Octave Discourse](#)." and a close button. The main content area features a 3D wireframe plot of a function on the left and a sidebar on the right. The sidebar contains the GNU Octave logo, the text "Scientific Programming Language", a list of bullet points describing the software's capabilities, and two large blue buttons labeled "Download" and "Documentation".

GNU Octave

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Need help? Try out our new user and developer forum [Octave Discourse](#).



GNU Octave

Scientific Programming Language

- Powerful mathematics-oriented syntax with built-in 2D/3D plotting and visualization tools
- Free software, runs on GNU/Linux, macOS, BSD, and Microsoft Windows
- Drop-in compatible with many Matlab scripts

Download

Documentation

CircuitLab

<https://www.circuitlab.com/>

The image shows a screenshot of the CircuitLab website and a tutorial video. The website header includes the CircuitLab logo, a search bar, and user information for 'milka.potrebic'. The main heading is 'Circuit simulation and schematics.' followed by the subheading 'Build and simulate circuits right in your browser.' Below this is a list of features: 'Design with our easy-to-use schematic editor.', 'Analog & digital circuit simulations in seconds.', 'Professional schematic PDFs, wiring diagrams, and plots.', and 'No installation required! Launch it instantly with [one click](#).' A green button labeled 'Launch CircuitLab' is present, along with a link to 'or watch a quick demo video →'. The tutorial video, titled 'Getting Started with CircuitLab', shows a circuit diagram with a sine wave source V1 (1 kHz), a resistor R1 (100 Ω), a resistor R2 (100 Ω), and a capacitor C1 (1 μF). The video includes a play button and a 'Deli' (Share) button. Below the video, a '1-minute Tutorial' is provided with five steps: 1. Click and drag a wire from the right of R1 to the top of C1. 2. Click "Simulate." 3. Click "Run Time-domain Simulation" and look at the filter output V(out). 4. Double-click R1, change it to "1k", and simulate again. 5. Run the Frequency-Domain simulation and see the Bode plot. The bottom of the image shows a circuit diagram with a square wave source V1 (1 kHz), a resistor R1 (100 Ω), and a capacitor C1 (10 μF). The circuit is labeled 'In' and 'out'.

CircuitLab

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[Launch CircuitLab](#)

[or watch a quick demo video →](#)

Getting Started with CircuitLab

Гледајте К... Дели

1-minute Tutorial

1. Click and drag a wire from the right of R1 to the top of C1.
2. Click "Simulate."
3. Click "Run Time-domain Simulation" and look at the filter output V(out)
4. Double-click R1, change it to "1k", and simulate again.
5. Run the Frequency-Domain simulation and see the Bode plot.

Textbook **NEW!**

Electronic systems with CircuitLab's free, 1k.

[Full Circuit Design and Analysis](#)

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Get started with some sample circuits !

Colpitts Oscillator

This circuit generates a continuous sinusoidal signal. The tank circuit is made up of two capacitors and an inductor in parallel

Active Low Pass Filter

This circuit made up using op-amp and will allow signals lower than a particular cut off frequency to pass though and attenuates those above it.

Active High Pass Filter

This circuit uses an op-amp as the active element and allows only the input signals with frequency higher than the cut-off frequency and rejects those below it.

Clipper

This is a wave-shaping circuit. It will modify the shape of the signal by "clipping" off a portion of it. When the diode is forward-biased, the voltage across it will be a constant 0.7 V. And when the diode is reverse-biased, it will be open. Thus the output will follow the input when it is forward biased.

Clamper

This circuit is another level shape. The wave is shifted to a positive or negative level.

Fig. 1: DoCircuits - Home

ngSpice

<http://ngspice.sourceforge.net/>

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MIXED MODE - MIXED LEVEL
CIRCUIT SIMULATOR

BASED ON BERKELEY'S SPICE3F5

NGSPICE SUMMARY

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Ngspice Home

Home
What is ngspice ?
Features, Extras & Options
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Tutorials

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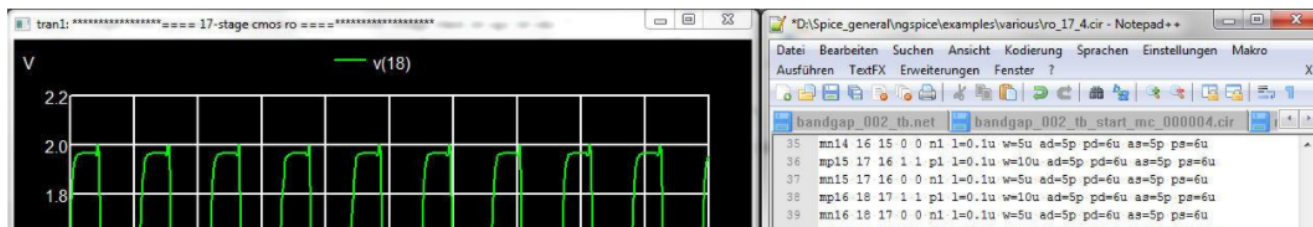
ngspice - open source spice simulator

ngspice is the open source spice simulator for electric and electronic circuits.

Such a circuit may comprise of JFETs, bipolar and MOS transistors, passive elements like R, L, or C, diodes, transmission lines and other devices, all interconnected in a netlist. Digital circuits are simulated as well, event driven and fast, from single gates to complex circuits. And you may enter the combination of both analog and digital as a mixed-signal circuit.

ngspice offers a wealth of device models for active, passive, analog, and digital elements. Model parameters are provided by our [collections](#), by the [semiconductor device manufacturers](#), or from [semiconductor foundries](#). The user adds her circuits as a netlist, and the output is one or more graphs of currents, voltages and other electrical quantities or is saved in a data file.

ngspice does not provide schematic entry. Its input is command line or file based. There are however [third party](#) interfaces available.



←

→

↺

🏠

🔒

https://www.ti.com/tool/TINA

 **TEXAS INSTRUMENTS**

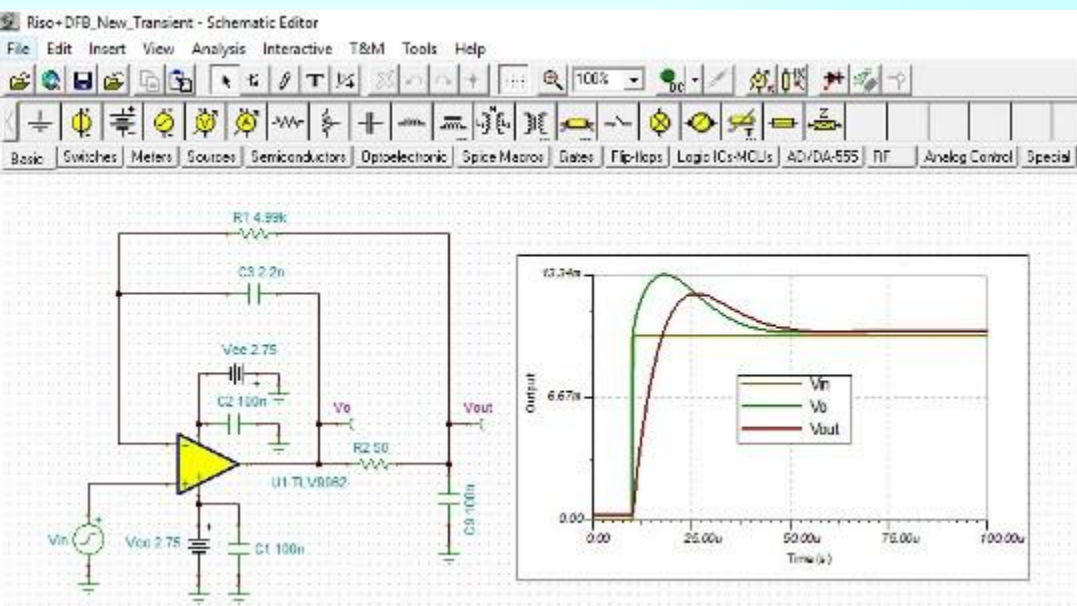
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TINA-TI

SPICE-based analog simulation program

Overview

Downloads

Technical documentation

Support & training

TINA-TI

https://www.ti.com/tool/TINA-TI

Overview

TINA-TI provides all the conventional DC, transient and frequency domain analysis of SPICE and much more. TINA has extensive post-processing capability that allows you to format results the way you want them. Virtual instruments allow you to



Electric Circuit Studio

← → ↻ 🏠 https://play.google.com/store/apps/details?id=com.ecstudiosystems.electriccircuitstudio&hl=en_US&gl=US



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Electric Circuit Studio

ECStudio Systems Education

★★★★☆ 2,709

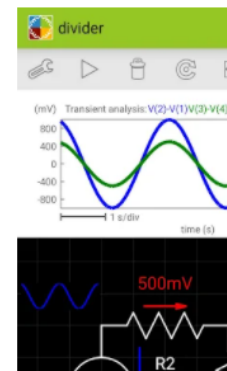
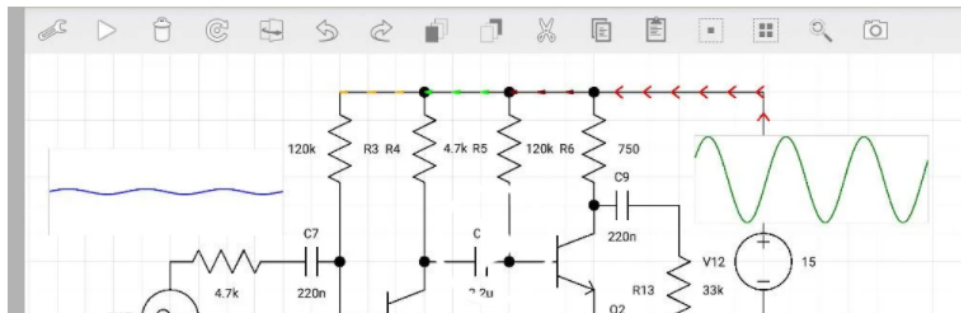
Everyone

Contains Ads

⚠ You don't have any devices

➕ Add to Wishlist

Install



CircuitSafari SPICE Simulator

← → ↺ 🏠

🔒 https://play.google.com/store/apps/details?id=com.logipipe.circuitsafari&hl=en_US&gl=US

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📱 Apps

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Parent Guide

CircuitSafari SPICE Simulator
(Early Access)

Logipipe, LLC Productivity

E Everyone

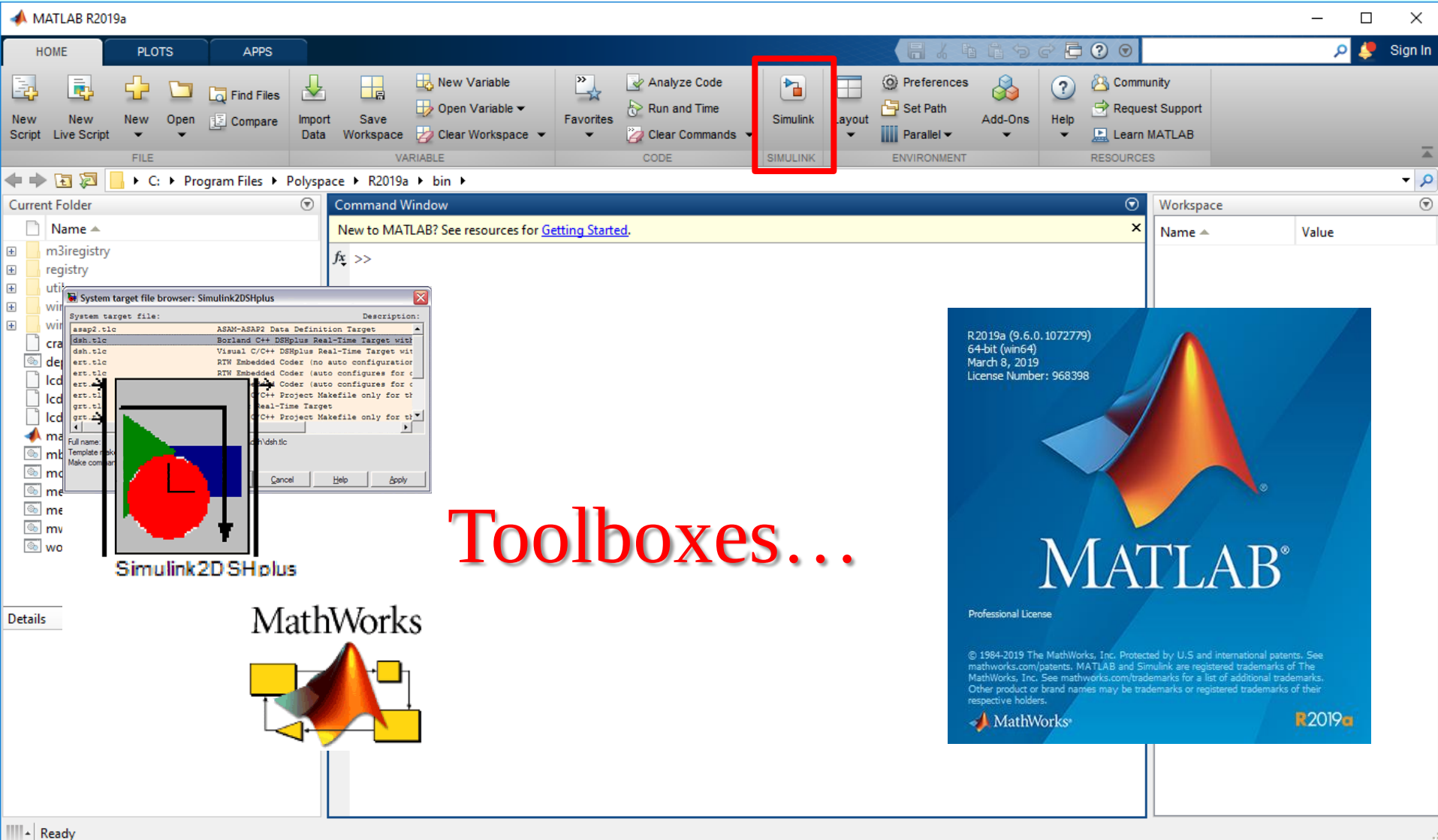
Offers in-app purchases

📄 This app is in development. It may be unstable.

⚠️ You don't have any devices

🔖 Add to Wishlist

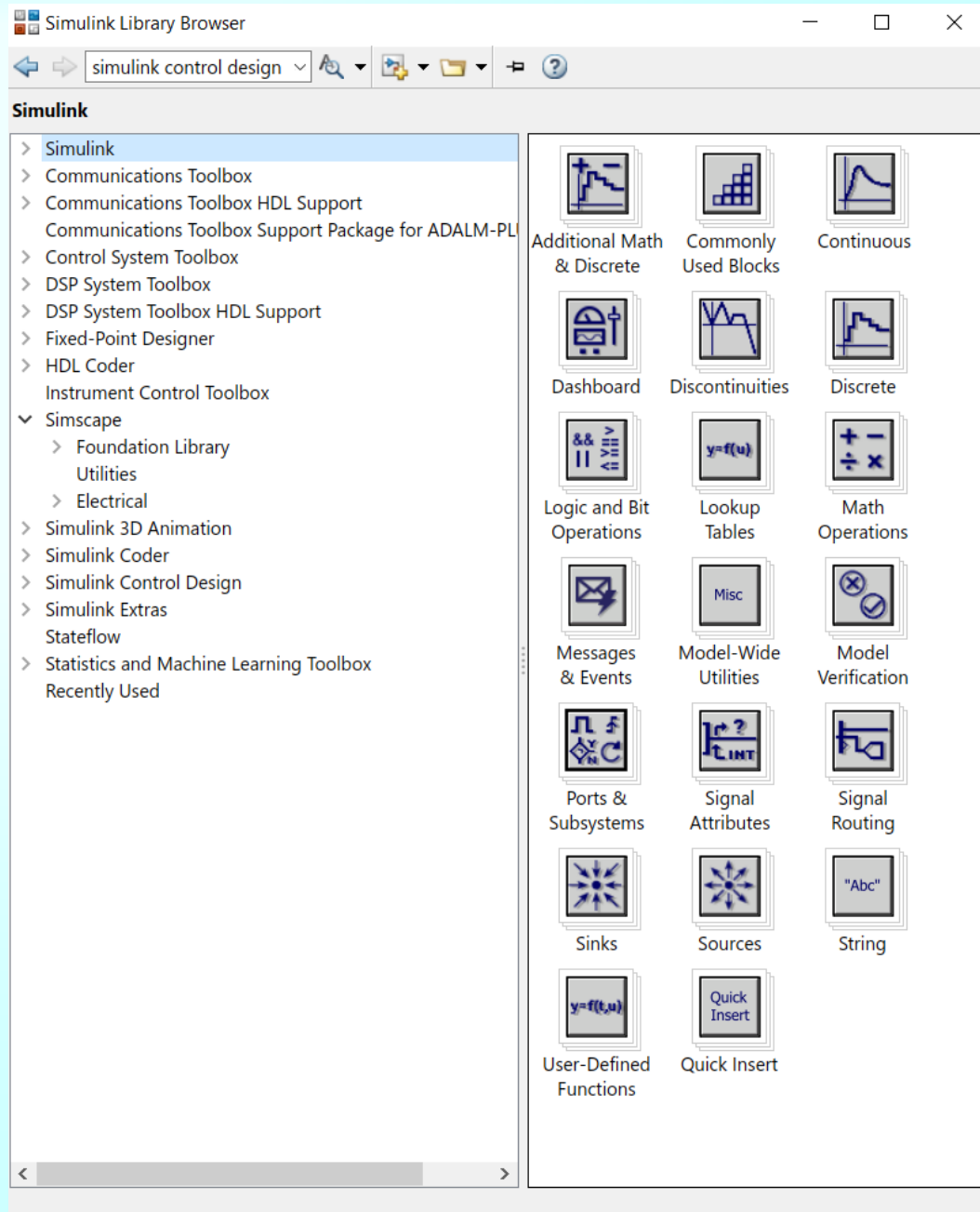
Install



MATLAB

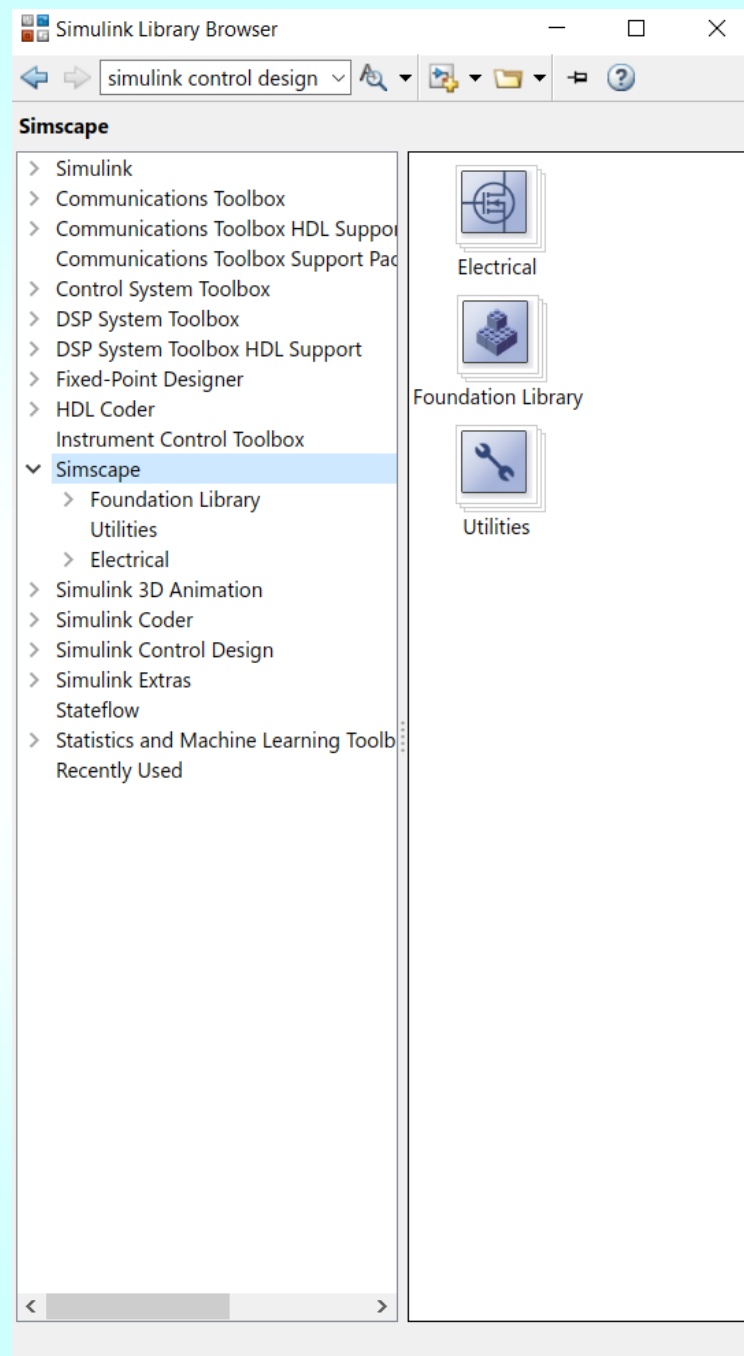
Simulink

- Алатка за нумеричку анализу математичких модела
- Систем се дефинише графички, уметањем блокова и њиховим повезивањем у мрежу



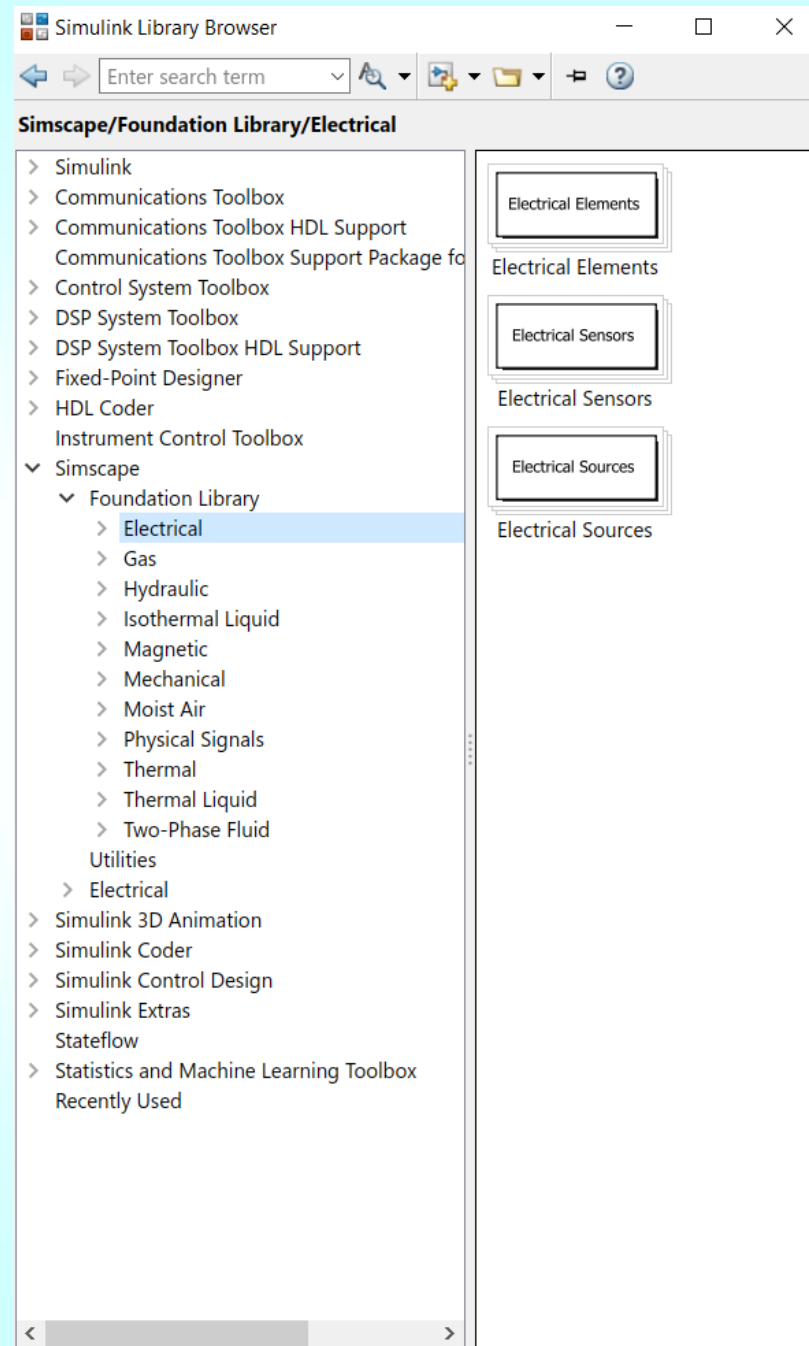
Simulink > Simscape

- Библиотека за симулацију и нумеричку анализу мултидоменских проблема (механика, електродинамика, оптика)



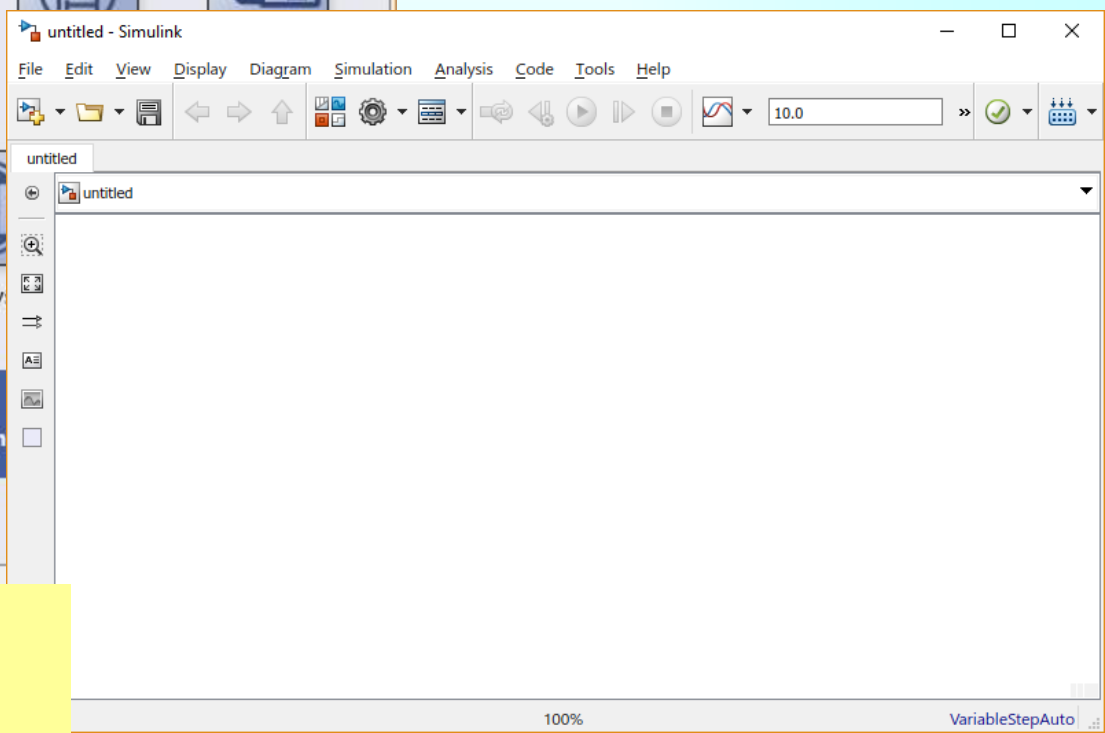
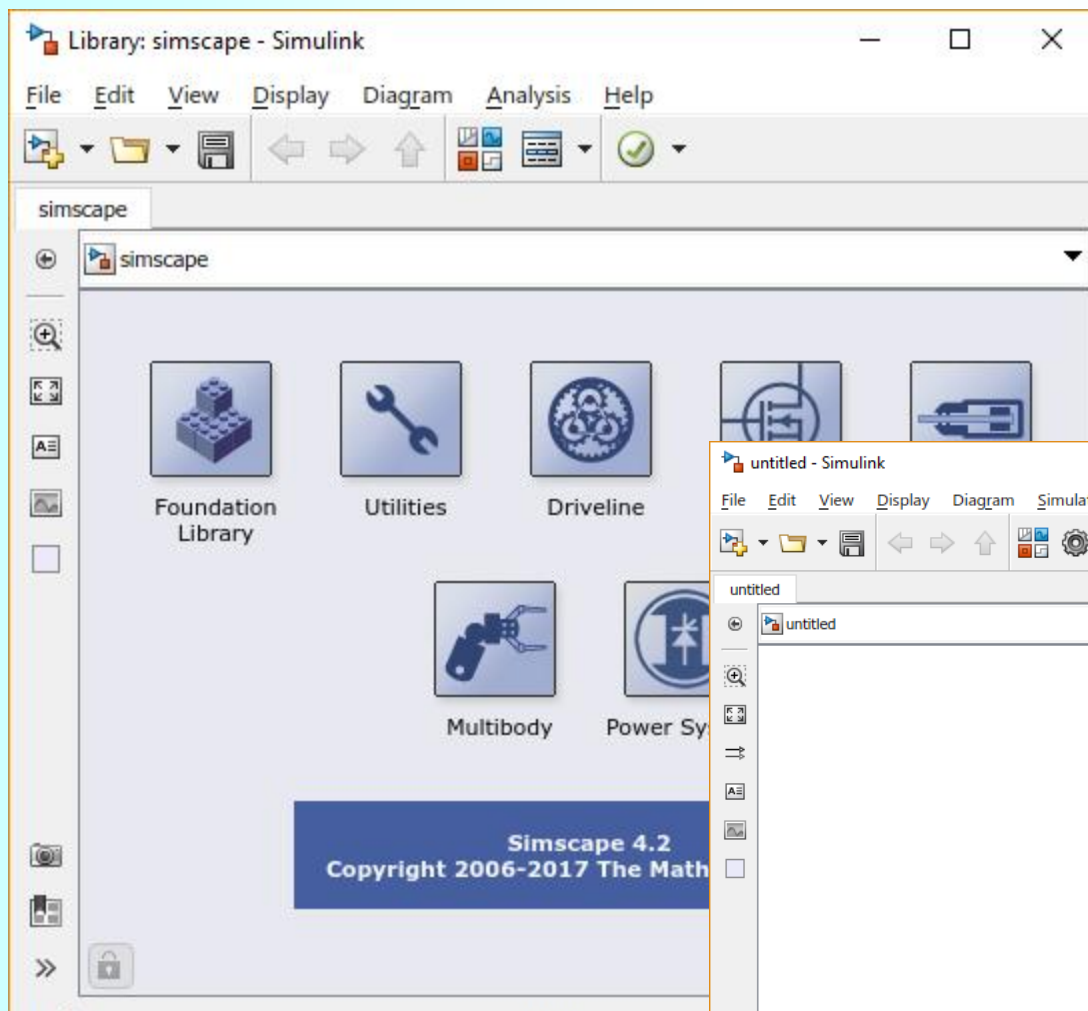
Simulink > Simscape > Foundation Library > Electrical

- Симулација линеарних и нелинеарних електричних кола

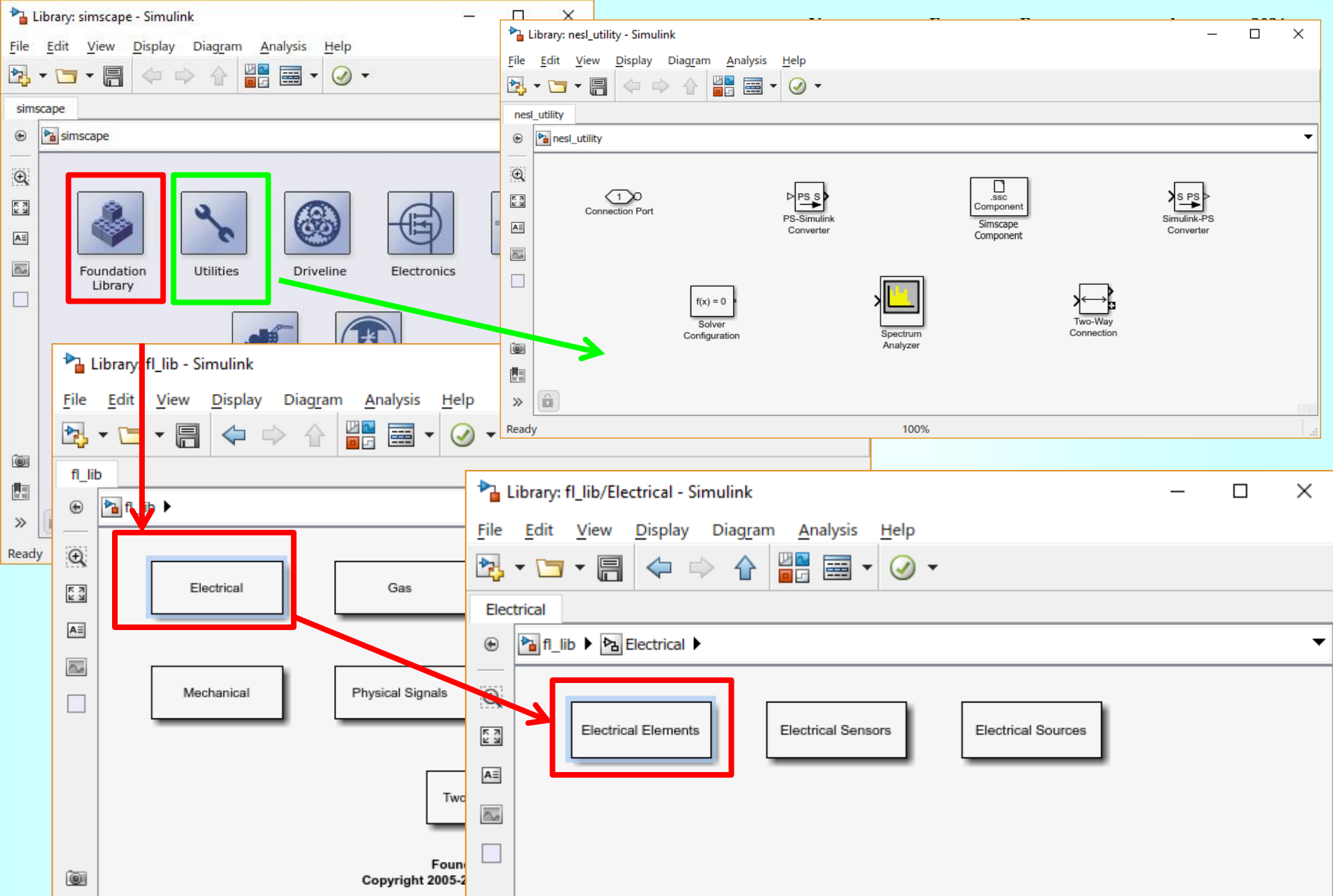


**MATLAB > Simscape >
Foundation Library, Utilities**

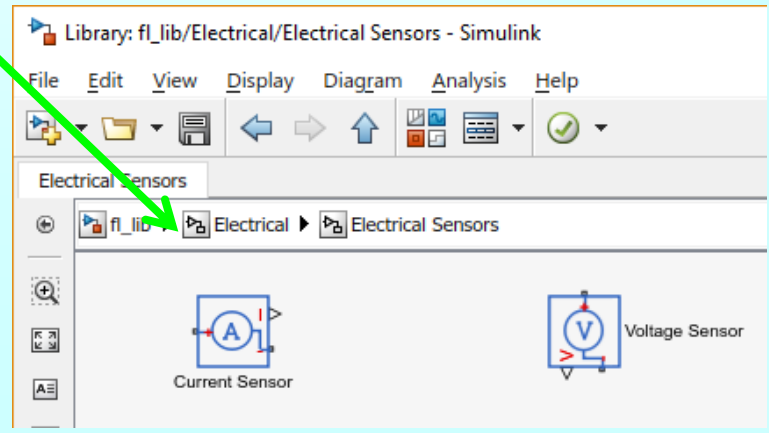
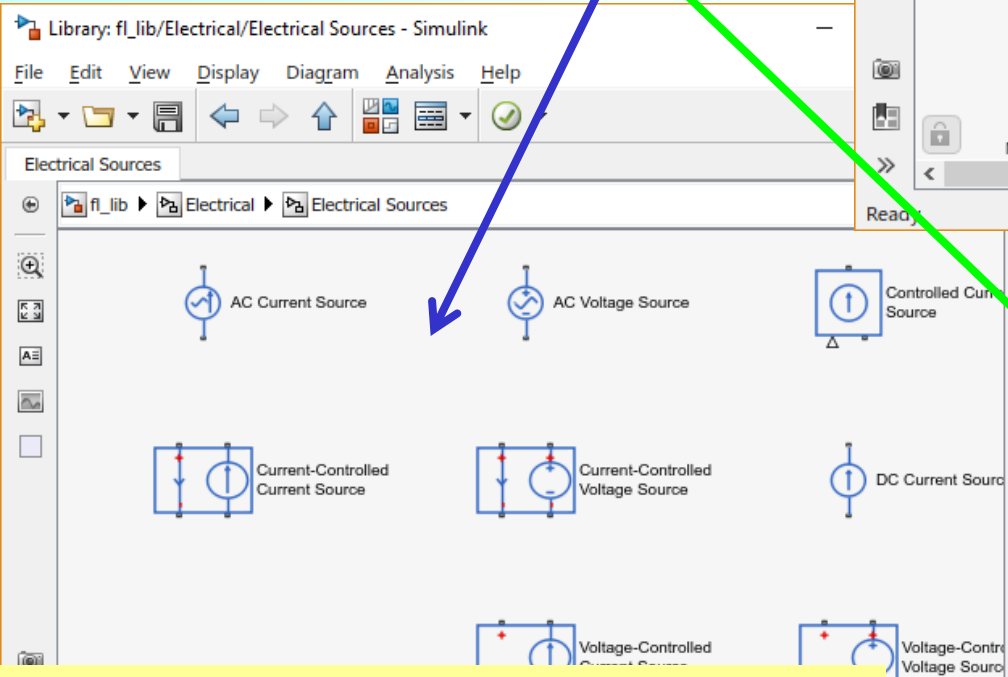
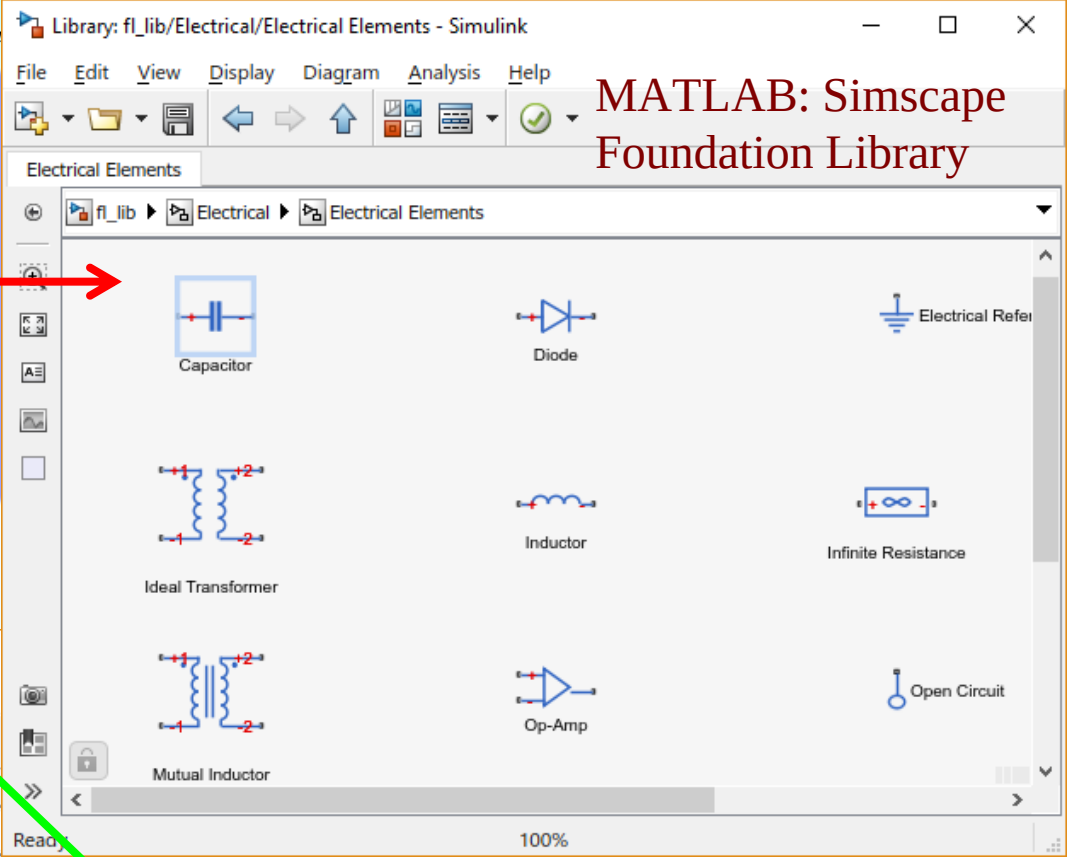
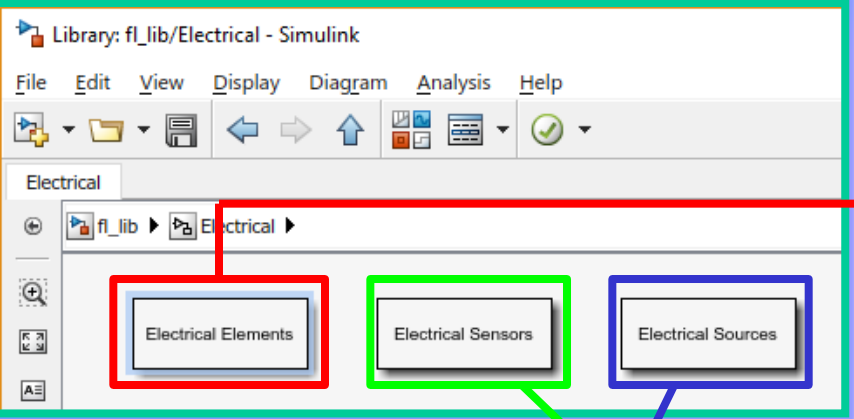
Симулација електричног кола коришћењем **Simscape > Foundation Library** библиотеке



**MATLAB > Simscape >
Foundation Library, Utilities**

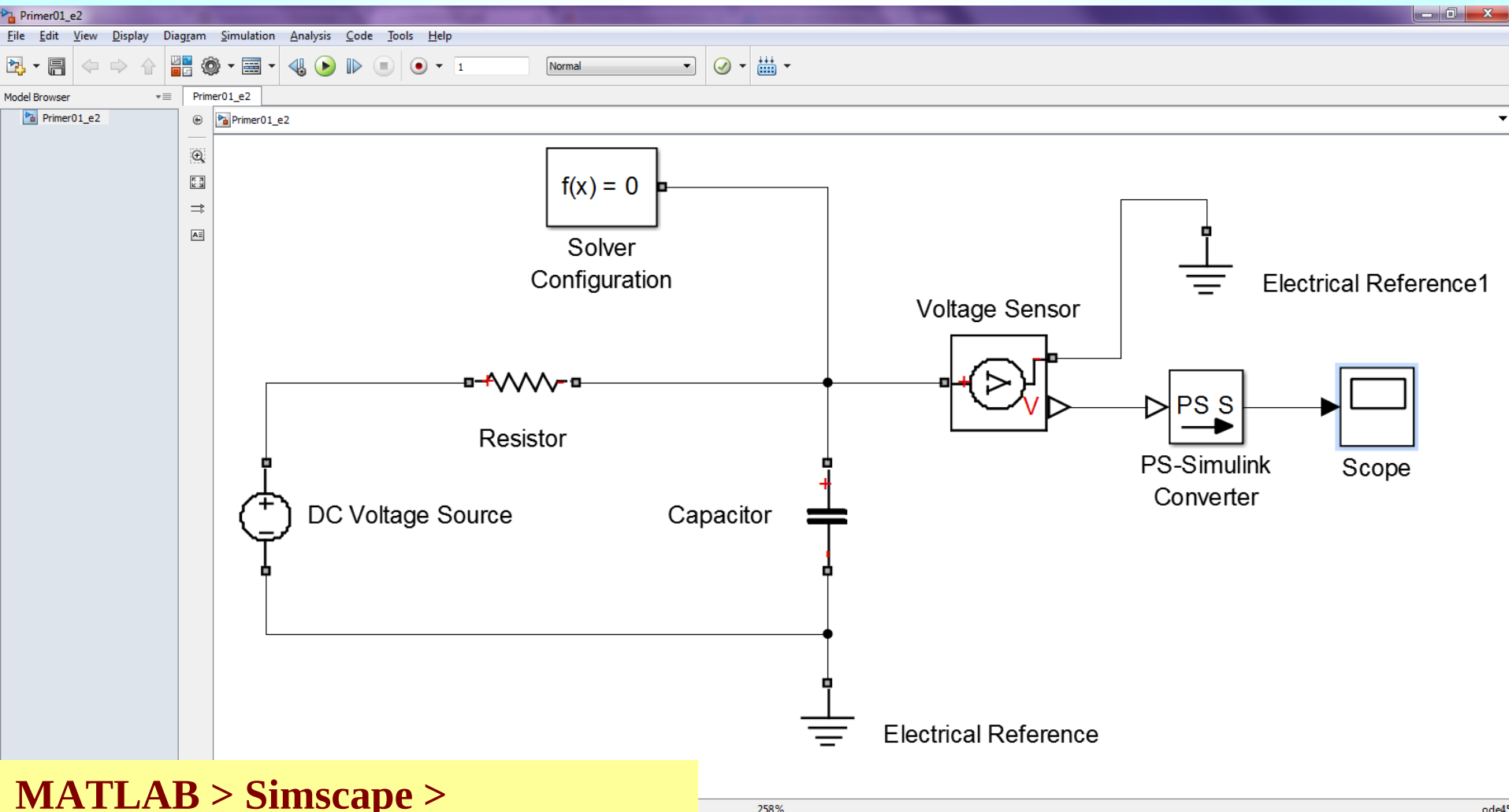


**MATLAB > Simscape >
Foundation Library, Utilities**



MATLAB > Simscape > Foundation Library, Utilities

Симулација електричног кола коришћењем **Simscape > Foundation Library** библиотеке



**MATLAB > Simscape >
Foundation Library, Utilities**

Block Parameters: Solver Configuration

Solver Configuration
Defines solver settings to use for simulation.

Parameters

☐ Start simulation from steady state

Consistency tolerance

☐ Use local solver

Solver type

Sample time

☐ Use fixed-cost runtime consistency iterations

Nonlinear iterations

Mode iterations

Linear Algebra

Delay memory budget [kB]

☒ Apply filtering at 1-D/3-D connections when needed

Filtering time constant

Block Parameters: DC Voltage Source

DC Voltage Source

The ideal voltage source maintains a constant voltage across its output terminals, independent of the current flowing through the source. The output voltage is defined by the Constant voltage parameter, and can be any real value.

[Source code](#)

Settings

Parameters

Constant voltage:

Block Parameters: Resistor

Resistor

The voltage-current (V-I) relationship for a linear resistor is $V=I \cdot R$, where R is the constant resistance in ohms.

The positive and negative terminals of the resistor are denoted by the + and - signs respectively. By convention, the voltage across the resistor is given by $V(+)-V(-)$, and the sign of the current is positive when flowing through the device from the positive to the negative terminal. This convention ensures that the power absorbed by a resistor is always positive.

[Source code](#)

Settings

Parameters Variables

Resistance:

Block Parameters: Capacitor

Capacitor

Models a linear capacitor. The relationship between voltage V and and current I is $I=C*dV/dt$ where C is the capacitance in farads.

The Series resistance and Parallel conductance represent small parasitic effects. The parallel conductance can be used to model dielectric losses and the series resistance used to represent the effective series resistance (ESR) of the capacitor. Simulation of some circuits may require the presence of the small series resistance. Consult the documentation for further details.

[Source code](#)

Settings

Parameters

Variables

Capacitance:

1e-6

F

Series resistance:

0

Ohm

Parallel conductance:

0

1/Ohm

OK

Cancel

Help

Apply

Почетни услов...

Settings

Parameters

Variables

Override	Variable	Priority	Beginning Value	Unit
☐	Current	None	0	A
☐	Voltage	None	0	V
☒	Capacitor voltage	High	-10	V

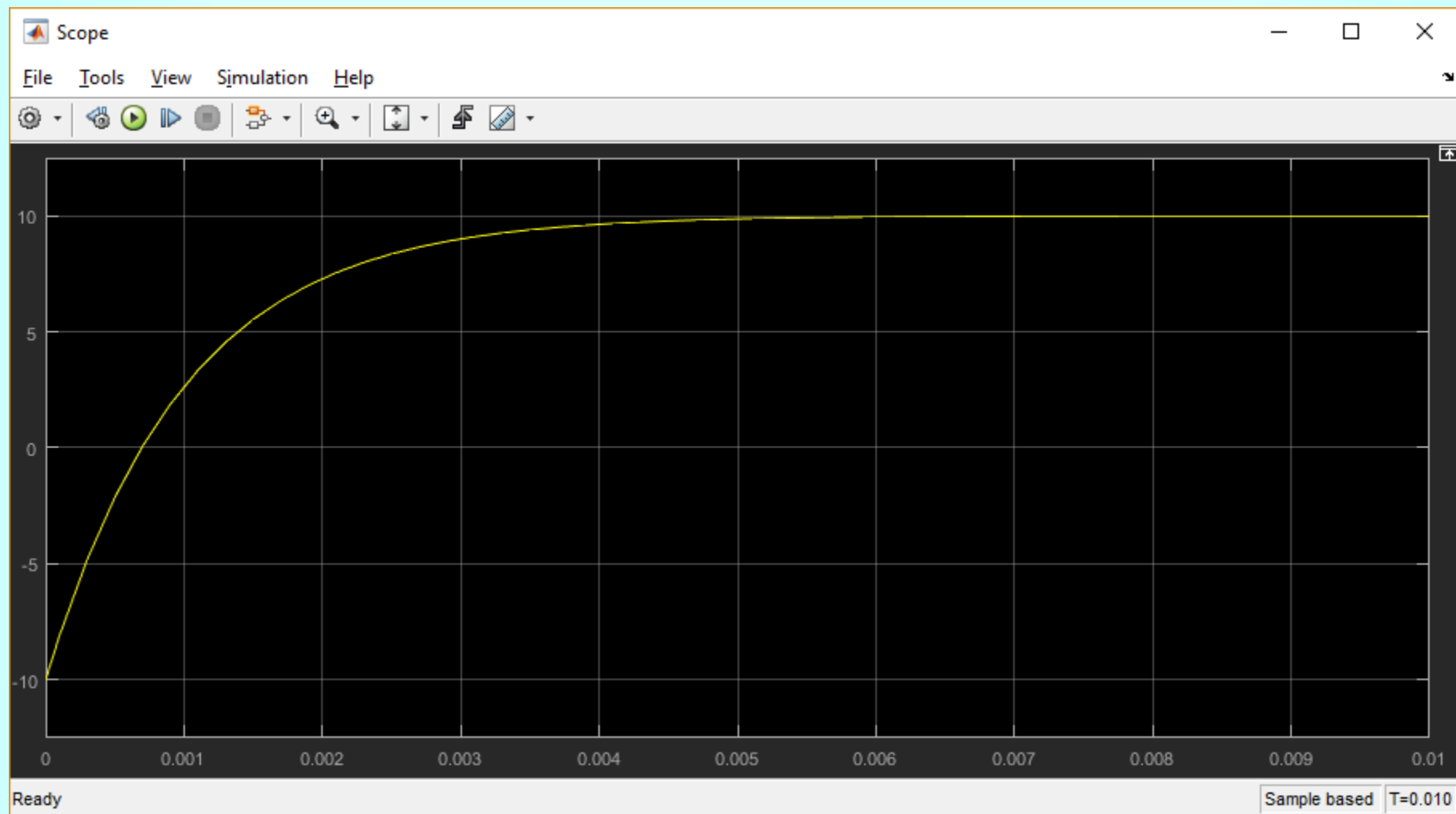
OK

Cancel

Help

Apply

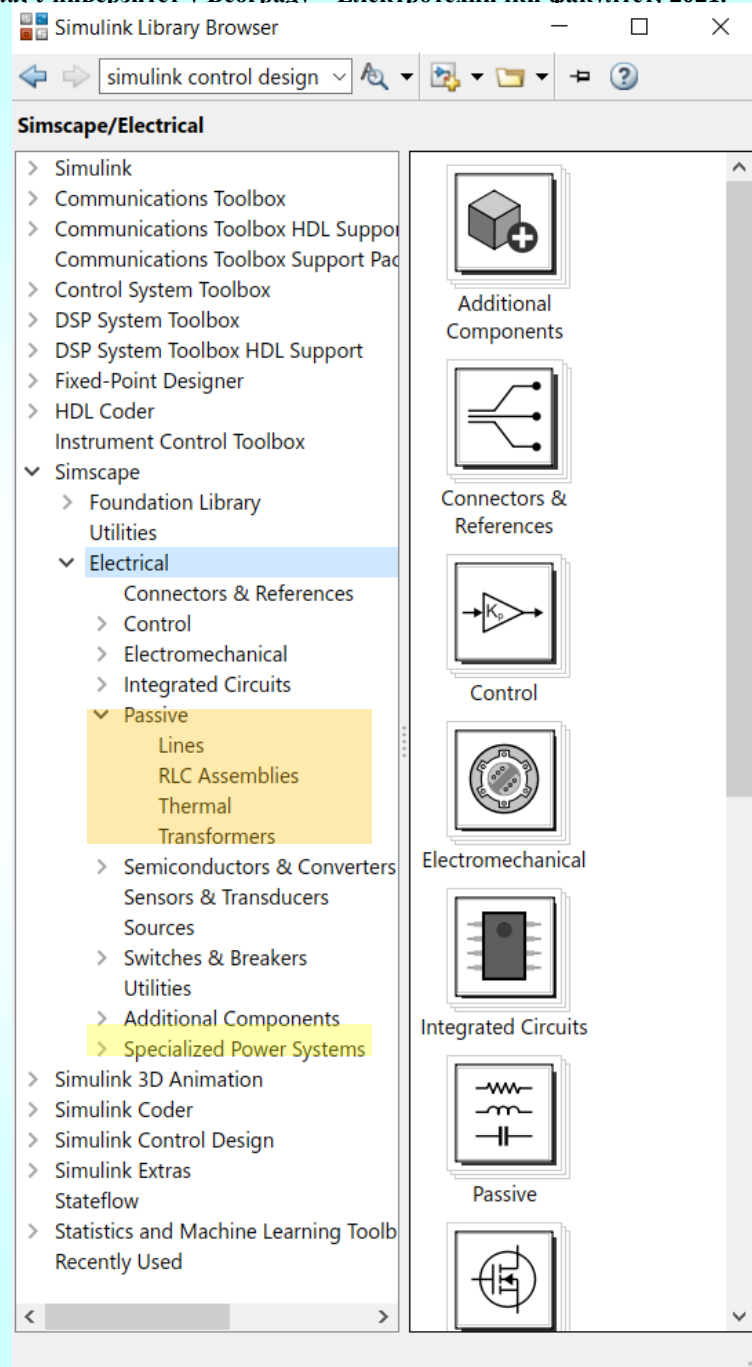
Налажење одзива...



**MATLAB > Simscape >
Foundation Library, Utilities**

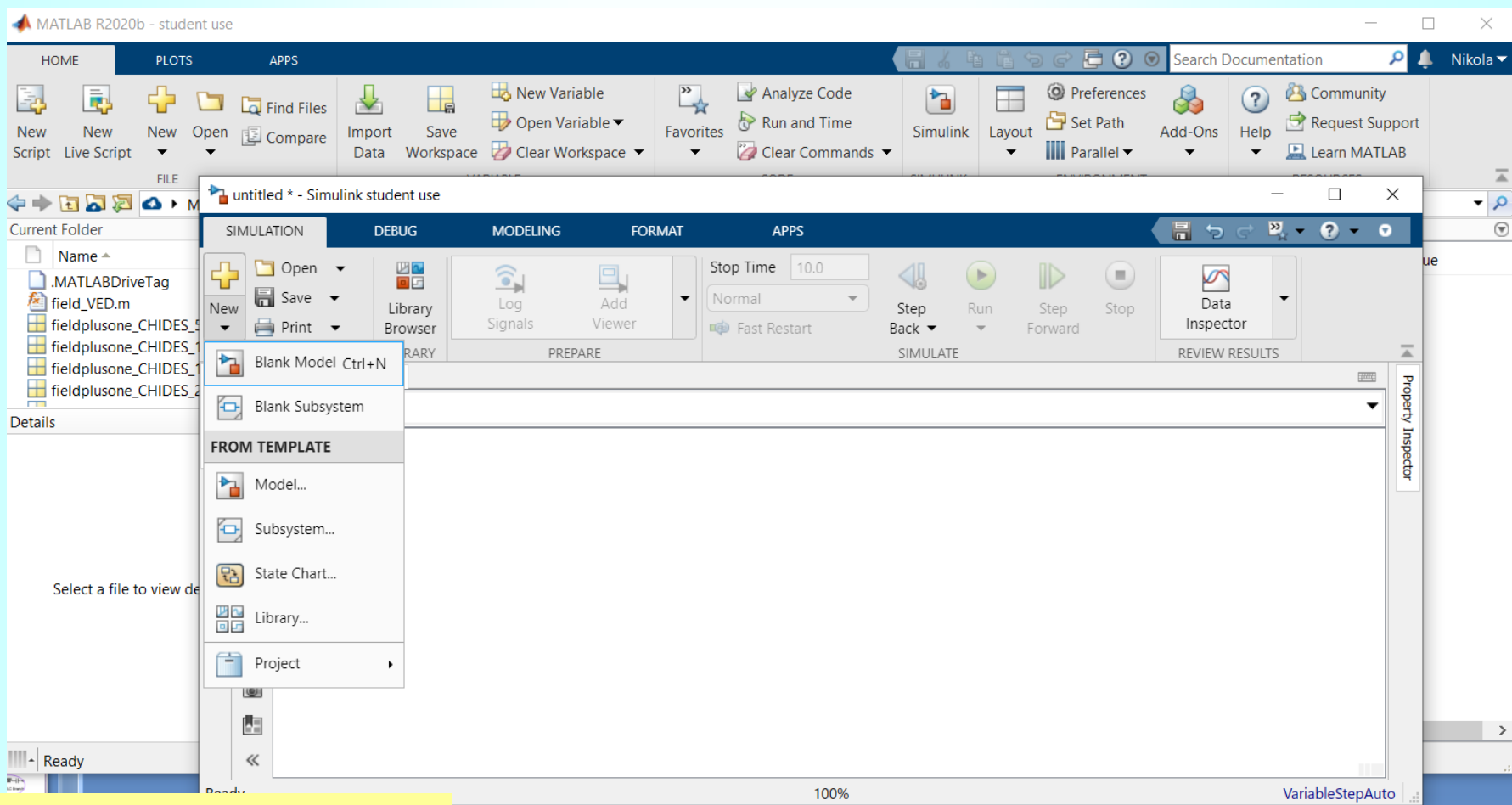
Simulink > Simscape > Electrical

- Библиотека за симулацију и нумеричку анализу електроенергетских система
- Трофазни извори, водови, трансформатори, потрошачи
- Термална анализа



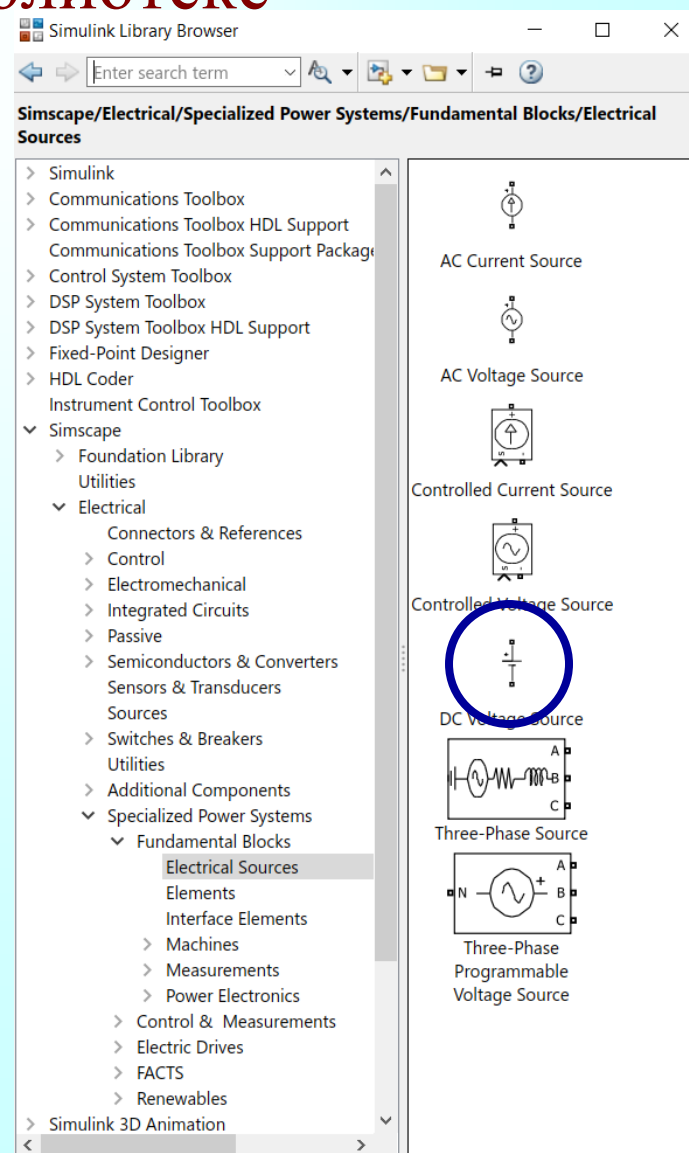
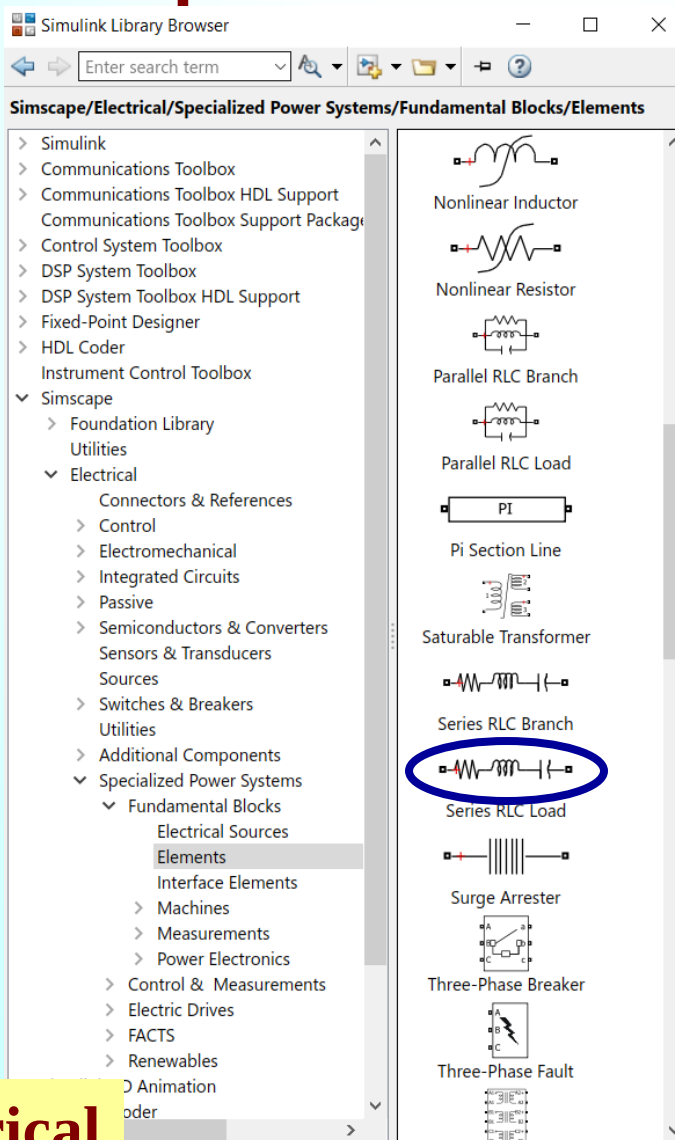
Simscape > Electrical

Симулација електричног кола коришћењем **Simscape>Electrical** библиотеке



Simscape > Electrical

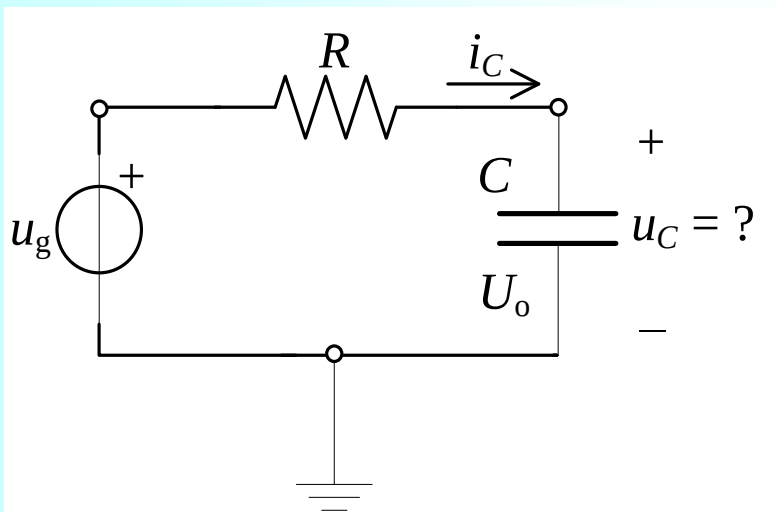
Симулација електричног кола коришћењем **Simscape>Electrical** библиотеке



Simscape > Electrical

Симулација електричног кола коришћењем **Simscape>Electrical** библиотеке

коло је образовано у тренутку $t_0 = 0$

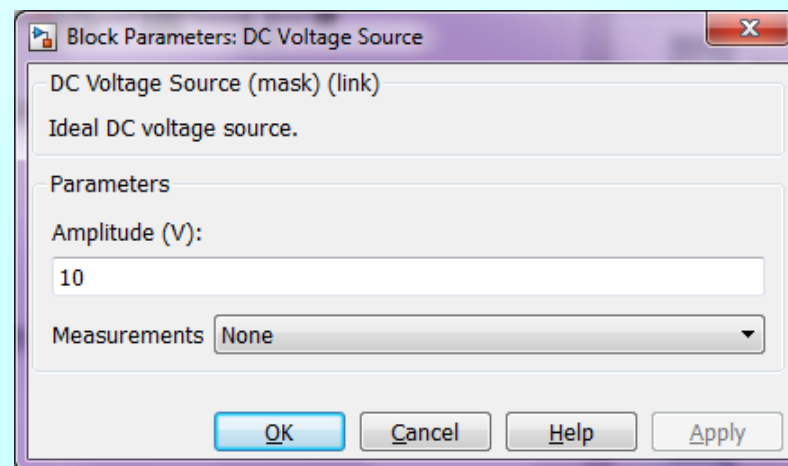
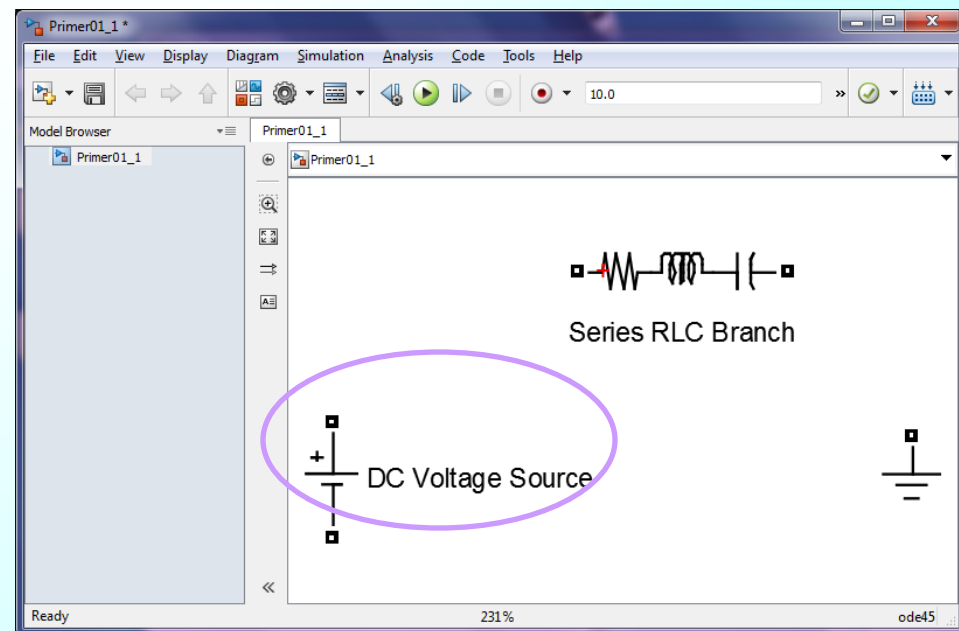


$$R = 1\text{ k}\Omega$$

$$C = 1\text{ }\mu\text{F}$$

$$u_g(t) = U h(t), U = 10\text{ V}$$

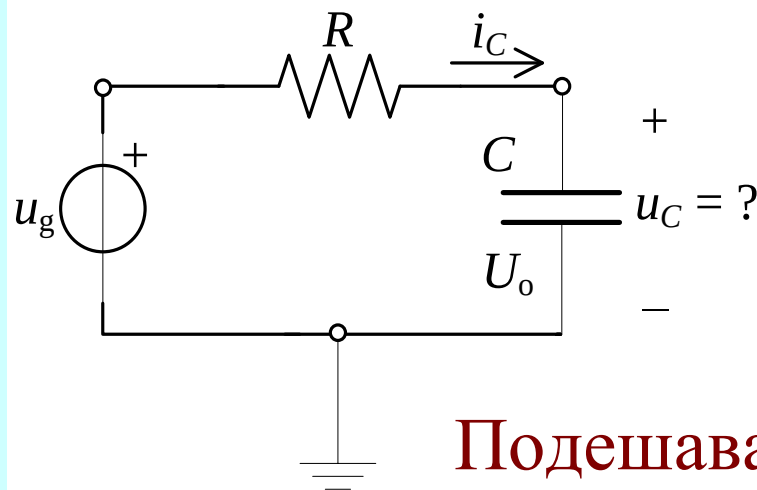
$$u(t_0^-) = U_0 = -10\text{ V}$$



Simscape > Electrical

Симулација електричног кола коришћењем **Simscape>Electrical** библиотеке

коло је образовано у тренутку $t_0 = 0$



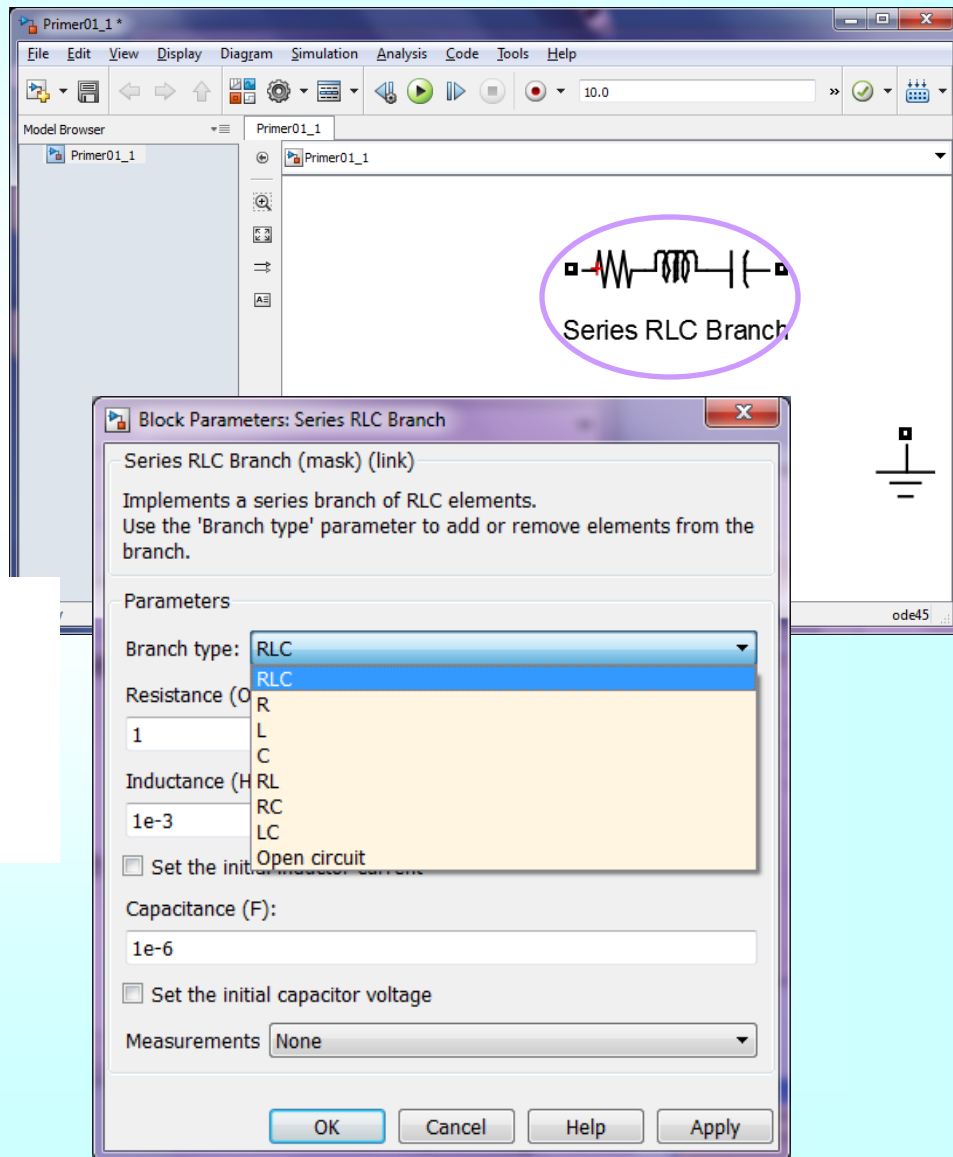
$$R = 1\text{k}\Omega$$

$$C = 1\mu\text{F}$$

$$u_g(t) = U h(t), U = 10\text{ V}$$

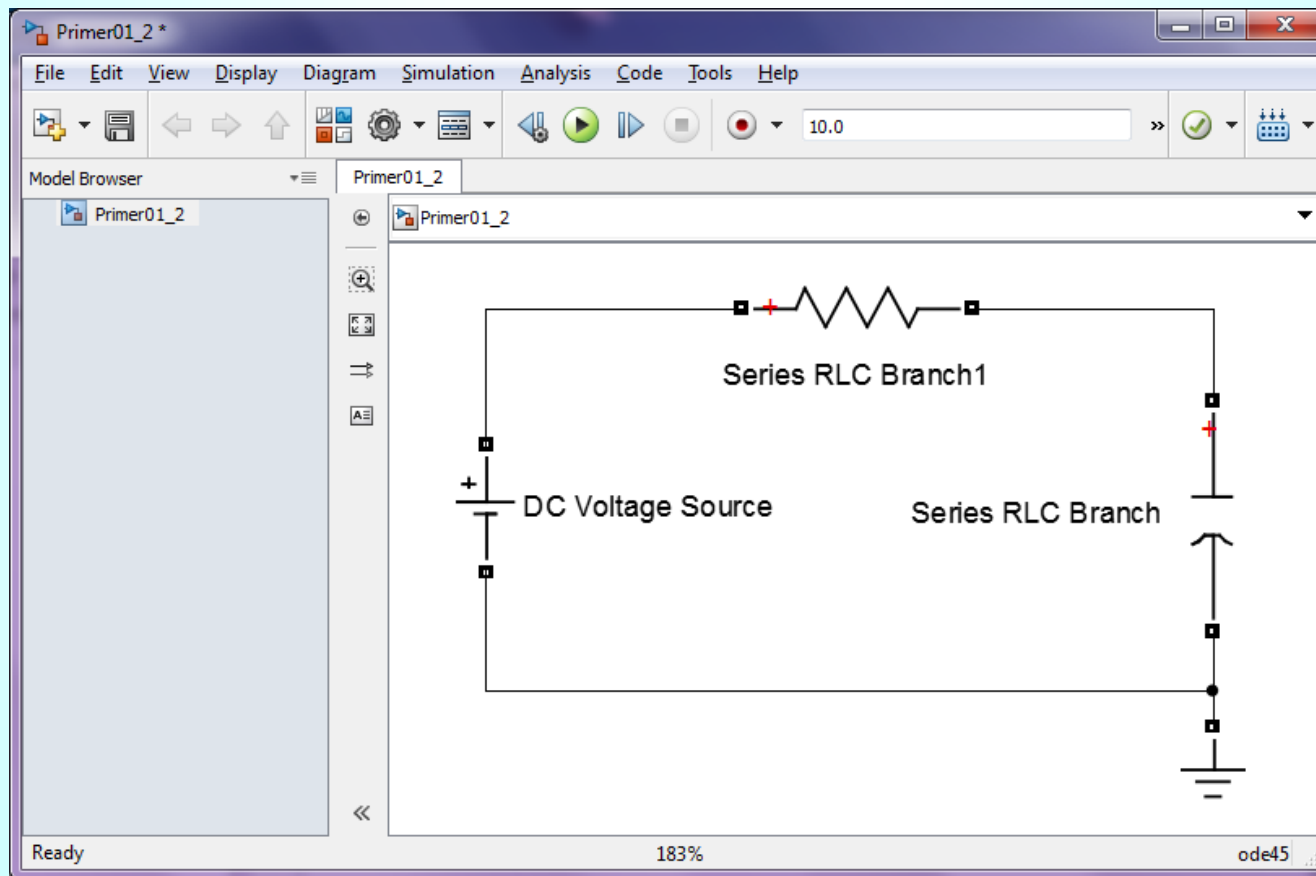
$$u(t_0^-) = U_0 = -10\text{ V}$$

Подешавање
параметара
симулације



Simscape > Electrical

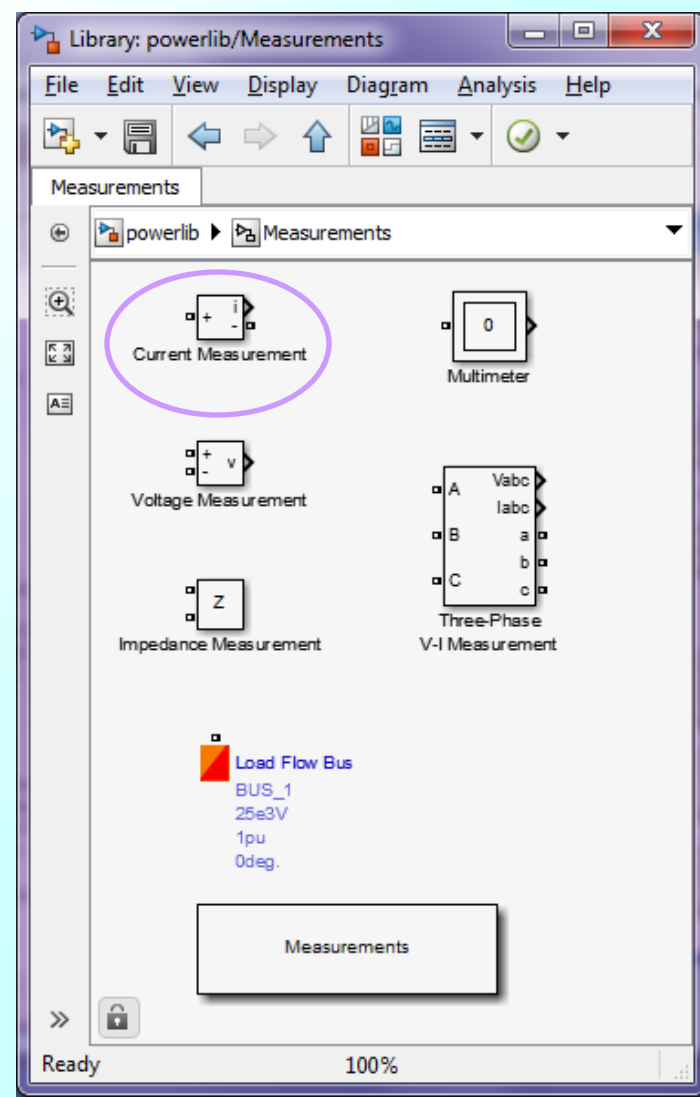
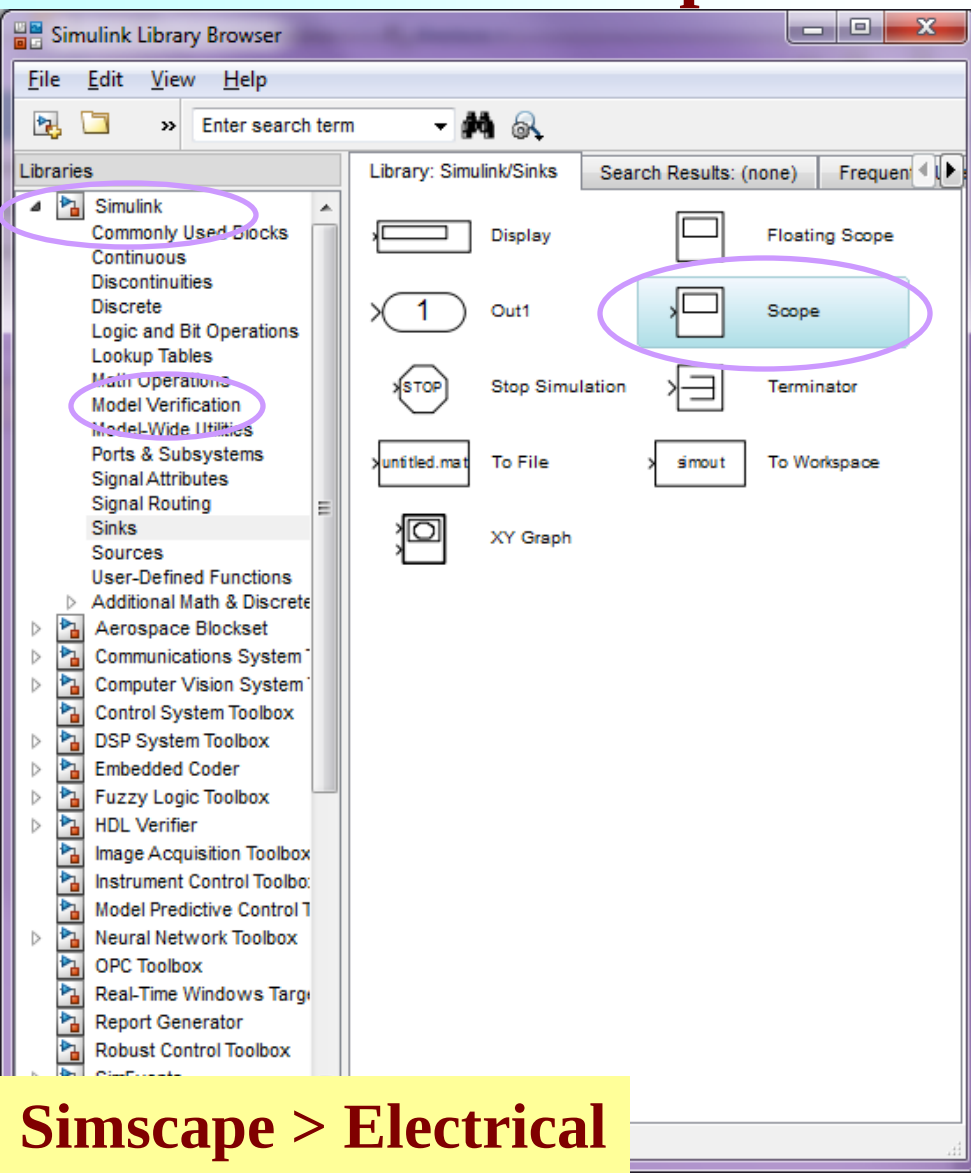
Симулација електричног кола коришћењем **Simscape>Electrical** библиотеке



Како се мери напон???

Simscape > Electrical

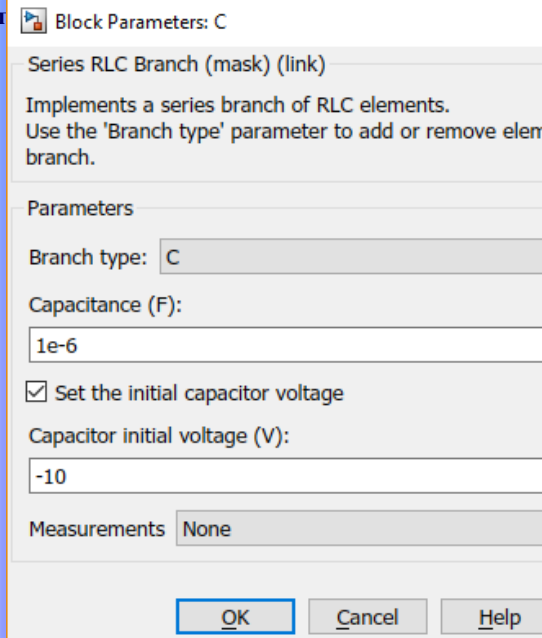
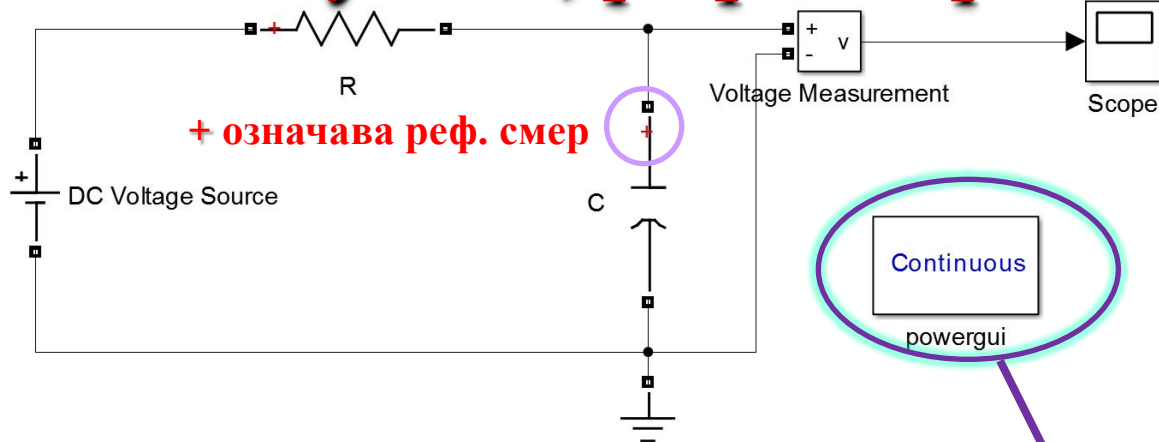
Симулација електричног кола коришћењем **Simscape>Electrical** библиотеке



Simscape > Electrical

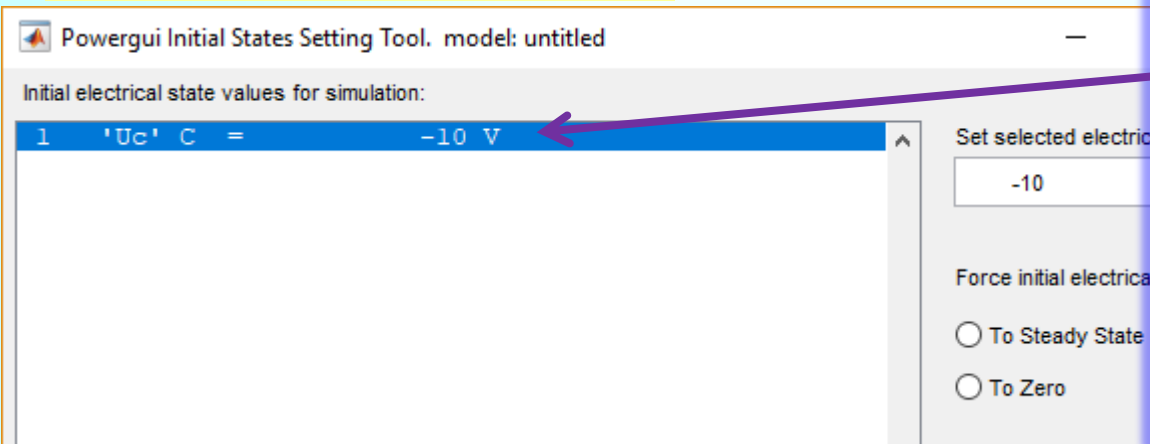
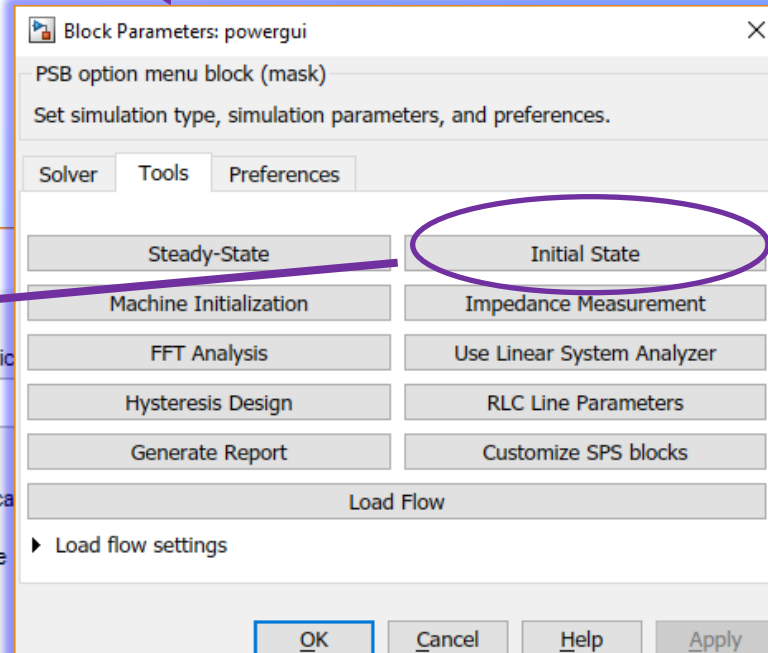
Почетни услов, реф. смер...

+ означава реф. смер



Плоче кондензатора се разликују!!!

Simscape > Electrical



Configuration Parameters: untitled/Configuration (Active)

★ Commonly Used Parameters

All Parameters

Select:

Solver

Data Import/Export

> Optimization

> Diagnostics

Hardware Implementation

Model Referencing

Simulation Target

> Code Generation

> Coverage

> HDL Code Generation

Simscape

Simscape Multibody 1G

> Simscape Multibody

Simulation time

Start time: 0.0Stop time: 0.01

Solver options

Type: Variable-stepSolver: auto (Automatic solver selection)

▶ Additional options

OK

Cancel

Help

Apply

Configuration Parameters: untitled/Configuration (Active)

★ Commonly Used Parameters

≡ All Parameters

Category: All

Search selected category

Parameter	Value	Command-Line Name
Solver ▶ Simulation time		
> Start time Simulation start time. Note that the values that you specify as block i...	0.0	StartTime
> Stop time Simulation stop time.	0.01	StopTime
Solver ▶ Solver options		
> Type Choose a variable or fixed-step solver.	Variable-step	SolverType
> Solver Choose a solver. If disabled, enable in "Additional options" by changi...	auto (Automatic solver selection)	Solver
Solver ▶ Additional options		
> Max step size Maximum step size for a variable-step solver.	1e-4	MaxStep
> Relative tolerance Specify the largest acceptable solver error, relative to the size of eac...	1e-3	RelTol
> Min step size Minimum step size for a variable-step solver.	auto	MinStep
> Absolute tolerance Specify the largest acceptable solver error, as the value of the meas...	auto	AbsTol
> Initial step size Specify the size of the first time step that the solver takes.	auto	InitialStep
> Shape preservation Improve the integration accuracy by preserving the shape of states b...	Disable All	ShapePreserveControl

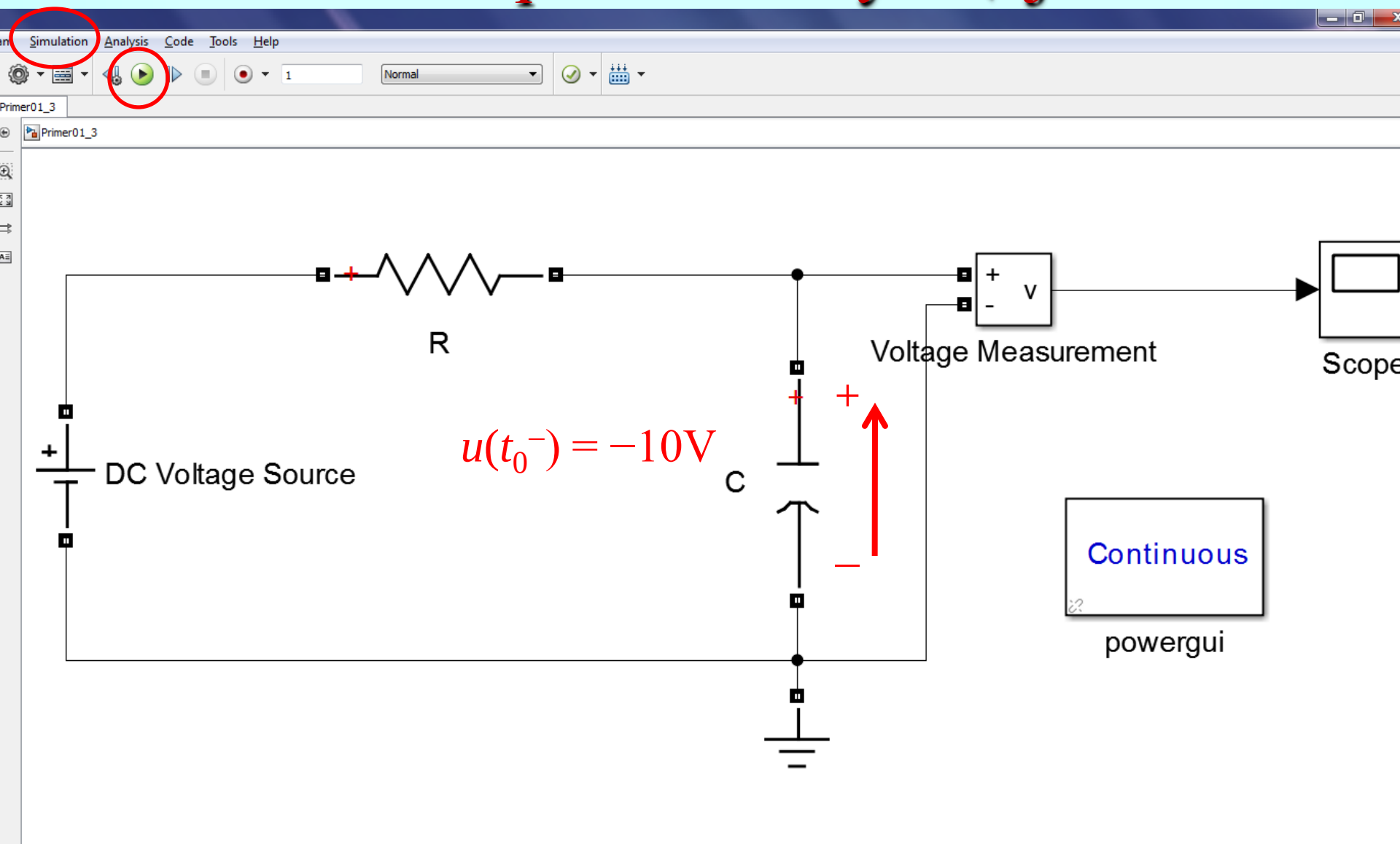
OK

Cancel

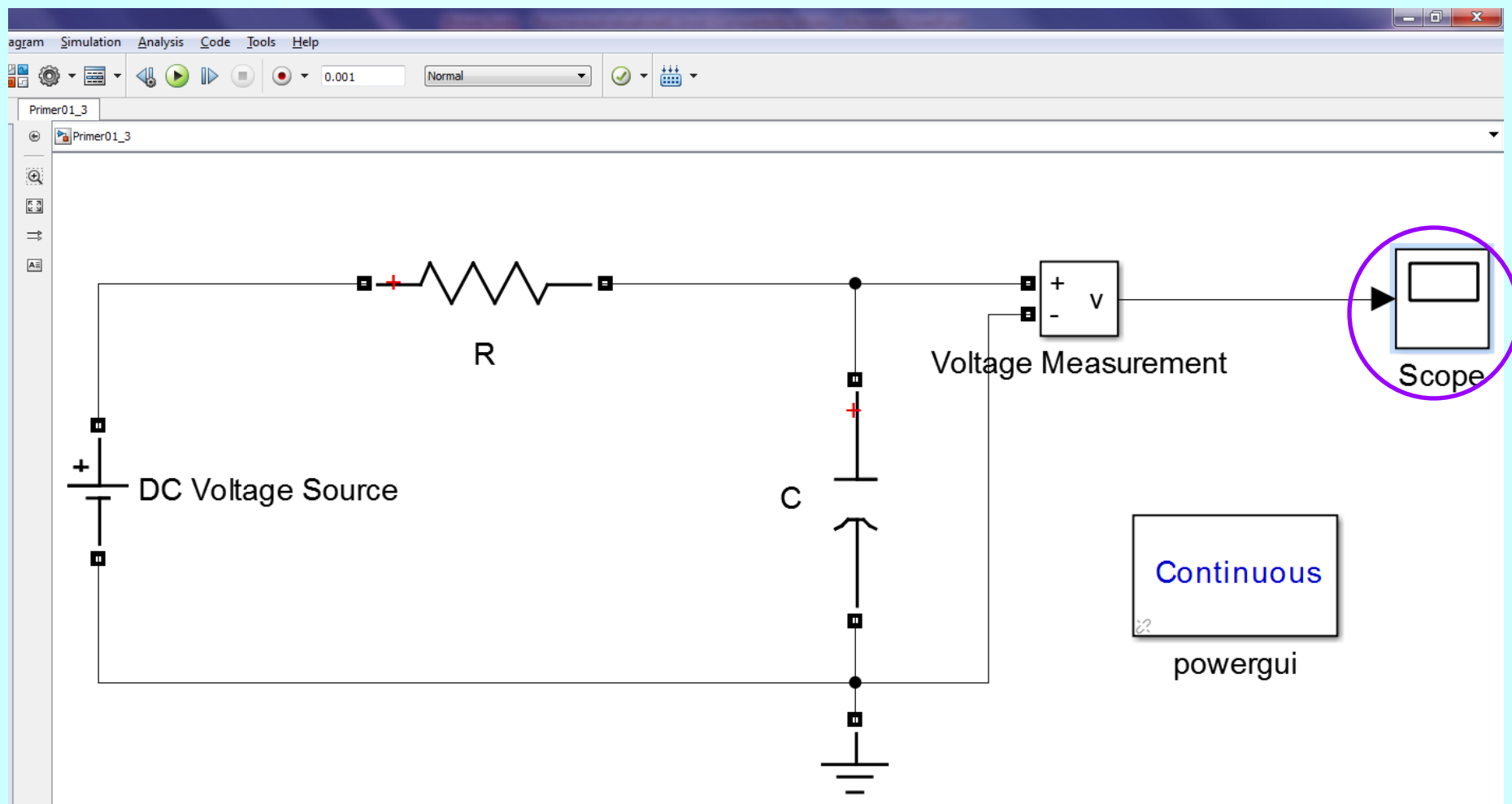
Help

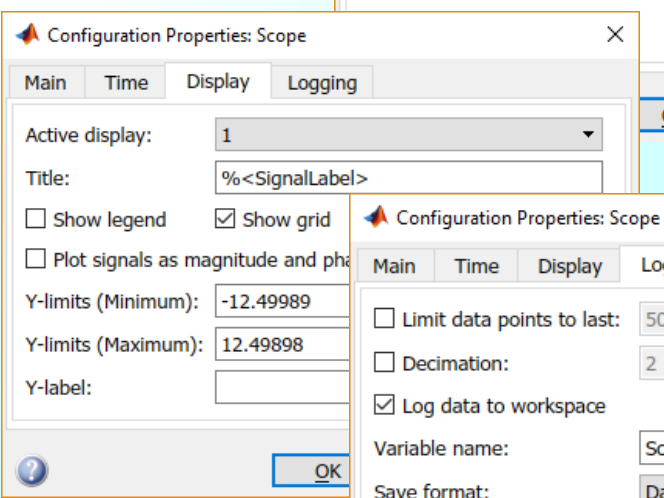
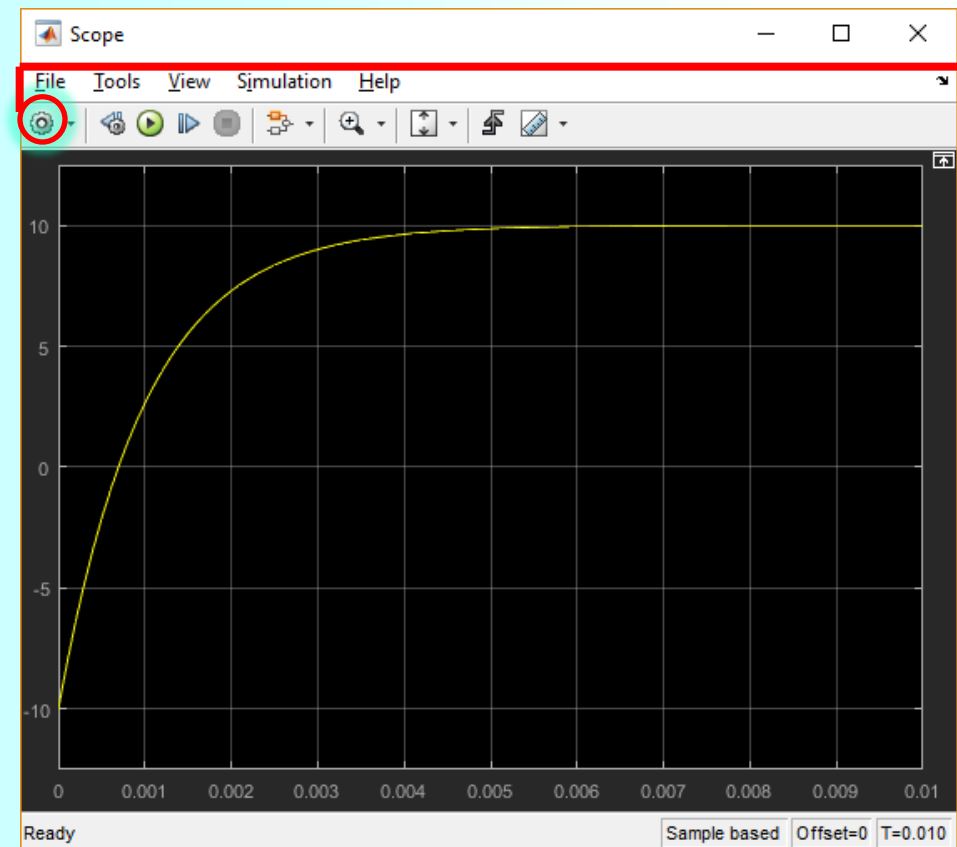
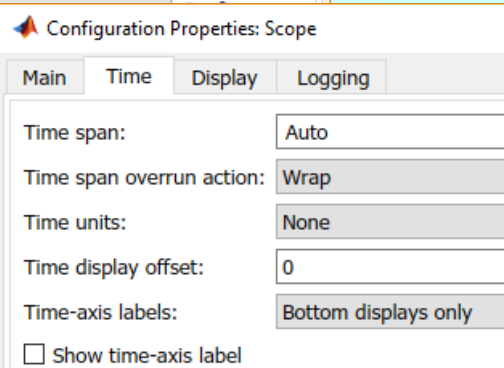
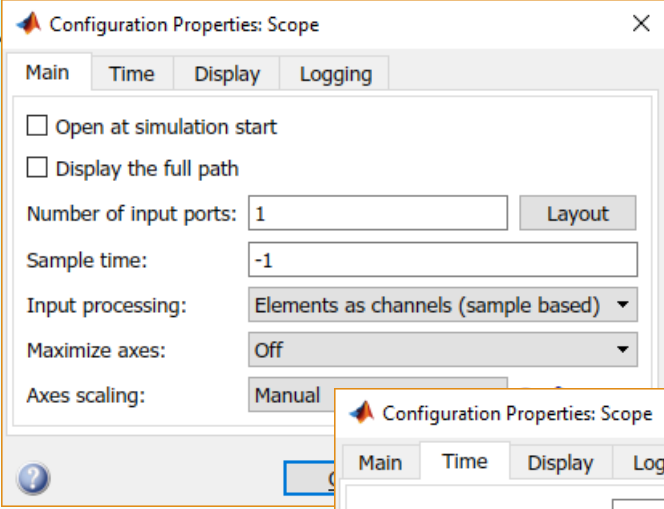
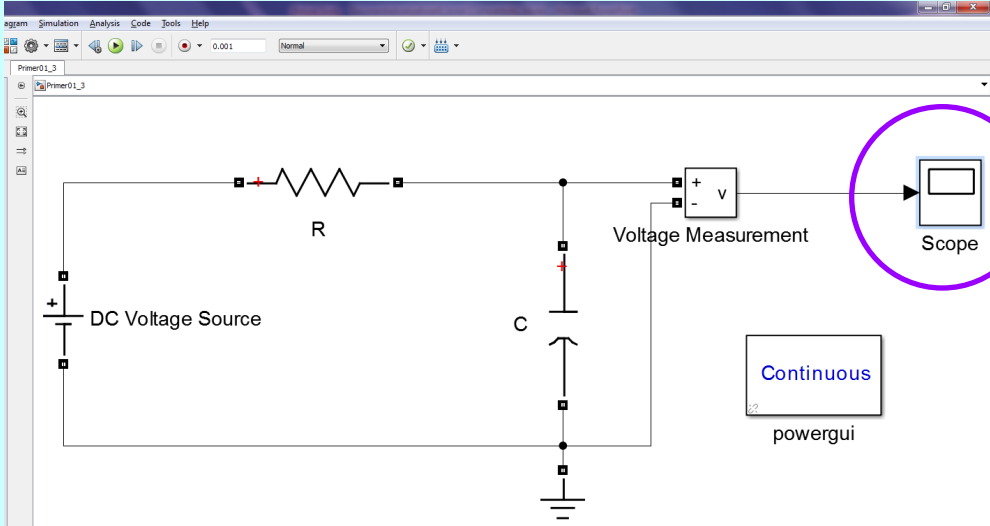
Apply

Покретање симулације...



Налажење одзива... Осцилоскоп





Simscape > Electrical

Configuration Parameters: untitled/Configuration (Active)

★ Commonly Used Parameters

≡ All Parameters

Category: All

Search selected category

Parameter	Value	Command-Line Name
Solver ▶ Simulation time		
> Start time Simulation start time. Note that the values that you specify as block i...	0.0	StartTime
> Stop time Simulation stop time.	0.01	StopTime
Solver ▶ Solver options		
> Type Choose a variable or fixed-step solver.	Variable-step	SolverType
> Solver Choose a solver. If disabled, enable in "Additional options" by changi...	auto (Automatic solver selection)	Solver
Solver ▶ Additional options		
> Max step size Maximum step size for a variable-step solver.	1e-4	MaxStep
> Relative tolerance Specify the largest acceptable solver error, relative to the size of eac...	1e-3	RelTol
> Min step size Minimum step size for a variable-step solver.	auto	MinStep
> Absolute tolerance Specify the largest acceptable solver error, as the value of the meas...	auto	AbsTol
> Initial step size Specify the size of the first time step that the solver takes.	auto	InitialStep
> Shape preservation Improve the integration accuracy by preserving the shape of states b...	Disable All	ShapePreserveControl

OK

Cancel

Help

Apply

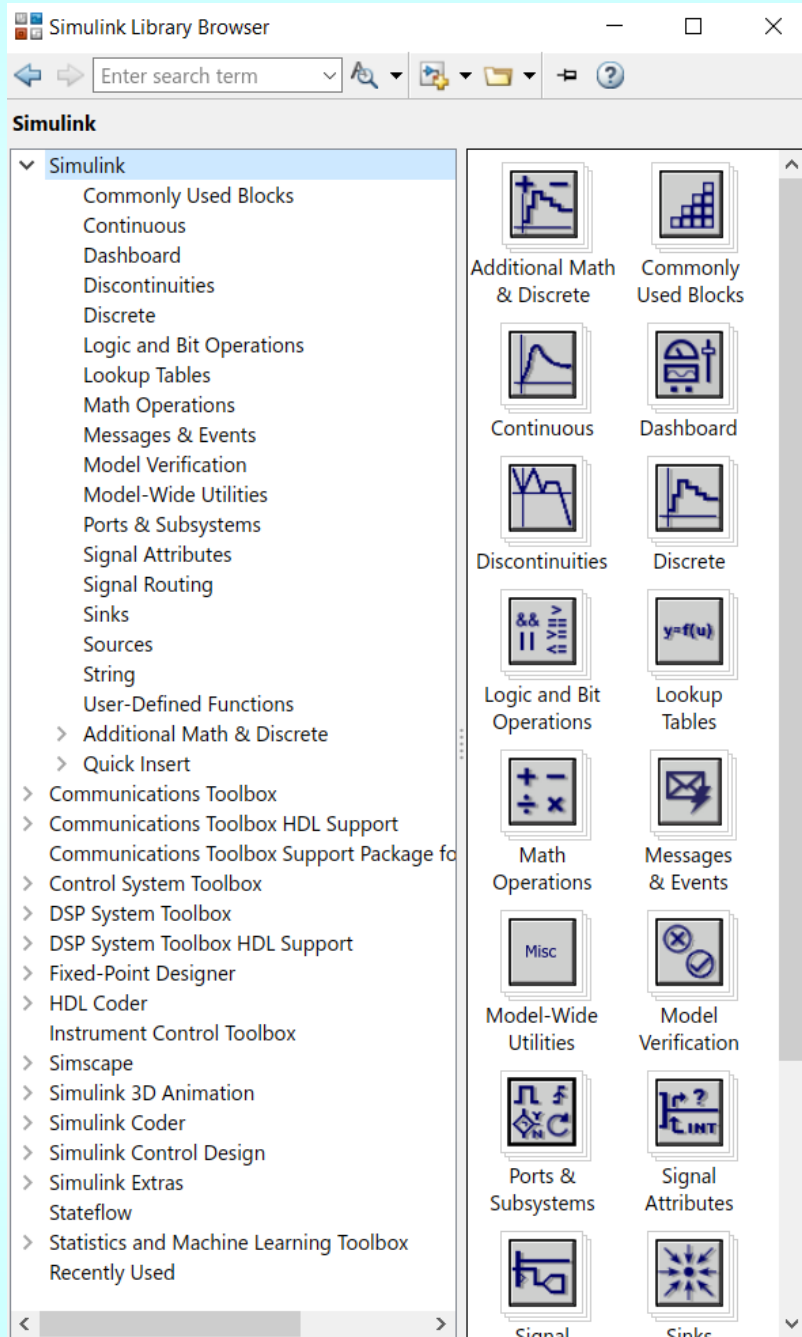
$\tau = RC = 1\text{ms}$

$\tau/10 = 0.1\text{ms}$

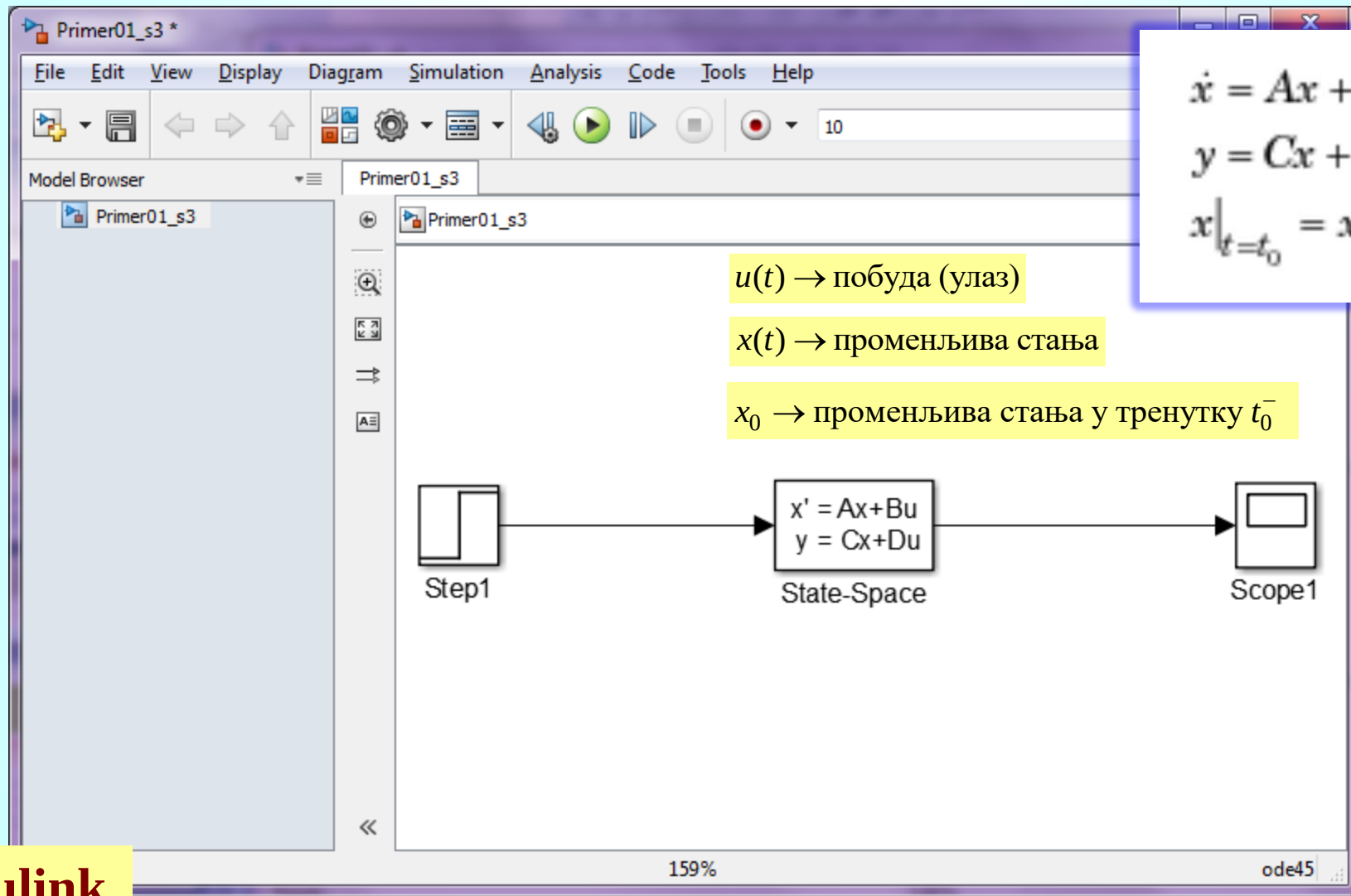
Simscape > Electrical

Simulink

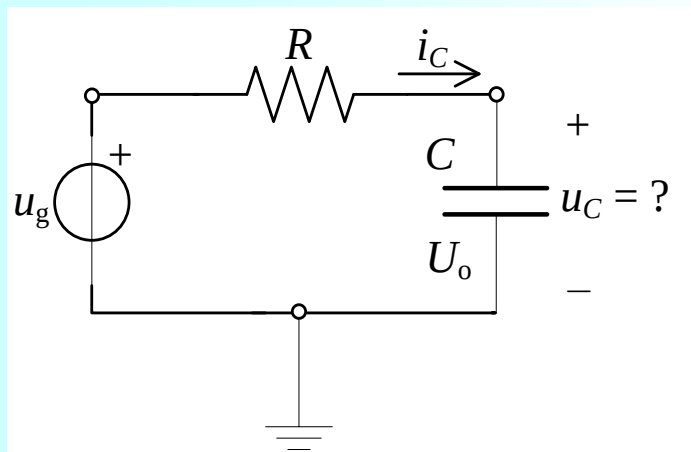
- Решавање кола може се извршити његовим свођењем на систем линеарних диференцијалних једначина
- Дати систем може се представити једноставним блоком са више улаза и излаза



Симулација електричног кола као уопштеног система коришћењем **Simulink**-а



Симулација електричног кола као уопштеног система коришћењем **Simulink**-а



коло је образовано у тренутку $t_0 = 0$

$$R = 1 \text{ k}\Omega$$

$$C = 1 \mu\text{F}$$

$$u_g(t) = U h(t), U = 10 \text{ V}$$

$$u_C(t_0^-) = U_0 = -10 \text{ V}$$

$$u = u_g(t) \rightarrow \text{побуда (улаз)}$$

$$x = u_C(t) \rightarrow \text{напон кондензатора (променљива стања и одзив - излаз)}$$

$$x(t_0^-) = U_0 \rightarrow \text{напон кондензатора у тренутку } t_0^-$$

$$u_g(t) = Ri_C + u_C(t)$$

$$i_C = C \frac{du_C}{dt}$$

$$u_C(t_0^-) = U_0 = -10 \text{ V}$$

$$\dot{x} = Ax + Bu$$

$$y = Cx + Du$$

$$x|_{t=t_0^-} = x_0,$$

$$\frac{du_C(t)}{dt} = \frac{i_C}{C} = \frac{u_g(t) - u_C(t)}{RC} = -\frac{u_C(t)}{RC} + \frac{u_g(t)}{RC}$$

$$u_C(t_0^-) = U_0 = -10 \text{ V}$$

$$\frac{du_C(t)}{dt} = Au_C(t) + Bu_g(t) \Rightarrow A = -\frac{1}{RC} = -1000, B = 1000$$

$$u_C(t) = Cu_C(t) \Rightarrow C = 1, D = 0$$

$$u_C(t_0^-) = U_0 = -10 \text{ V}$$

Simulink

Практикум из рачунарске анализе кола, Ун

Симулација електричног кола као уопштеног система коришћењем Simulink-а

Source Block Parameters: Step1

Step

Output a step.

Parameters

Step time:

0

Initial value:

0

Final value:

10

Sample time:

0

☒ Interpret vector parameters as 1-D

☒ Enable zero-crossing detection

OK Cancel Help Apply

Function Block Parameters: State-Space

State Space

State-space model:

$$\frac{dx}{dt} = Ax + Bu$$
$$y = Cx + Du$$

Parameters

A:

-1000

B:

1000

C:

1

D:

0

Initial conditions:

-10

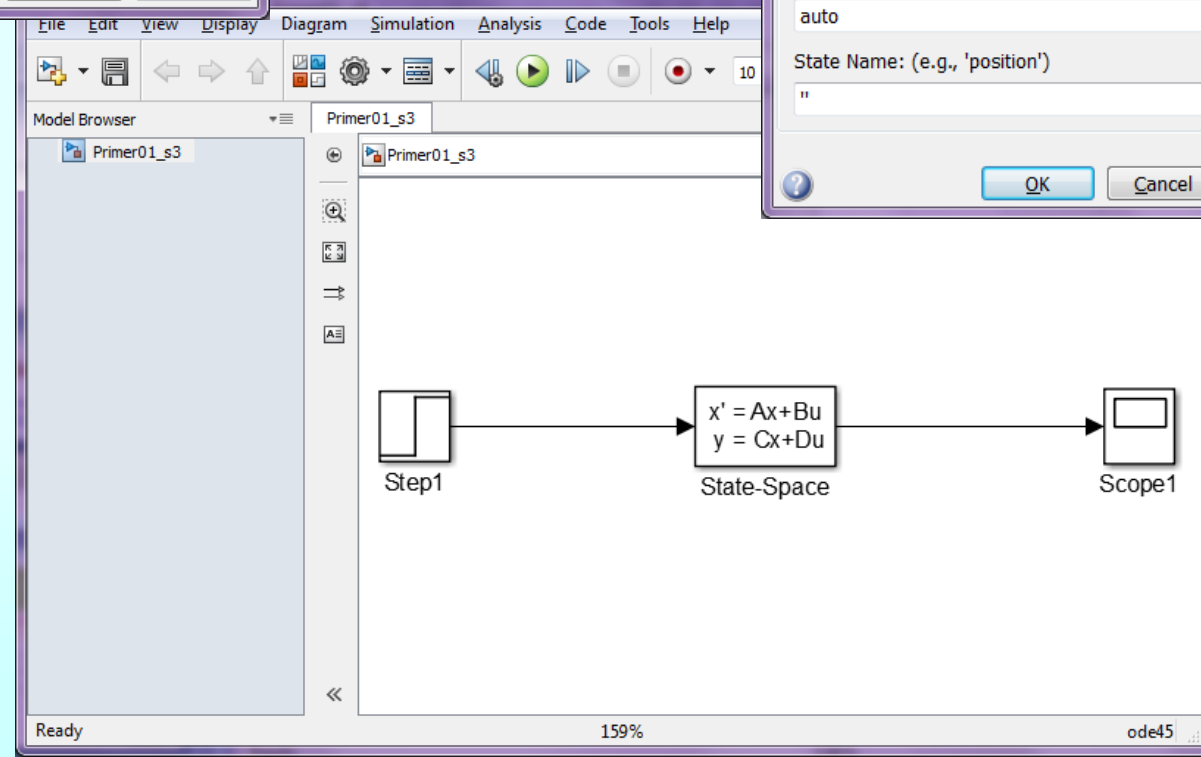
Absolute tolerance:

auto

State Name: (e.g., 'position')

"

OK Cancel Help Apply



Function Block Parameters: State-Space

State Space

State-space model:
 $\dot{x}/dt = Ax + Bu$
 $y = Cx + Du$

Parameters

A:
-1000

B:
1000

C:
1

D:
0

Initial conditions:
-10

Absolute tolerance:
auto

State Name: (e.g., 'position')
"

OK Cancel

Практикум из рачунарске анализе кола, УНИВ

Симулација електричног кола као уопштеног система коришћењем Simulink-a

Source Block Parameters: Step1

Step

Output a step.

Parameters

Step time:
0

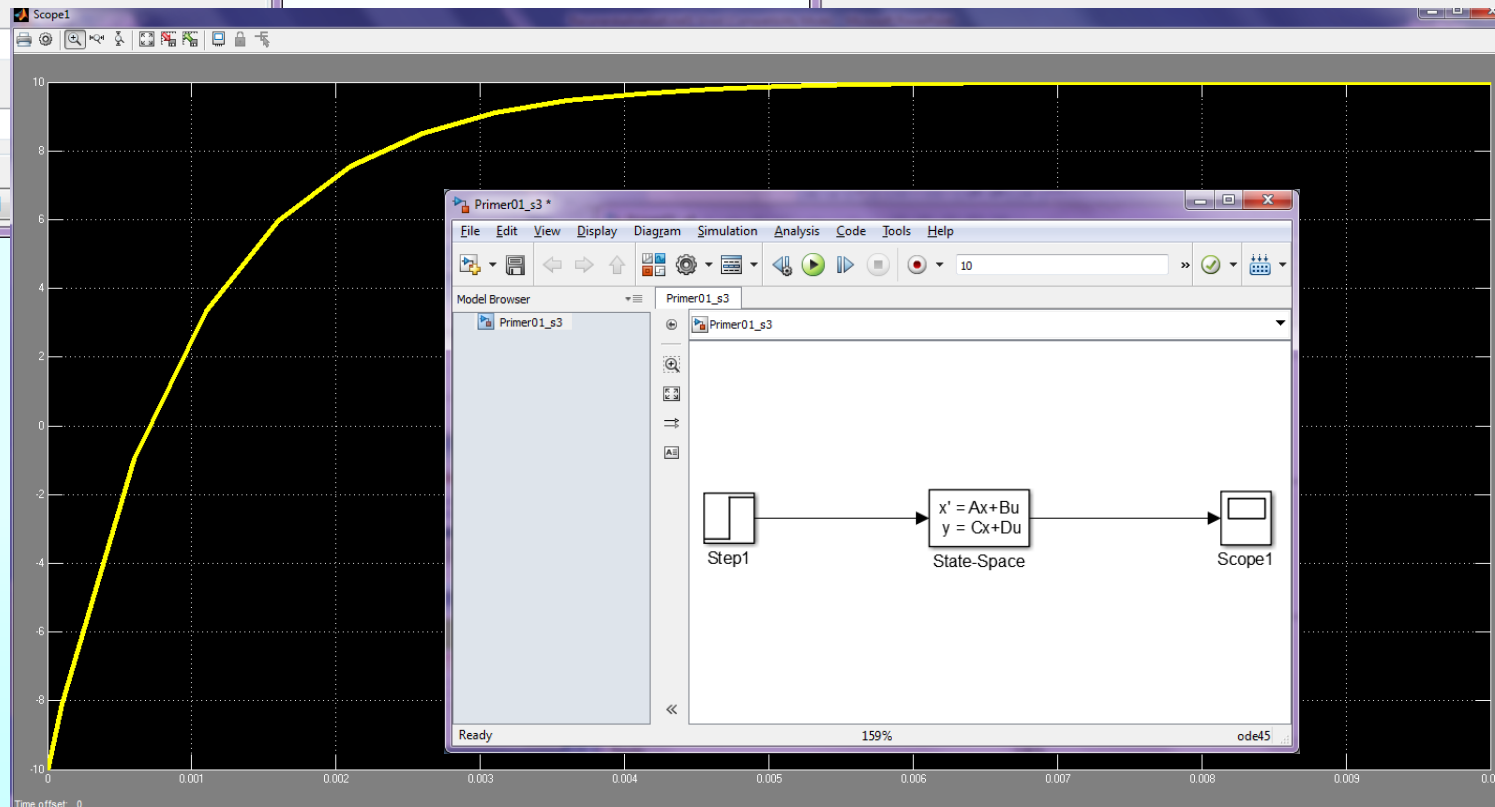
Initial value:
0

Final value:
10

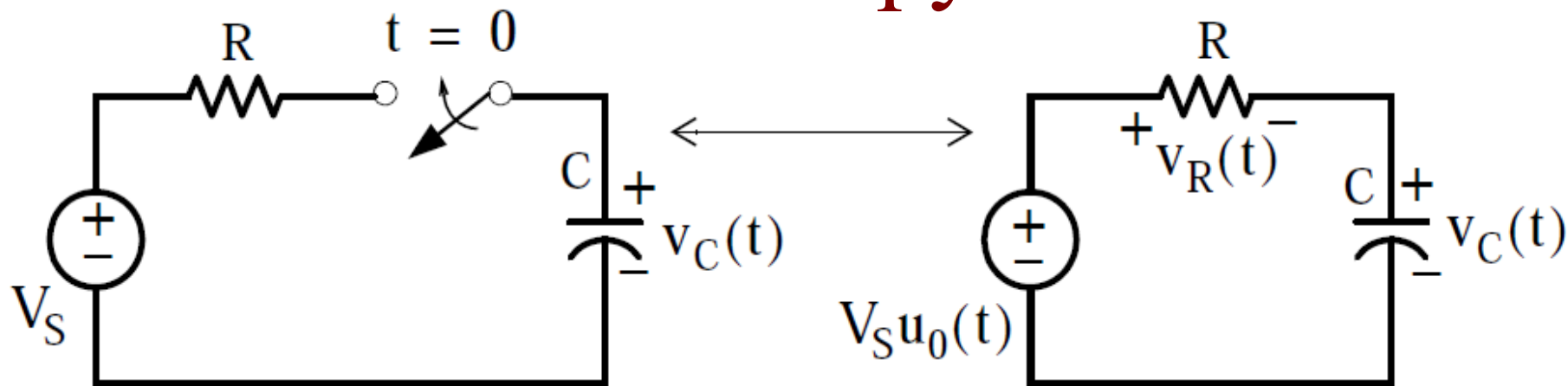
Sample time:
0

☒ Interpret vector parameters as 1-D

☒ Enable zero-crossing detection



Решимо “ручно”



$$v_R + v_C = V_S u_0(t)$$

$$i = i_C = C \frac{dv_C}{dt}$$

$$v_R = Ri = RC \frac{dv_C}{dt}$$

$$RC \frac{dv_C}{dt} + v_C = V_S u_0(t)$$

$$t > 0$$

$$RC \frac{dv_C}{dt} + v_C = V_S$$

$$v_C(t) = (V_S - V_S e^{-(1/RC)t}) u_0(t)$$

MATLAB

Symbolic Math Toolbox (Live Script)

- Библиотека за симболички рачун (алгебарске и диференцијалне једначине)
- Омогућава нумеричку анализу резултата прорачуна

