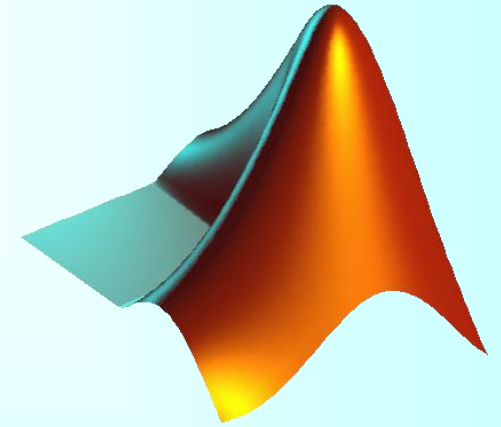
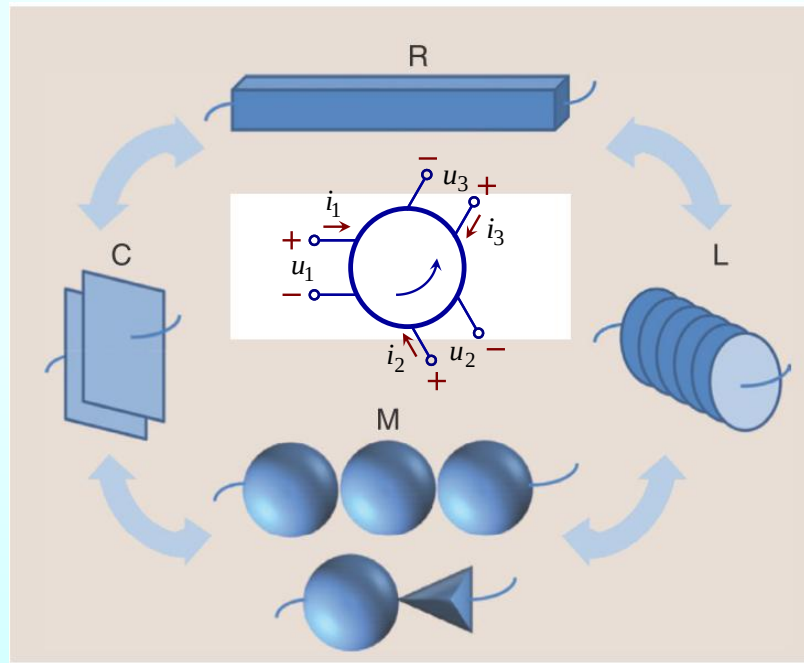


Практикум из рачунарске анализе трофазних кола



Милка Потребих Иваниш
Никола Баста

Практикум из рачунарске анализе трофазних кола 19E072ПРТК

- **Настава се изводи према текућем студијском програму који је Електротехнички факултет акредитовао** <http://www.etf.bg.ac.rs>
- Студијски програм: **Електротехника и рачунарство**
- Изборно подручје (модул): **Енергетика**
- **Циљ.** Излагање основних концепата анализе помоћу рачунара који се користе у софтверским пакетима за симулацију трофазних електричних кола са гледишта инжењера и истраживача електроенергетике. Увођење основа за анализу модела електроенергетских система и направа за нумеричку и симболичку анализу у временском и фреквенцијском домену. Изградња основних знања из теорије и примене симетричних компоненти.
- **Исход.** Разумевање основних концепата анализе трофазних електричних кола помоћу рачунара и одговарајућих математичких алгоритама. Решавање линеарних трофазних електричних кола у временском и фреквенцијском домену помоћу система компјутерске алгебре.
- **Садржај.** Основни концепти рачунарске симулације трофазних електричних кола. Симболичко и нумеричко израчунавање симетричних компоненти. Моделовање и симулација електроенергетских водова, компоненти и система помоћу савремених софтверских алата.
- **Наставници.** Др **Милка Потребих Иваниш**, редовни професор, соба 64 (milka_potrebic@etf.rs); Др **Никола Баста**, доцент, соба 63 (nbasta@etf.rs).
- **Сарадници у настави.** **Ања Ковачевић**, дипл. инж., **Филип Нешковић**, дипл. инж.
- Белешке са предавања и лаб. вежби, примери испитних задатака и питања, <http://tek.etf.rs>
- **Додатни материјали и консултације биће организовани преко канала на MS Teams платформи** (линкови за канале су на адреси <http://tek.etf.rs>)
- **Начин одржавања наставе.** Рачунски центар.
- **Начин полагања испита.** 1) Решавање задатака на рачунару у пару (или самостално) у РЦ, или алтернативно
2) издрада два домаћа задатка у пару (или самостално) са пратећим извештајем у виду презентецајује која се усмено брани.
Испит се може полагати у сваком испитном року.
Усмена одбрана домаћих задатака се заказује са предметним наставницима.
За издраду домаћих задатака јавити се е-поштом Милки Потребих Иваниш.
- **Пратити званично представљање предмета и објављивање општих службених порука на адреси** <http://tek.etf.rs/>

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

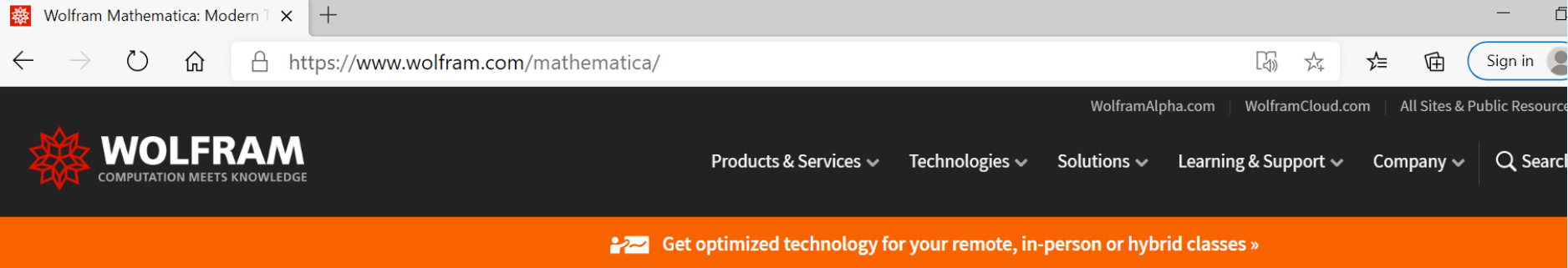
Free/Libre Open Source Software (FLOSS)

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...

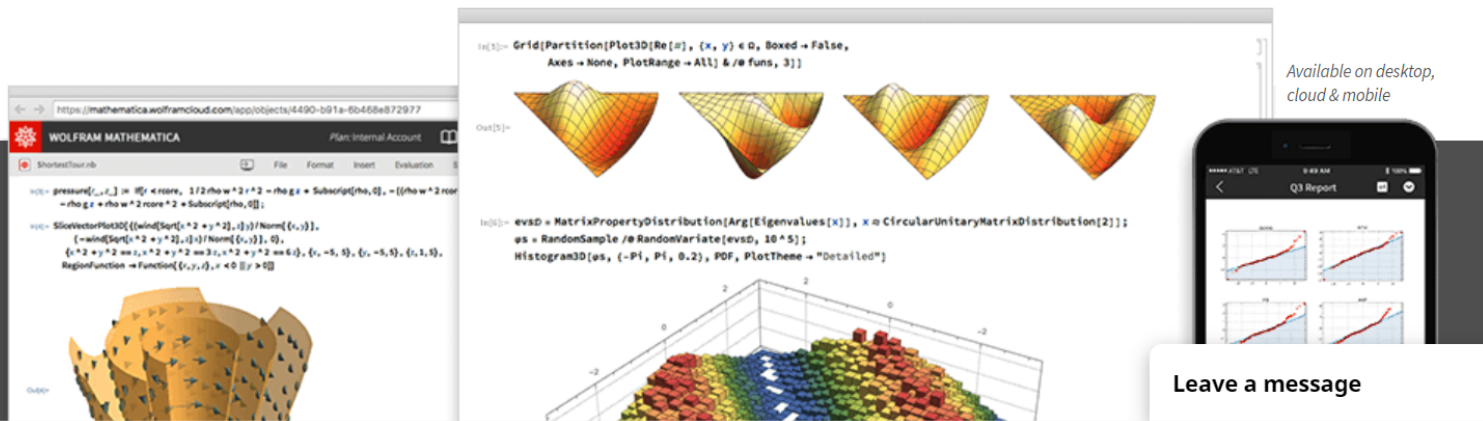
Mathematica

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



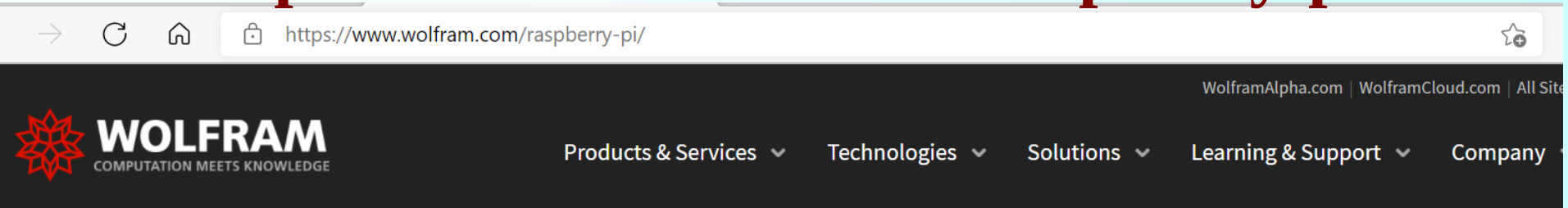
WOLFRAM MATHEMATICA

The world's definitive system for modern technical computing

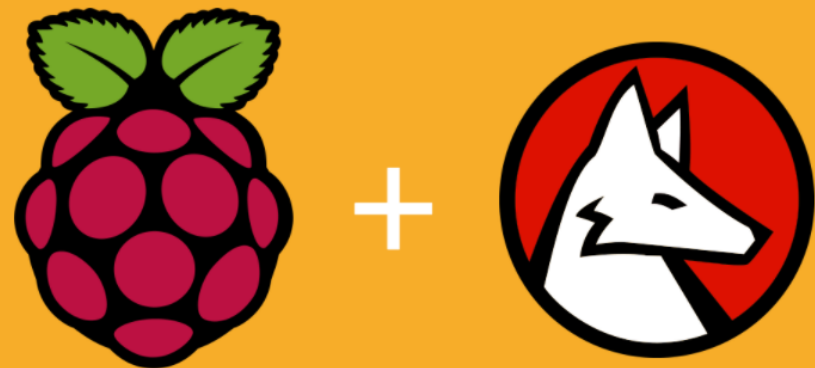


Mathematica free on every Raspberry Pi!

<https://www.wolfram.com/raspberry-pi/>



Wolfram Language &
Mathematica free on
every Raspberry Pi!



www.wolframalpha.com

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:

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

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

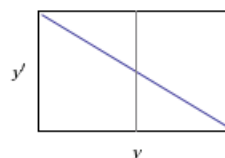
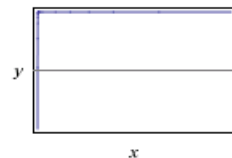
Differential equation solution:

[Approximate form](#)

[Step-by-step solution](#)

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

Plots of the solution:



New to
Wolfram|Alpha?



[Take the Tour >>](#)

New!
Wolfram Problem
Generator

Need a hint?

Maxima

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

The screenshot shows the Maxima website interface. At the top, there's a navigation bar with links for Downloads, Documentation, Project, and Page Top. Below this, a large central area displays a mathematical result for the integral of $1/(1+x^4)$. The result is a complex expression involving logarithms, square roots, and arctangents. To the right of the main content, there's a sidebar with a 'Recent Releases' section listing versions 5.44.0, 5.43.2, 5.43.1, 5.43.0, and 5.42.2 with their respective release dates. The bottom of the page features a section titled 'Maxima, a Computer Algebra System' with a detailed description of the software's capabilities and its history as a descendant of Macsyma.

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

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

[AVISO LEGAL](#)

(%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

https://play.google.com/store/apps/details?id=jp.yhonda&hl=en_US&gl=US

The screenshot shows the Google Play Store interface. At the top, the Google Play logo and a search bar are visible. Below the logo, there's a navigation menu with options like 'My apps', 'Shop', 'Games', 'Kids', and 'Editors' Choice'. The main content area displays the app 'Maxima on Android' by 'Yasuaki Honda' in the 'Education' category. The app is rated 'Everyone' and has 2,100 reviews. A green 'Install' button is present. Below the app title, there are three preview images: the first shows the app's interface with text about version 1.1 and MathJax 2.0; the second shows a 3D surface plot of the function $2^{*(v^2-u^2)}$; the third shows the 'Maxima 5.28.0 Manual' page, which includes a brief history of the system and its development at MIT.

← → ↺ 🏠 🔒 https://play.google.com/store/apps/details?id=jp.yhonda&hl=en_US&gl=US

Google Play Search 🔍

Apps Categories ▾ Home Top charts New releases

My apps
Shop
Games
Kids
Editors' Choice

Account
Payment methods
Play Points **New**
My subscriptions
Redeem
Buy gift card
My wishlist
My Play activity
Parent Guide

Maxima on Android

Yasuaki Honda Education ⭐⭐⭐⭐☆ 2,100

E Everyone

⚠️ You don't have any devices

🔖 Add to Wishlist

Install

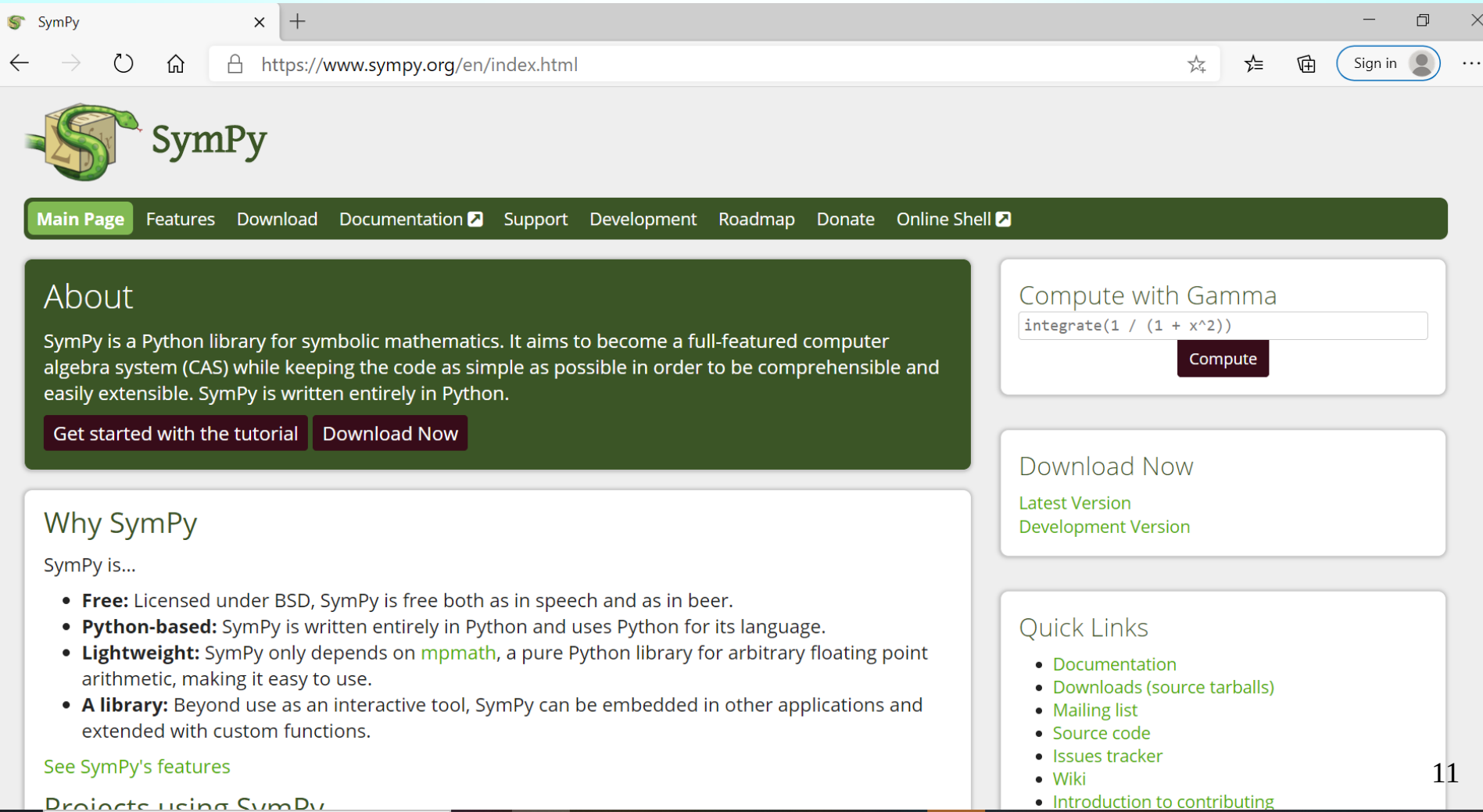
MaximaOnAndroid 9:58
Maxima on Android 1.1, Aug 11, 2012
powered by MathJax 2.0 for math rendering
written by Yasuaki Honda
Maxima 5.27 post <http://maxima.sourceforge.net>
using Lisp ECL 11.1.1
Distributed under the GNU Public License.
See the file COPYING.
Dedicated to the memory of William Schelter.
The function `bug_report()` provides bug reporting information.
(%i1) 'integrate(exp(-x)*sin(x),x,0,inf)=

MaximaOnAndroid 10:38 PM
2^{*(v^2-u^2)}

Maxima 5.28.0 Manual
Maxima is a computer algebra system, implemented in Lisp.
Maxima is derived from the Macsyma system, developed at MIT in the years 1968 through 1982 as part of Project MAC. MIT turned over a copy of the Macsyma source code to the Department of Energy in 1982; that version is now known as DOE Macsyma. A copy of DOE Macsyma was maintained by Professor William F. Schelter of the University of Texas from 1982 until his death in 2001. In 1996, Schelter obtained permission from the Department of Energy to release the DOE Macsyma source code under the GNU Public License, and in 2000 he

SymPy

www.sympy.org/



The screenshot shows the SymPy website homepage. At the top, there's 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's an 'About' section with a description of SymPy as a Python library for symbolic mathematics, followed by 'Get started with the tutorial' and 'Download Now' buttons. Below that is a 'Why SymPy' section with a list of features: Free (BSD license), Python-based, Lightweight (depends on mpmath), and A library (embeddable). On the right, there's a 'Compute with Gamma' section with a text input field containing the expression $\int \frac{1}{1+x^2} dx$ and a 'Compute' button. Below that is a 'Download Now' section with links for 'Latest Version' and 'Development Version'. At the bottom right, there's a 'Quick Links' section with links to Documentation, Downloads (source tarballs), Mailing list, Source code, Issues tracker, Wiki, and Introduction to contributing.

SymPy

https://www.sympy.org/en/index.html

Sign in

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](#)

Compute with Gamma

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

[Compute](#)

Download Now

[Latest Version](#)
[Development Version](#)

Quick Links

- [Documentation](#)
- [Downloads \(source tarballs\)](#)
- [Mailing list](#)
- [Source code](#)
- [Issues tracker](#)
- [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/>.

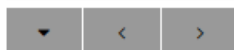
```
>>> diffeq = Eq(f(x).diff(x) + 1000*f(x), 10000)
>>> diffeq
```

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

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

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

```
>>>
```



Evaluate

Clear

Fullscreen

Log In

About this page

SymPy Live is SymPy running on the SymPy Engine.

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

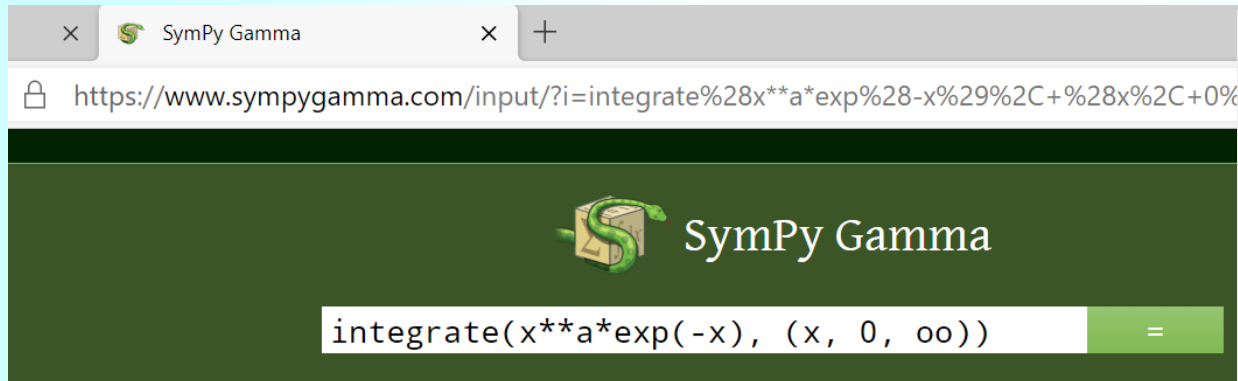
```
>>> from __future__ import division
>>> from sympy import *
>>> x, y, z, t = symbols('x y z t')
>>> k, m, n = symbols('k m n', integer=True)
>>> f, g, h = symbols('f g h', cls=Function)
```

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.

The thumbtack icon is from the Bar Icon Pack and is used under a Creative Commons license. You may use the materials in this presentation without restriction to develop your application.

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



The image shows the Jupyter website (https://jupyter.org) with a large, semi-transparent text overlay in the center. The text reads: "SymPy and the Jupyter Notebook for engineering calculations". The Jupyter logo is visible in the background. Below the main text, there is a small paragraph: "Project Jupyter exists to develop open-source software, open interactive computing across dozens of programs".

Sympy and the Jupyter Notebook for engineering calculations

Project Jupyter exists to develop open-source software, open interactive computing across dozens of programs

```
[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]: 
$$\sqrt{\pi}$$

```

Google калкулатор



$x \cdot \sin(x)$



Све

Сlike

Видео

Мапе

Вести

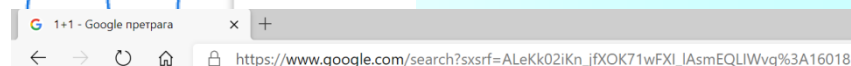
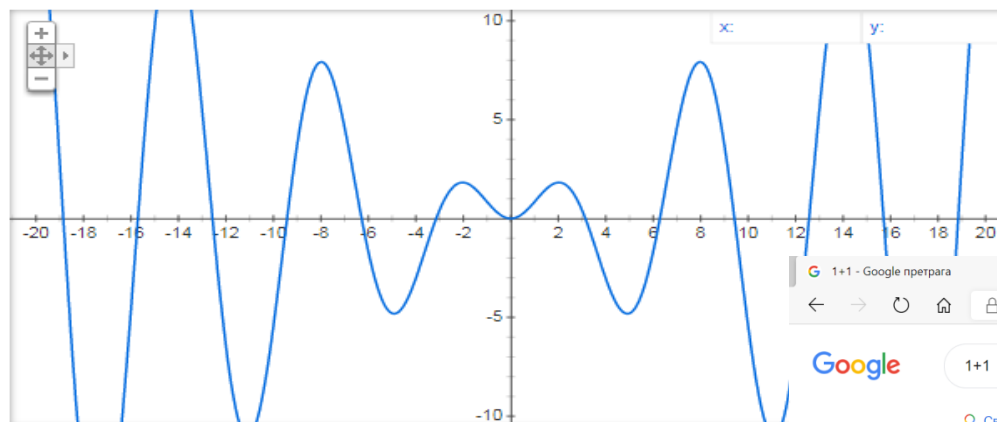
Још

Подешавања

Алатке

Око 3.640.000.000 резултата (0,57 секунде/и)

Графикон за $x \cdot \sin(x)$



1+1



Све

Сlike

Мапе

Видео

Вести

Још

Подешавања

Алатке

Око 25.270.000.000 резултата (0,72 секунде/и)

[www.mytutor.co.uk > Maths](https://www.mytutor.co.uk/Maths) ▾ Преведи ову страницу

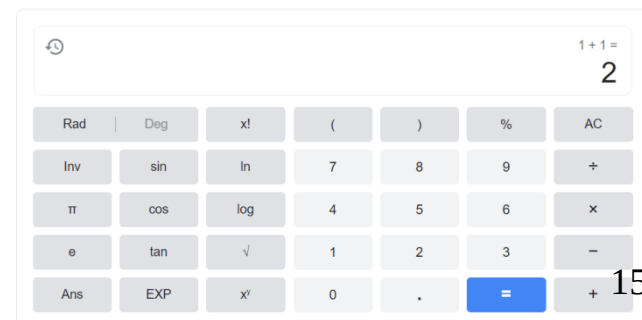
What is the integral of $x \sin(x) dx$? | MyTutor

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...

[www.teachoo.com > category](https://www.teachoo.com/category) ▾ Преведи ову страницу

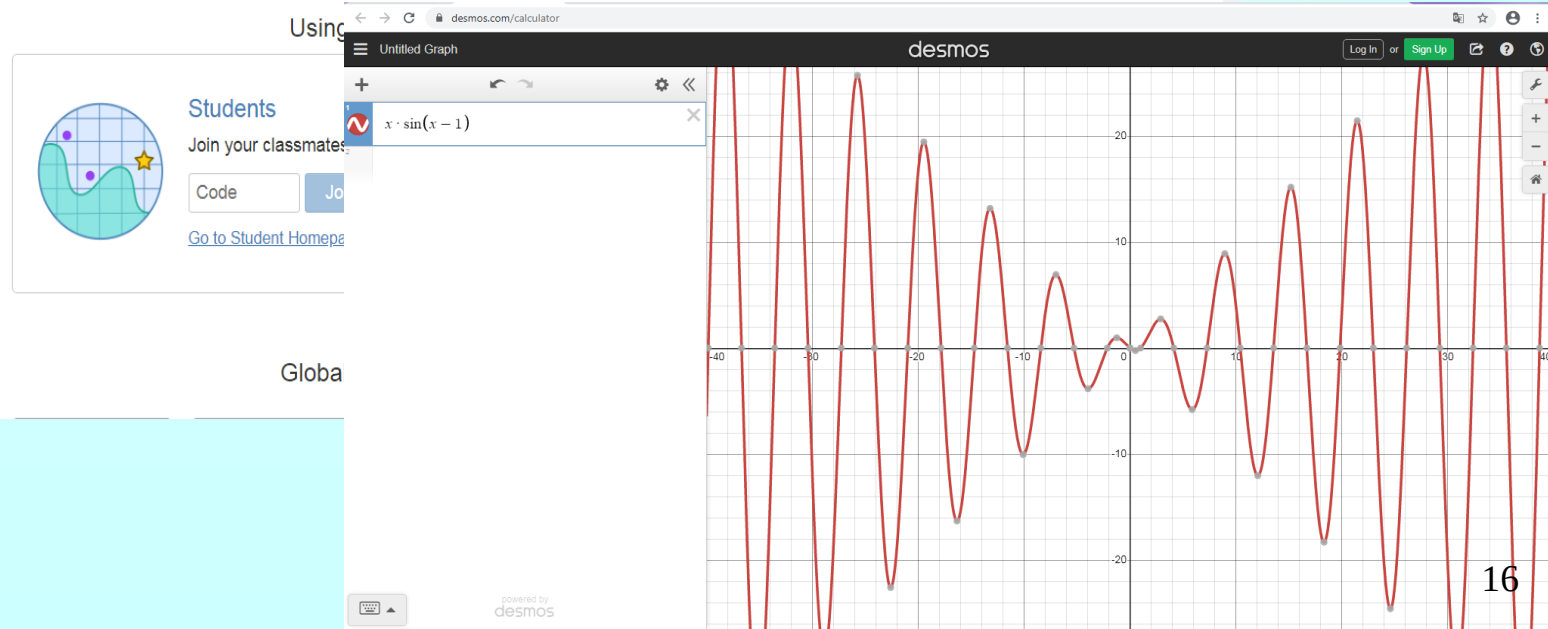
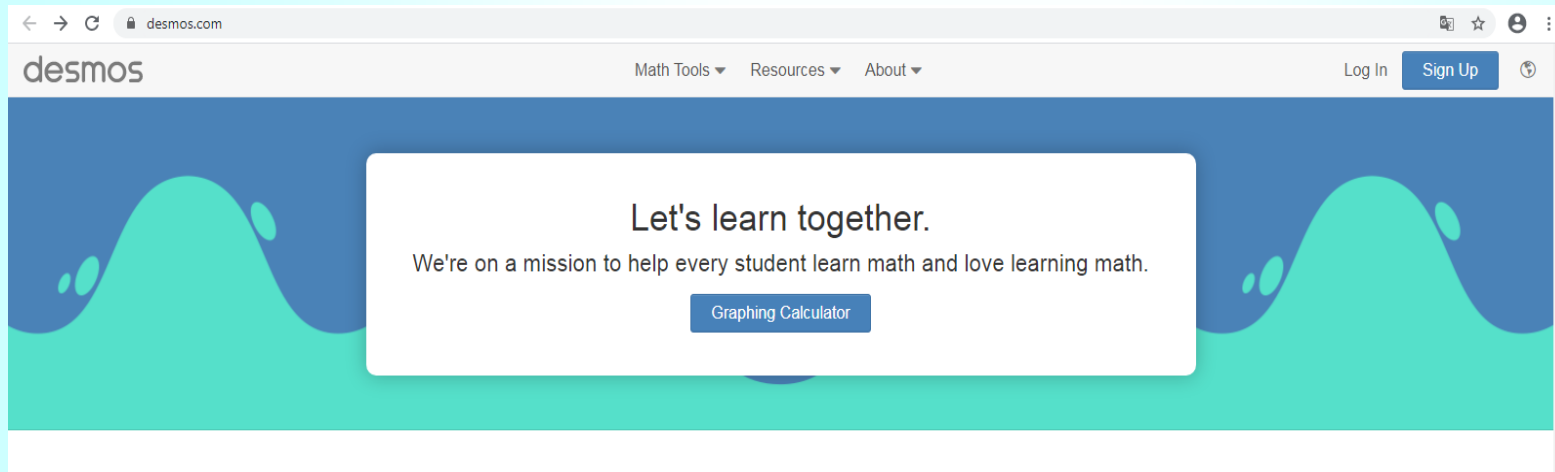
Ex 7.6, 1 - Find integration of $x \sin x$ - Chapter 7 Clas

25.09.2018. - Ex 7.6, $\int x \sin x dx$ | 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/>

Symbolab Math Solver interface showing the main navigation bar, a search bar, and a grid of mathematical symbols and functions for input. The interface includes a 'Try our new Geometry solver!' button and a 'Most Used Actions' section with buttons for simplify, solve for, inverse, tangent, and line. The page also displays a sidebar with subject categories (Pre Algebra, Algebra, Pre Calculus, Calculus, Functions, Matrices & Vectors, Geometry, Trigonometry, Statistics, Physics) and a 'Step-by-Step Calculator' section.

Solution steps for the integral $\int_0^T x \sin(x) dx$:

Solution

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

Steps

Apply Integration By Parts: $u = x, v' = \sin(x)$

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

$\int -\cos(x) dx = -\sin(x)$

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

Simplify

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

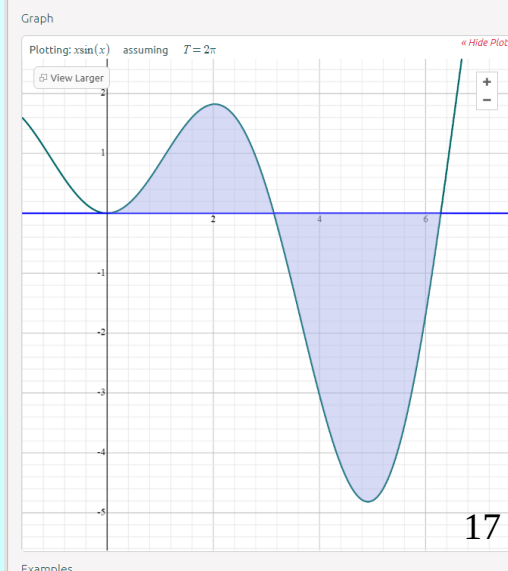
Compute the boundaries: $[-x \cos(x) + \sin(x)]_0^T = \sin(T) - T \cos(T)$

Answer

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

Got a different answer? Check if it's correct

Verify



SciLab

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

The image is a composite showing the SciLab website and its software interface. The top part is a screenshot of the SciLab website (https://www.scilab.org/) in a web browser. The website has a navigation bar with links: Download, Software, Tutorials, Applications, Services, Cloud, and About. Below the navigation bar, there's a large blue banner with the text "Download Scilab 6.1.0" and "Windows, Linux and Mac OS X". Below this, it says "Open source software for numerical computation". To the right of the banner, there's a screenshot of the SciLab 6.1.0 software interface. The interface shows a file browser, a variable browser, a console window, and a 3D plot of a surface. The 3D plot is a colorful surface plot with axes labeled x, y, and z. Below the 3D plot, there's a "SciLab CONFERENCE" logo. In the bottom left corner, there's a screenshot of the SciLab software interface showing the "Toolboxes" menu. The menu is open, showing options: Numerical Analysis, Data visualization, Algorithm development, and Application development. Below the menu, there's a screenshot of the SciLab software interface showing the "Toolboxes" menu with a list of toolboxes: 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.

Home Page | www.scilab.org

Search

Download Software Tutorials Applications Services Cloud About

Download Scilab 6.1.0

Windows, Linux and Mac OS X

Open source software for numerical computation

Toolboxes

- Numerical Analysis
- Data visualization
- Algorithm development
- Application development

- Image Processing & Computer Vision
- Model Order Reduction
- Scilab Code Generator
- Signal acquisition & instrument control
- Functional Mock-Up Interface (FMI) for Model-Exchange & Co-Simulation

Xcos

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

The screenshot displays the Xcos website interface. At the top, the Scilab logo is on the left, and a navigation menu includes 'Download', 'Software', '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 the center. At the bottom, four example diagrams are shown, each representing a different application area: 'Signal Processing' (a block diagram with three 'Signal Builder' blocks), 'Control Systems' (a 'Water-Tank System' diagram with a 'Controller' and 'Robot-Tank System'), 'Mechanics/Thermodynamics' (a diagram with multiple interconnected blocks), and 'Electronics' (a diagram with a 'MUX' block and various signal processing blocks). Each diagram is labeled with its respective category name at the bottom.

Signal Processing

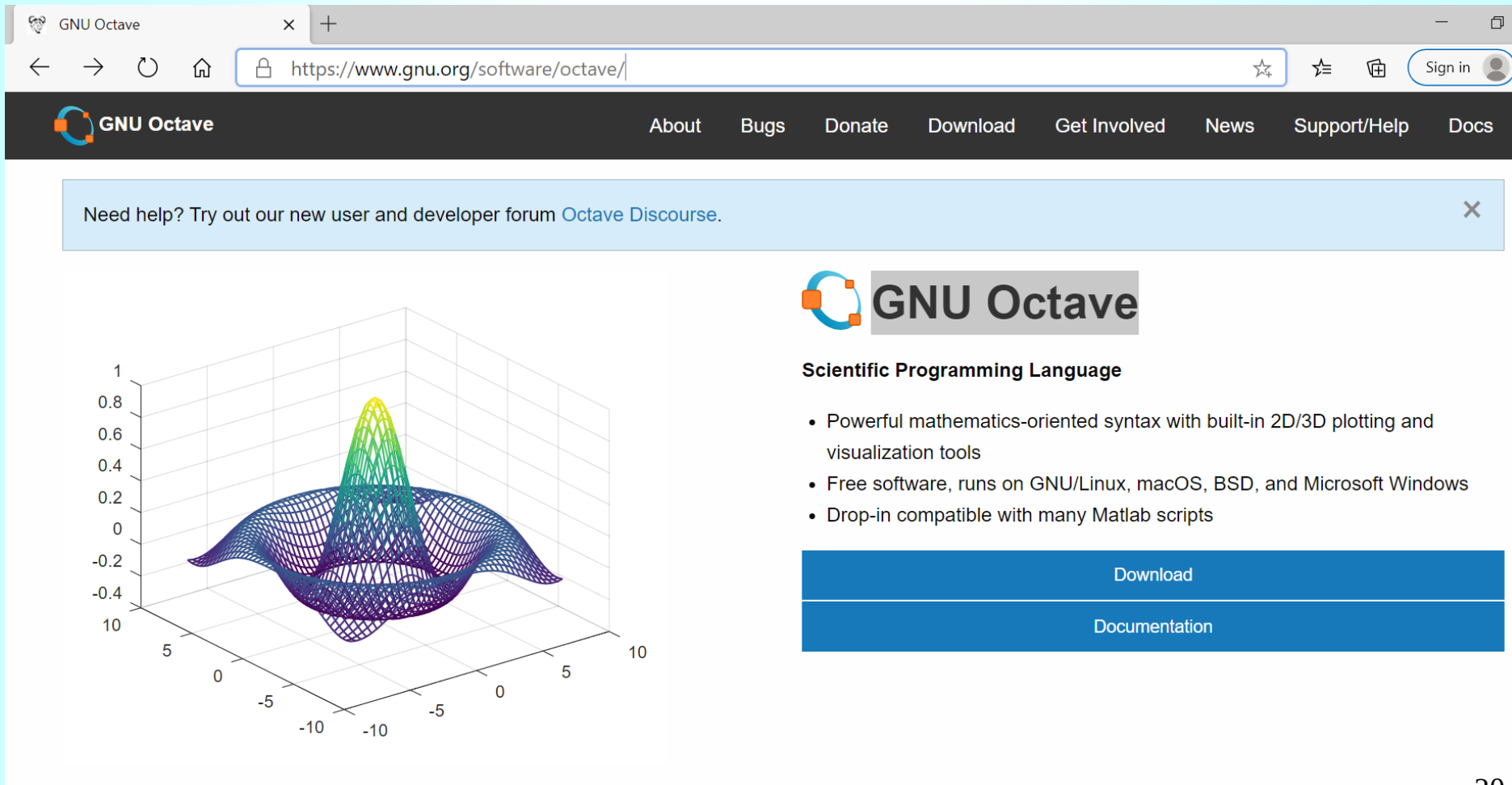
Control Systems

Mechanics/Thermodynamics

Electronics

GNU Octave

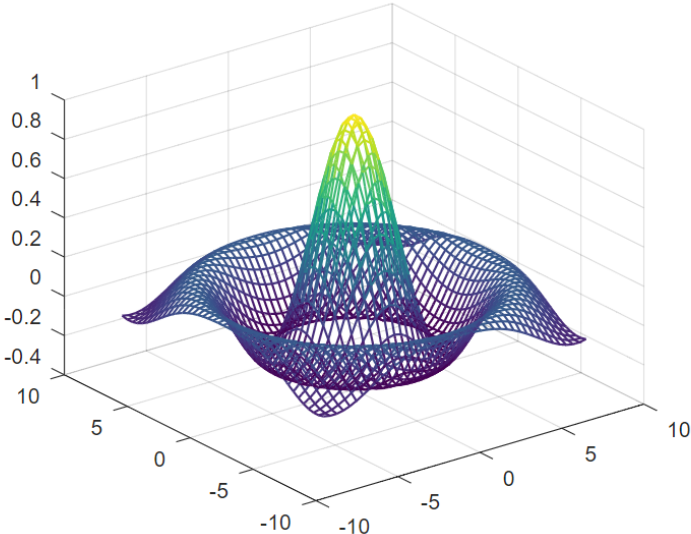
<https://www.gnu.org/software/octave/>



GNU Octave

[About](#) [Bugs](#) [Donate](#) [Download](#) [Get Involved](#) [News](#) [Support/Help](#) [Docs](#)

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](#)

Micro-Cap

<http://www.spectrum-soft.com/index.shtml>

The screenshot displays the Spectrum Software website's Micro-Cap 12 download page. At the top, a navigation bar includes links for Home, Products, Download, Newsletters, Support, and Contact Us. The main heading is "Industrial Strength Simulation". A red banner across the top of the circuit diagram area states: "MC10, MC11, and MC12 are now free and need no key." Below this, a large circuit diagram is shown, featuring various components like transistors (Q1, Q2, Q4, Q5, Q10, Q11, Q16, Q21), resistors (R1, R10, R16, R17, R18), capacitors (C3), and a 15V source (V2). A large, circular gold coin with the number "12" and the text "SPECTRUM SOFTWARE" and "MICRO-CAP TWELVE" is prominently displayed in the center of the circuit diagram. On the left side, a sidebar contains a "Select:" menu with options: "MC12 Revision History", "Product Information", "Features Tour", and "New MC12 Features". Below this menu, a "News:" section states: "Effective 7/4/2019, Spectrum Software is closed. Micro-Cap is now free." and "Technical support will be available for at least 90 days via email at [Support](#)." Further down, it says: "You can download the latest versions of Micro-Cap here: [Download](#) You can choose either the executable program or the entire installation CD for MC10, MC11, and MC12. If you have an earlier version, download and use MC12. These new versions do not require". On the right side, there are two informational boxes. The top one, titled "About Spectrum", provides background on the company's founding in February 1980 and its early products like Logic Designer and Simulator. The bottom one, titled "Help", directs users to search newsletter issues or the Frequently Asked Questions section for common questions.

Spectrum Software

Home Products Download Newsletters Support Contact Us

Industrial Strength Simulation

Select :

- MC12 Revision History
- Product Information
- Features Tour
- New MC12 Features

News:
Effective 7/4/2019, Spectrum Software is closed. Micro-Cap is now free.
Technical support will be available for at least 90 days via email at [Support](#).
You can download the latest versions of Micro-Cap here: [Download](#)
You can choose either the executable program or the entire installation CD for MC10, MC11, and MC12. If you have an earlier version, download and use MC12. These new versions do not require

MC10, MC11, and MC12 are now free and need no key.

About Spectrum
Spectrum Software was founded in February of 1980 to provide software for personal computers. Initially, the company concentrated on providing software for Apple II systems.
One of the earliest products was Logic Designer and Simulator. Released in June 1980, this product was the first integrated circuit editor and logic simulation system available for personal computers. More...

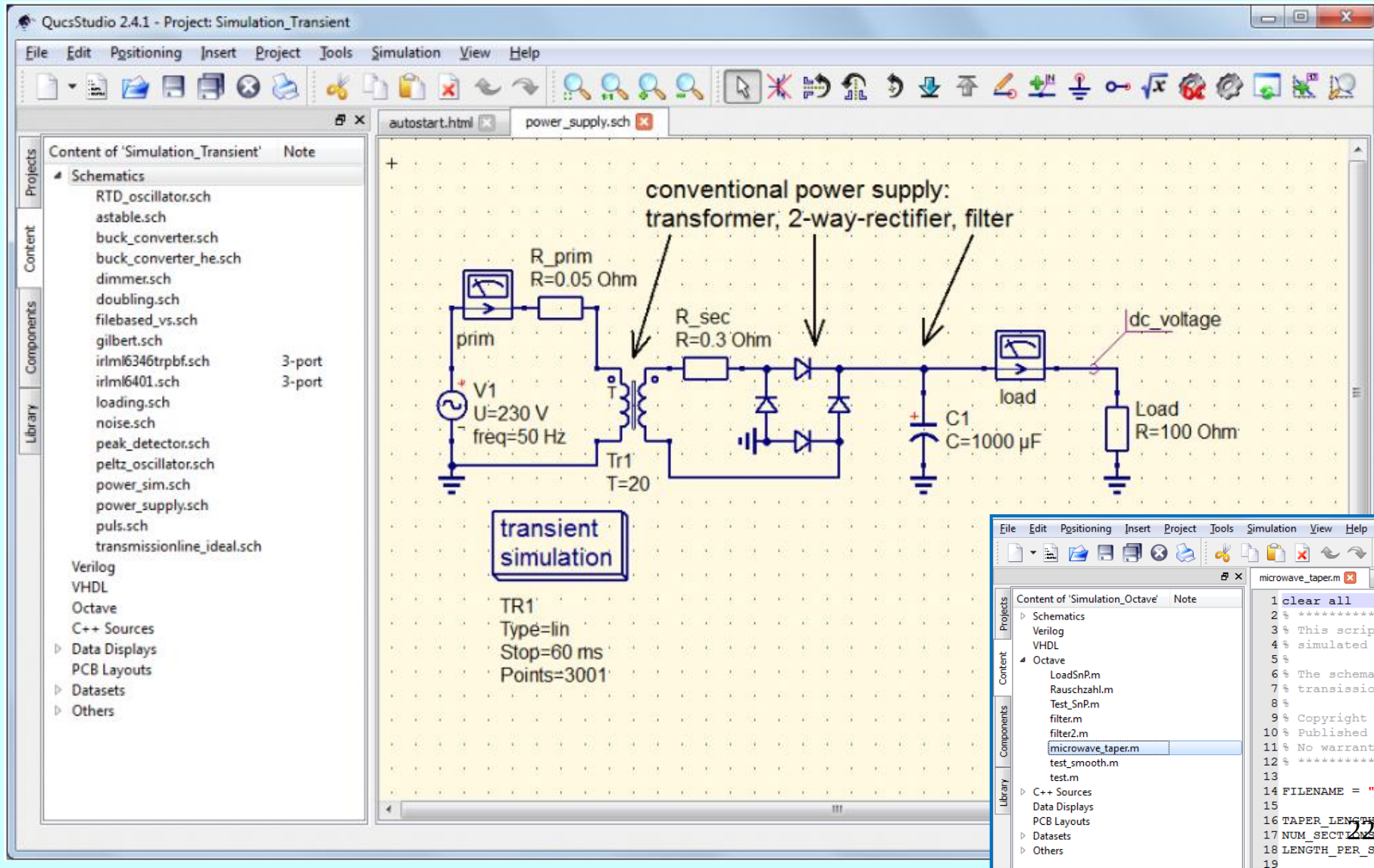
Help
Search our newsletter issues which contain application notes for Micro-Cap or view our Frequently Asked Questions section for common questions that arise with Micro-Cap use.

12
SPECTRUM SOFTWARE
MICRO-CAP TWELVE

QucsStudio

<http://qucsstudio.de>

*Octave engine
inside!*



CircuitLab

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

The image shows a screenshot of the CircuitLab website and a circuit simulation interface. 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.' A list of features is provided: '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 'watch a quick demo video'. Below this, a video player shows a 'Getting Started with CircuitLab' tutorial. The bottom section displays a circuit simulation interface with a schematic diagram of a low-pass filter. The schematic includes a 1 kHz square wave voltage source (V1), a 100 Ω resistor (R1), and a 10 μF capacitor (C1). The input is labeled 'In' and the output is labeled 'out'. A list of 5 steps for a 1-minute tutorial is provided: 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 interface also shows a component library on the left and a status bar at the bottom.

CircuitLab

Search

milka.potrebic
inbox (0) · settings · log out

Circuit simulation and schematics.

Build and simulate circuits right in your browser.

- Design with our easy-to-use schematic editor.
- Analog & digital circuit simulations in seconds.
- Professional schematic PDFs, wiring diagrams, and plots.
- No installation required! Launch it instantly with [one click](#).

► Launch CircuitLab

[or watch a quick demo video →](#)

Getting Started with CircuitLab

Гледајте К... Дели

CircuitLab

File Edit Run Help

Press 'F' to search

Essentials

NAME WIRE

DC Sources

Passive Elements

Voltage Signal Sources

Current Signal Sources

Operational Amplifiers

Diodes

V1 square 1 kHz

R1 100 Ω

C1 10 μF

In

out

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,
ik.

[Circuit Design and Analysis](#)

Powered by CircuitLab - to learn about the full version, please visit www.circuitlab.com/

148%

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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 shaper. The wave will be shifted to a positive or negative level.

Fig. 1: DoCircuits - Home

ngSpice

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

← → ↻ 🏠 ⚠ Not secure | ngspice.sourceforge.net



MIXED MODE - MIXED LEVEL
CIRCUIT SIMULATOR

BASED ON BERKELEY'S SPICE3F5

NGSPICE SUMMARY

Home News Screenshots Download Documentation Tutorials Extras/Options Applications Development Simulation Environments Recipes

Ngspice Home

Home
What is ngspice ?
Features, Extras & Options
F.A.Q.
Tutorials
Sourceforge Developer Pages

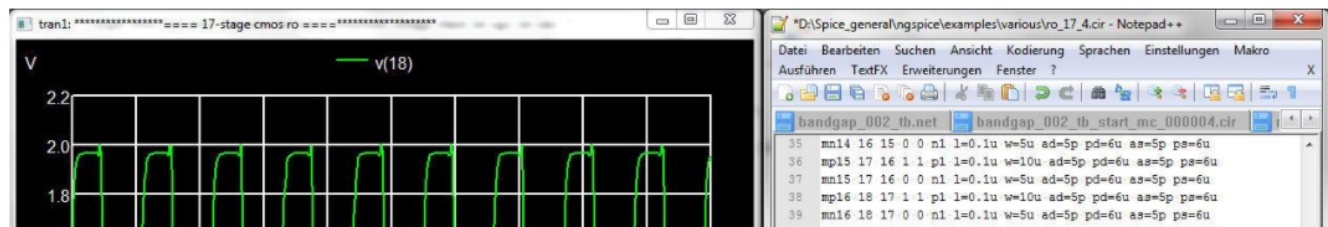
ngspice - open source spice simulator

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>



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TINA-TI

SPICE-based analog simulation program

Overview

Downloads

Technical documentation

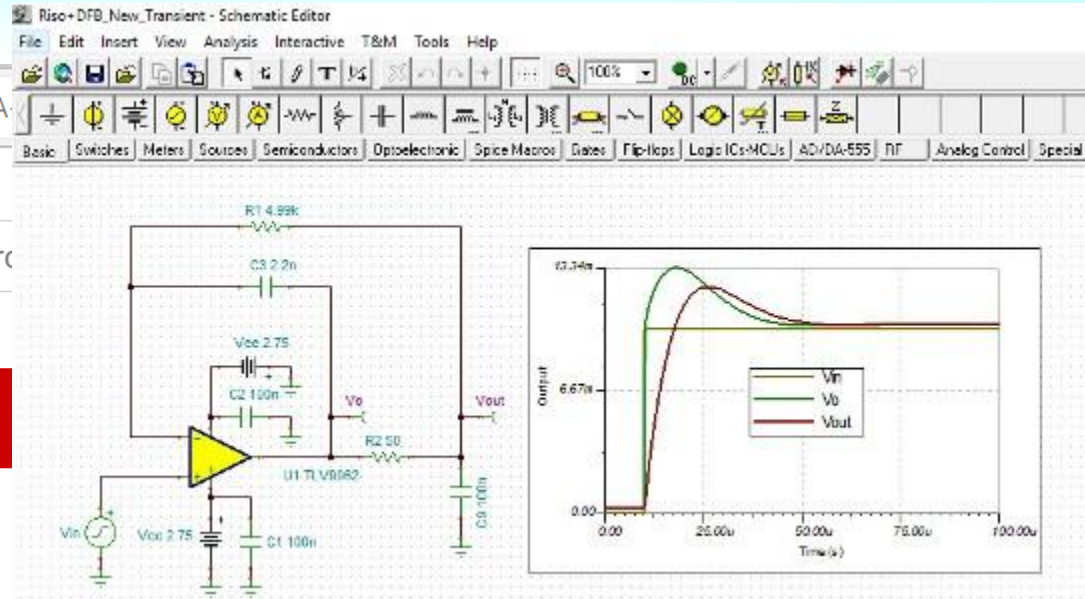
Support & training

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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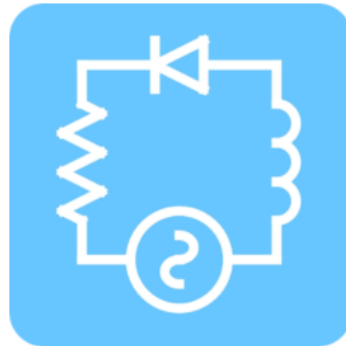
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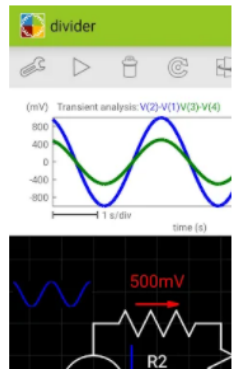
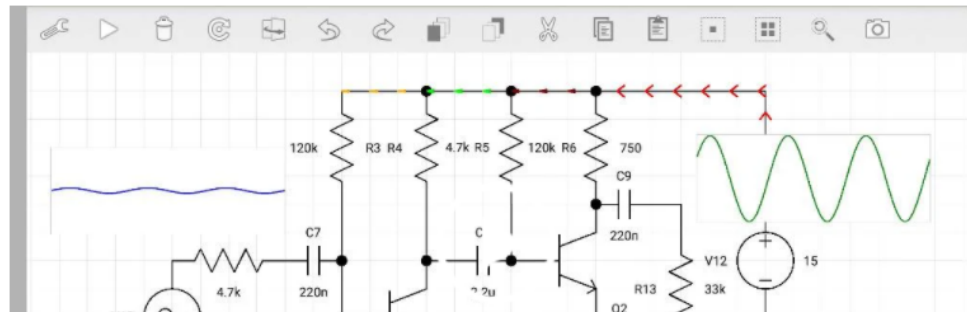
Everyone

Contains Ads

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Install



CircuitSafari SPICE Simulator

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



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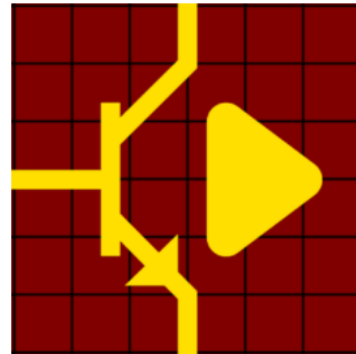
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CircuitSafari SPICE Simulator (Early Access)

Logipipe, LLC Productivity

E Everyone

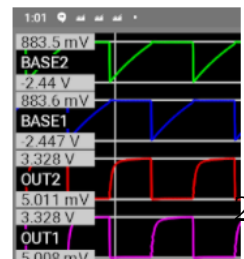
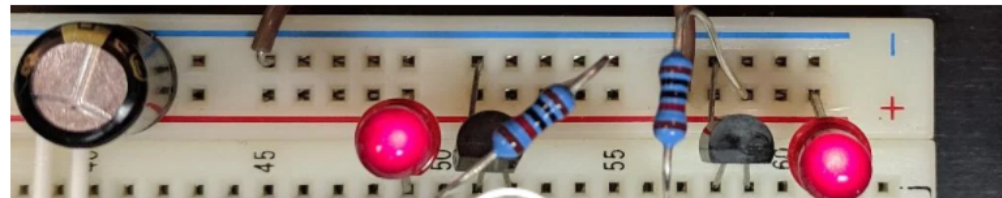
Offers in-app purchases

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

⚠ You don't have any devices

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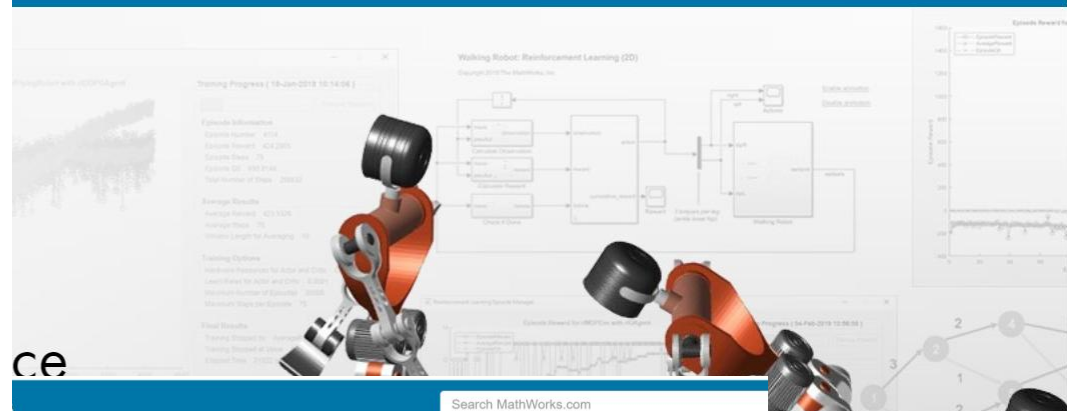
Install



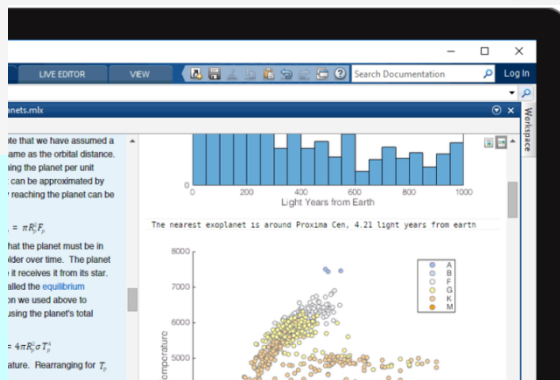


Millions of Engineers and Scientists Trust MATLAB

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.



Design AI models and AI-driven systems



Products by Category Alphabetical

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MATLAB Parallel Server

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Curve Fitting Toolbox
Optimization Toolbox
Global Optimization Toolbox
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SIMULINK® PRODUCT FAMILY

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MATLAB

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

MATLAB R2019a

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FILE VARIABLE CODE ENVIRONMENT RESOURCES

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Command Window

Workspace

System target file browser: Simulink2DSHplus

Simulink2DSHplus

MathWorks

MATLAB®

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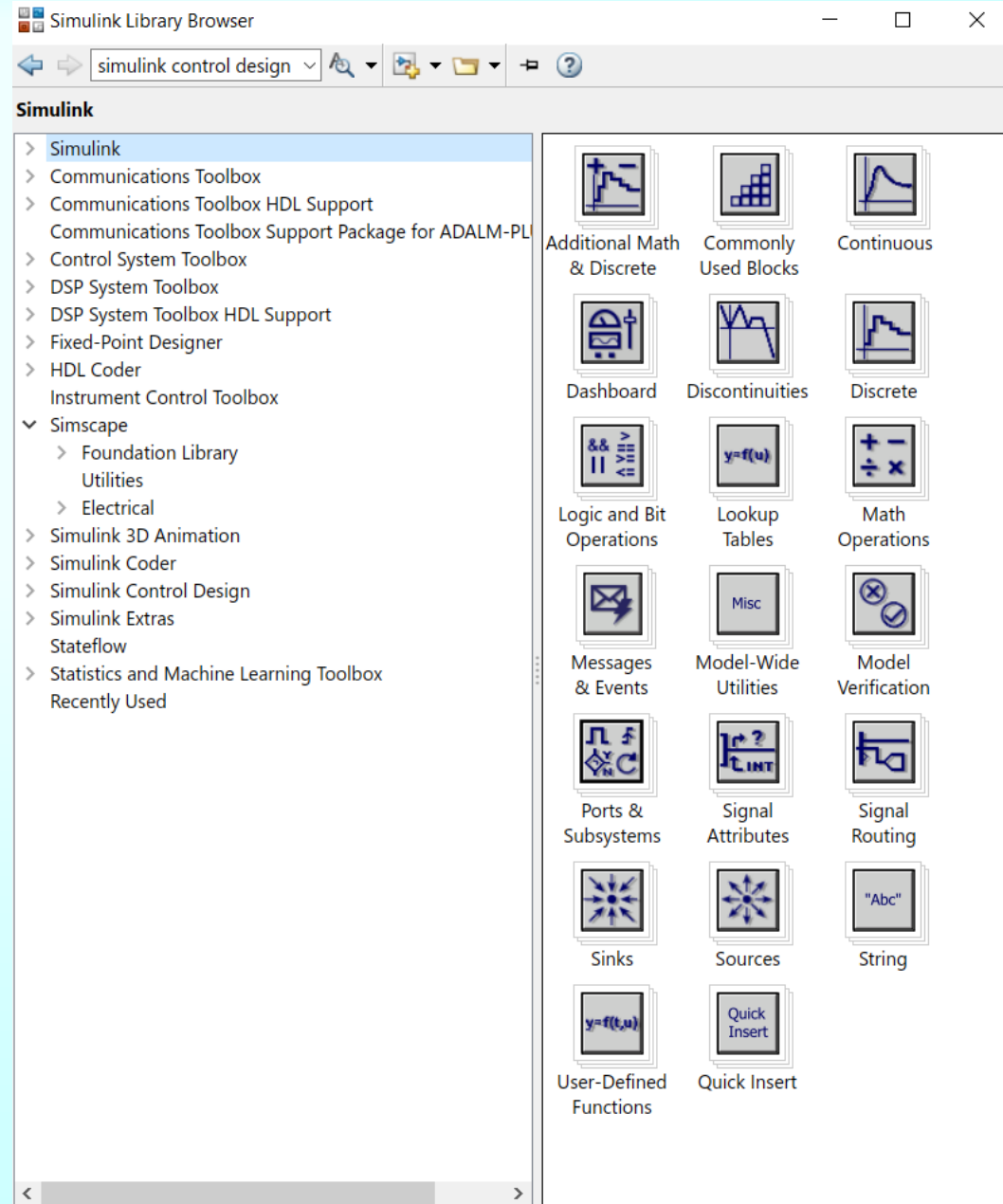
R2019a

Ready

Toolboxes...

MATLAB Simulink

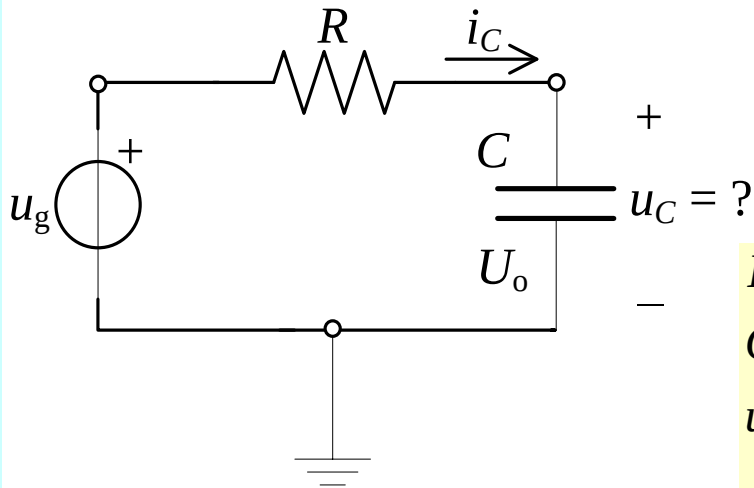
- Алатка за нумеричку анализу математичких модела
- Систем се дефинише графички, уметањем блокова и њиховим повезивањем у мрежу



Simulink > Simscape

- Библиотека за симулацију и нумеричку анализу мултидоменских проблема (механика, електродинамика, оптика)
- Пример једноставног електричног кола:

коло је образовано у тренутку $t_0 = 0$

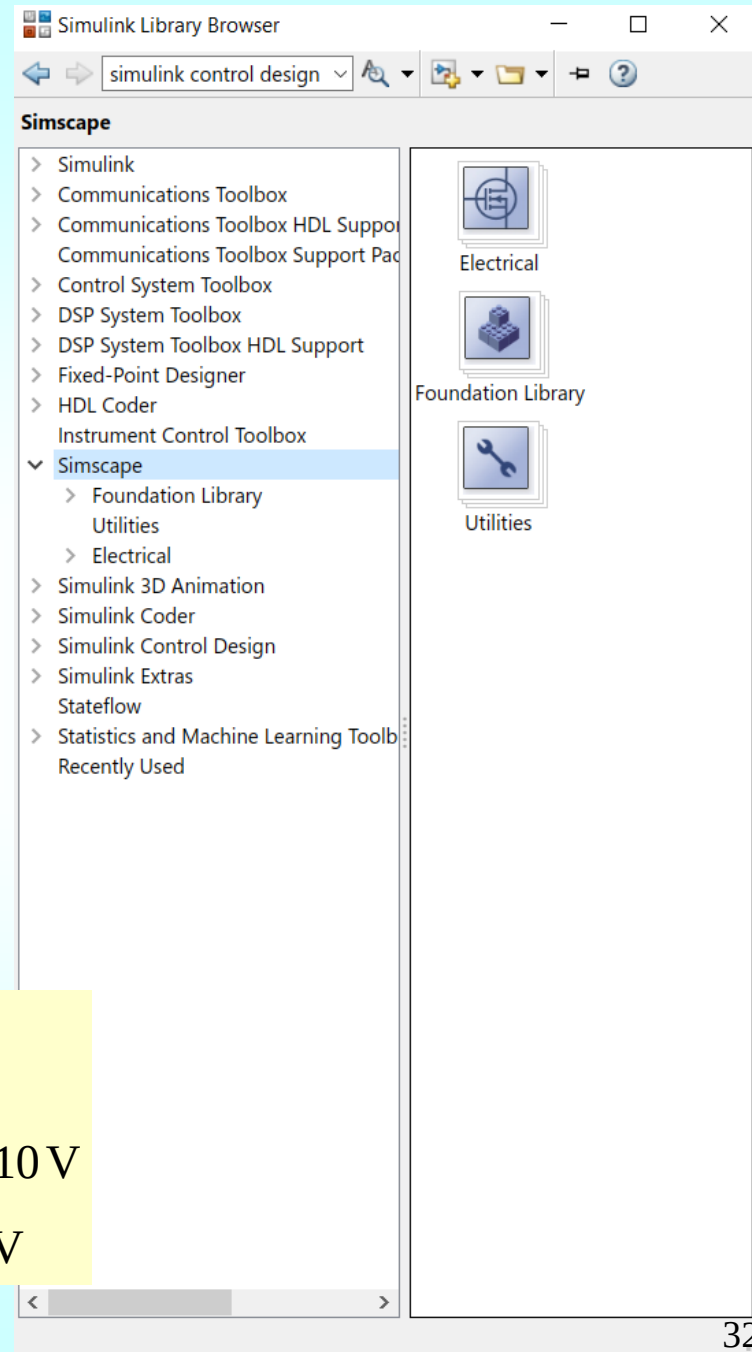


$$R = 1\text{k}\Omega$$

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

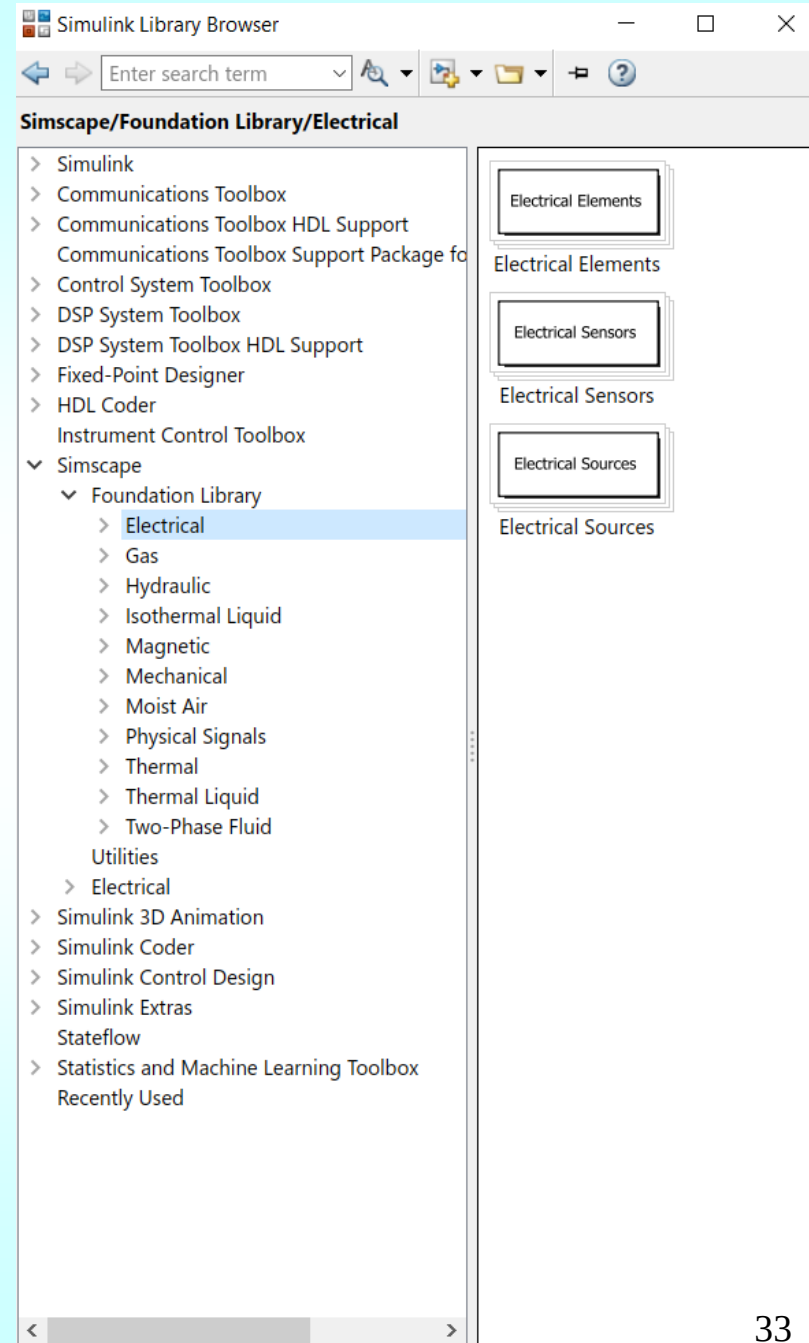
$$u_g(t) = U h(t), U = 10\text{ V}$$

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



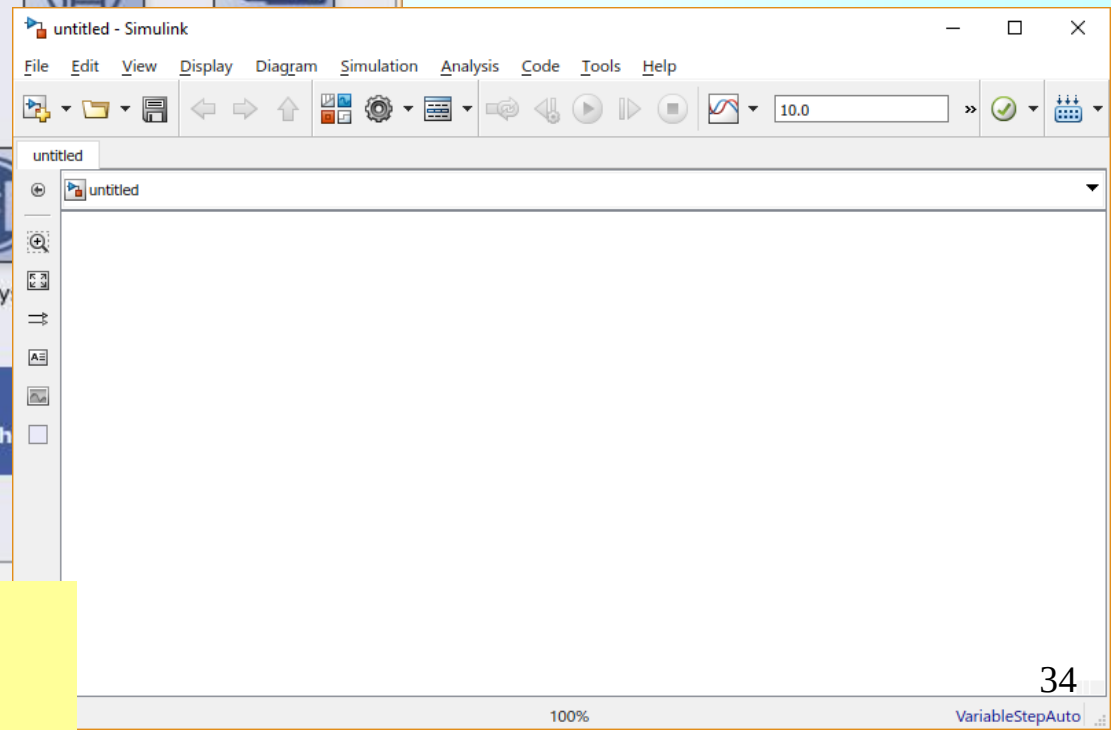
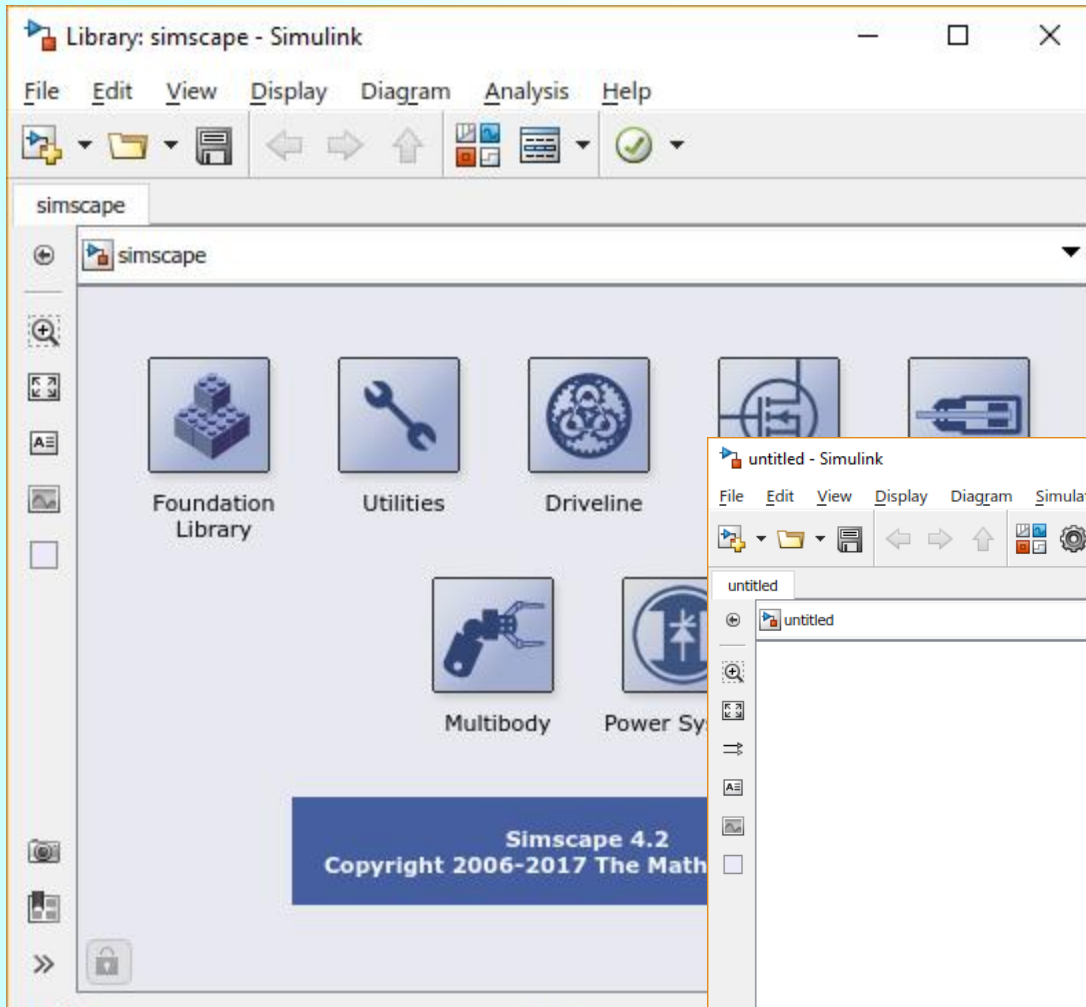
Simulink > Simscape > Foundation Library > Electrical

- Симулација линеарних и нелинеарних електричних кола

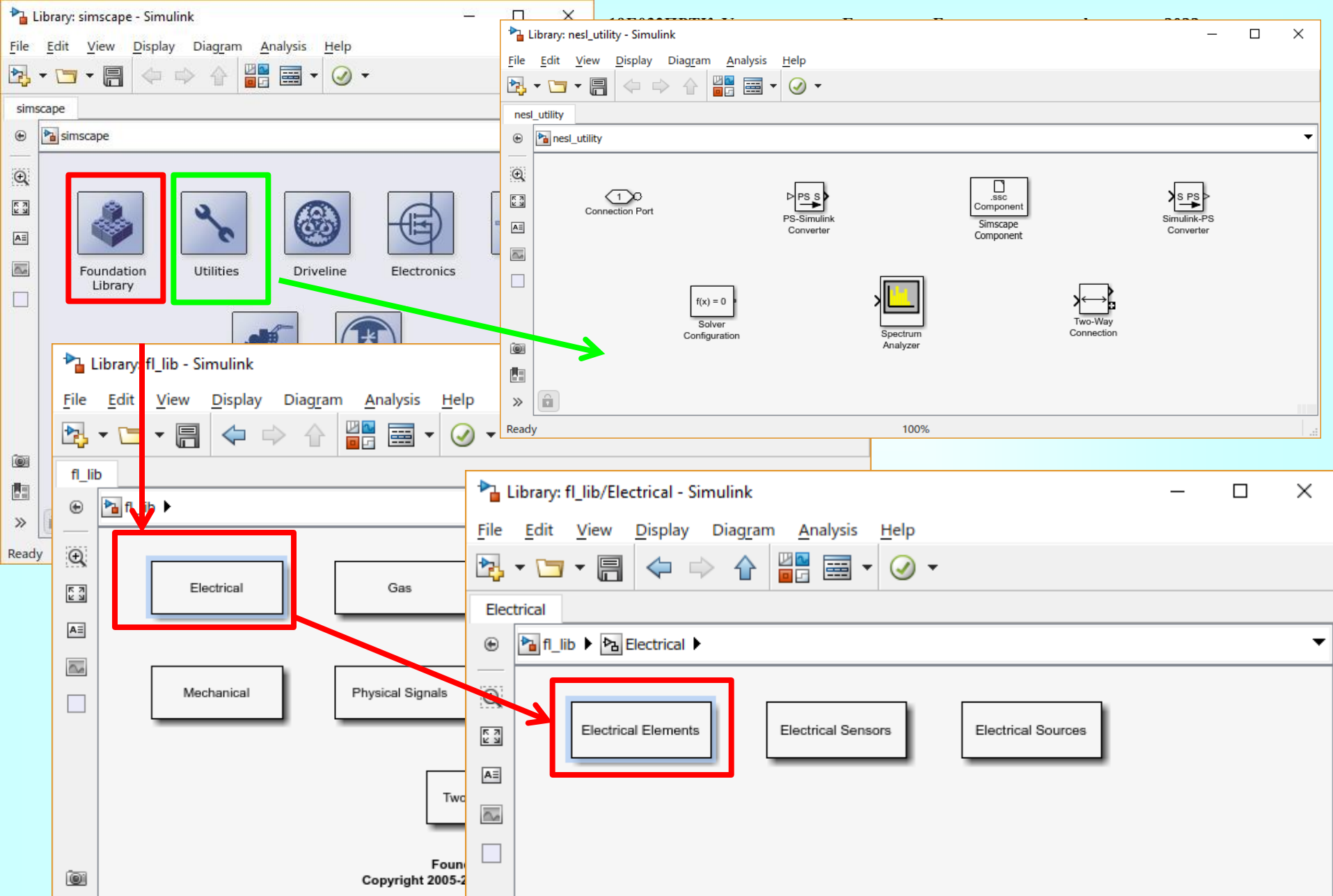


**MATLAB > Simscape >
Foundation Library, Utilities**

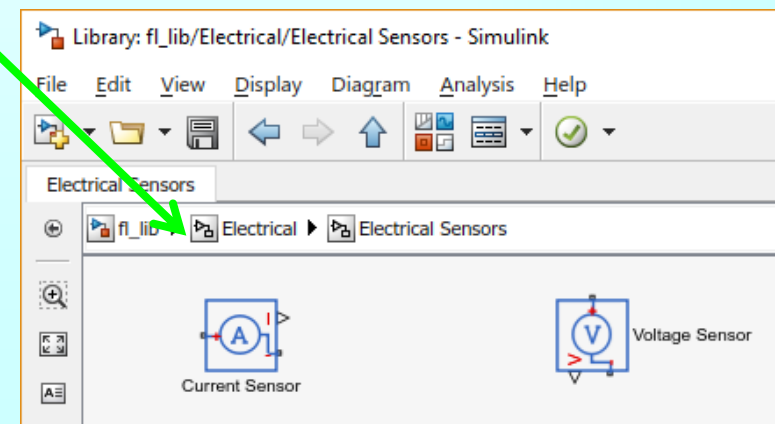
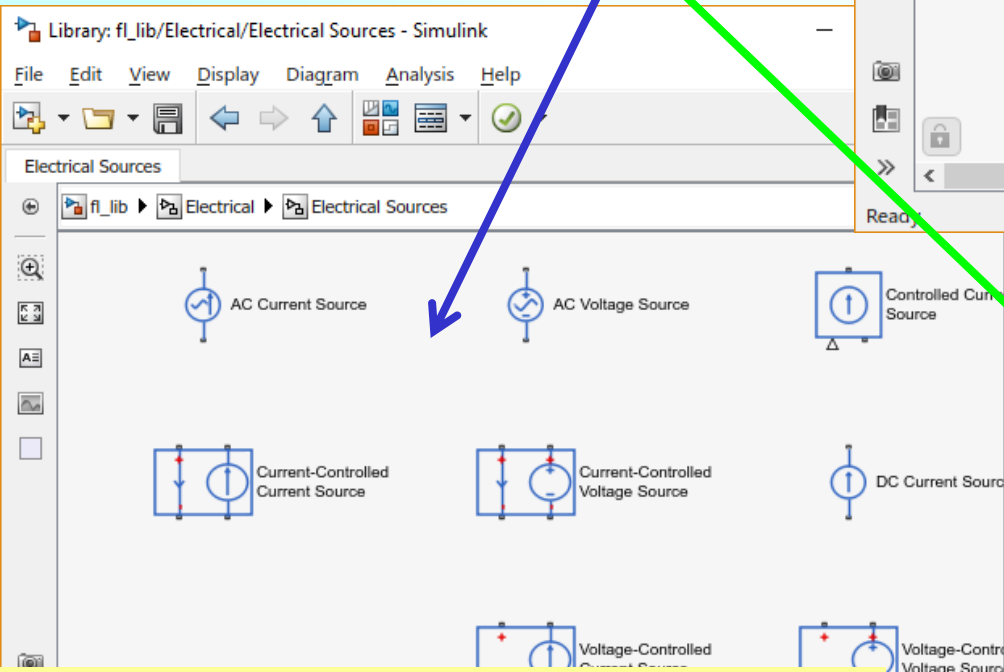
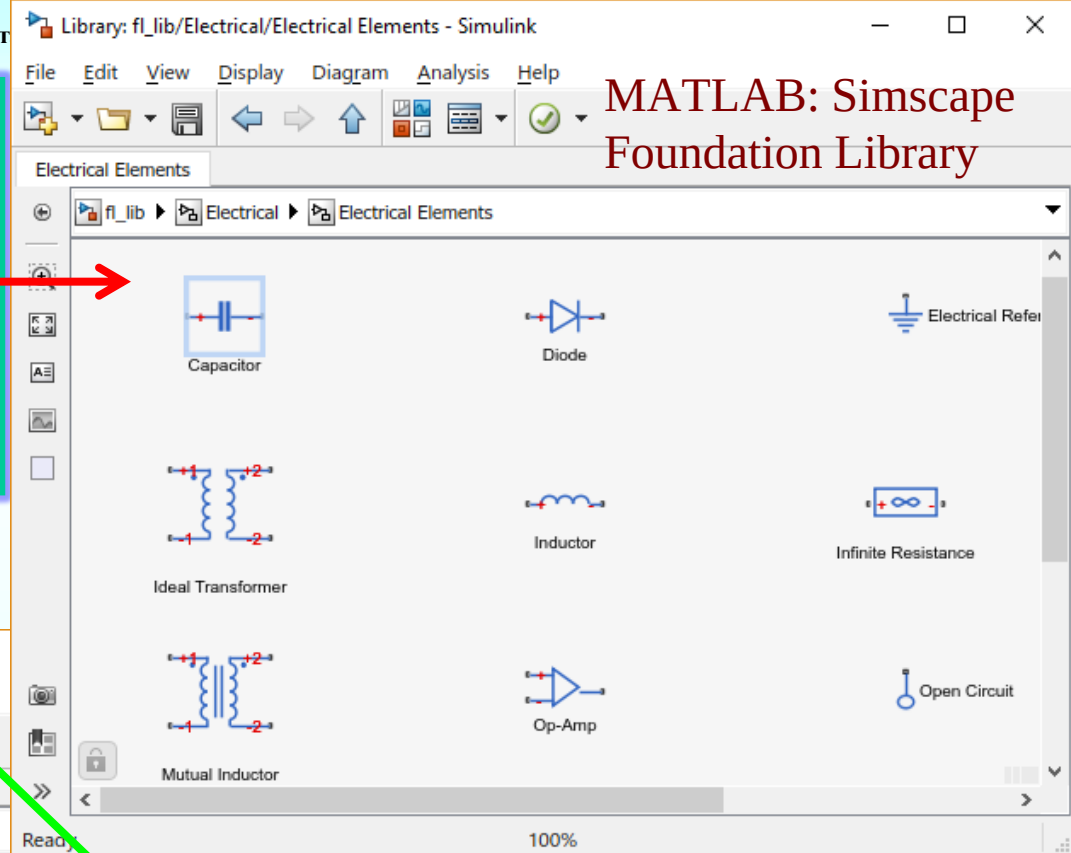
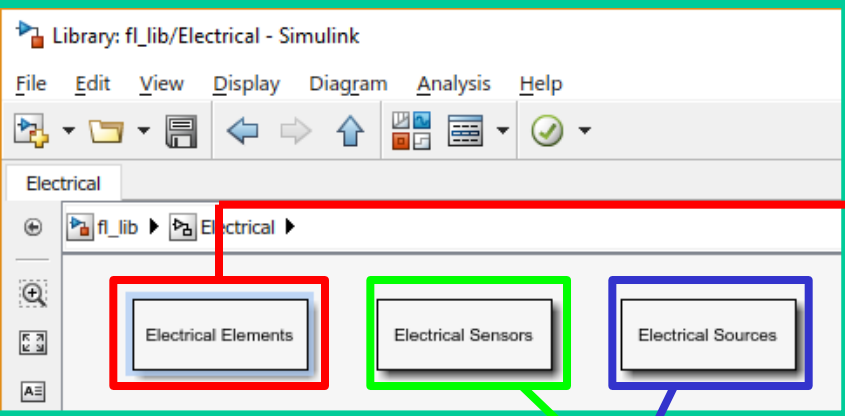
Симулација електричног кола коришћењем **Simscape > Foundation Library** библиотеке



**MATLAB > Simscape >
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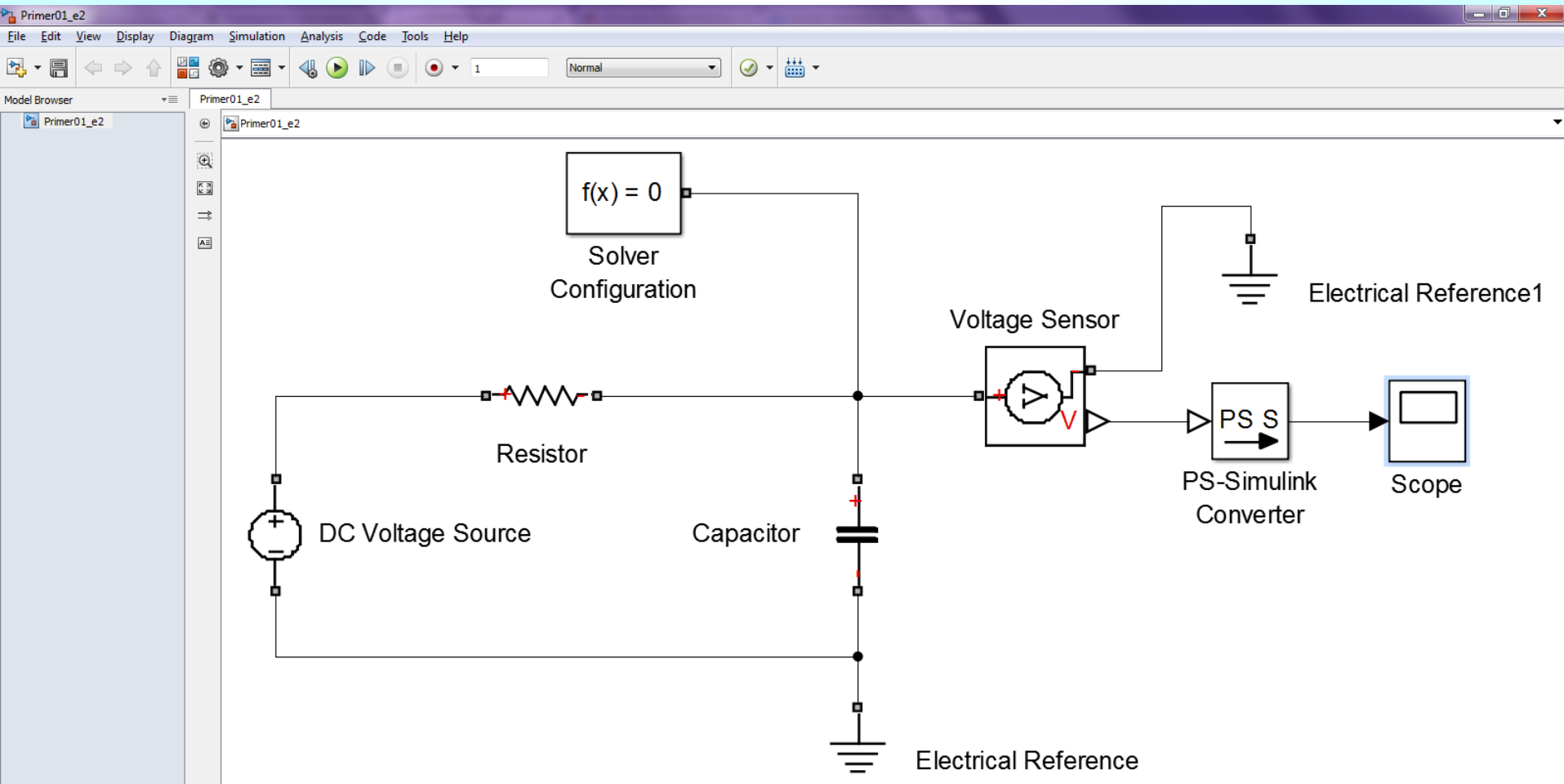


**MATLAB > Simscape >
Foundation Library, Utilities**

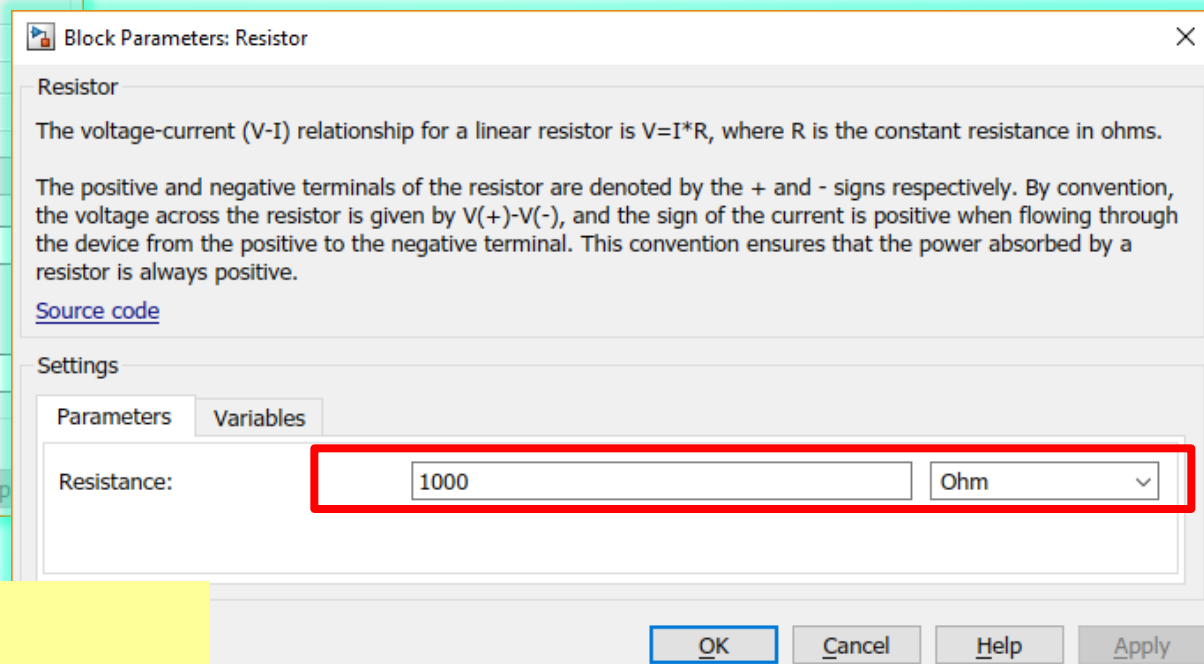
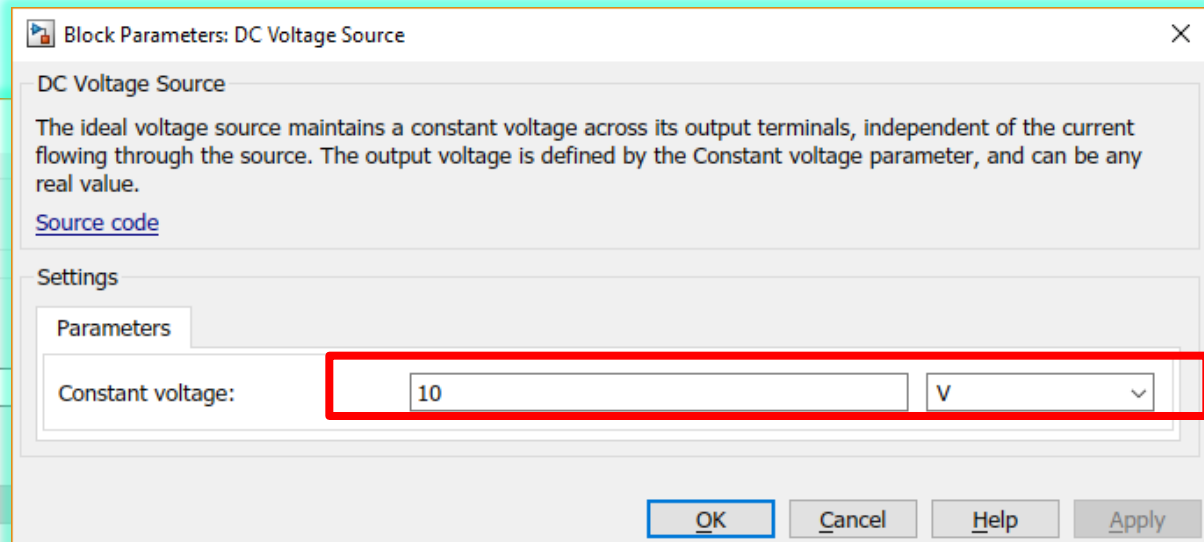
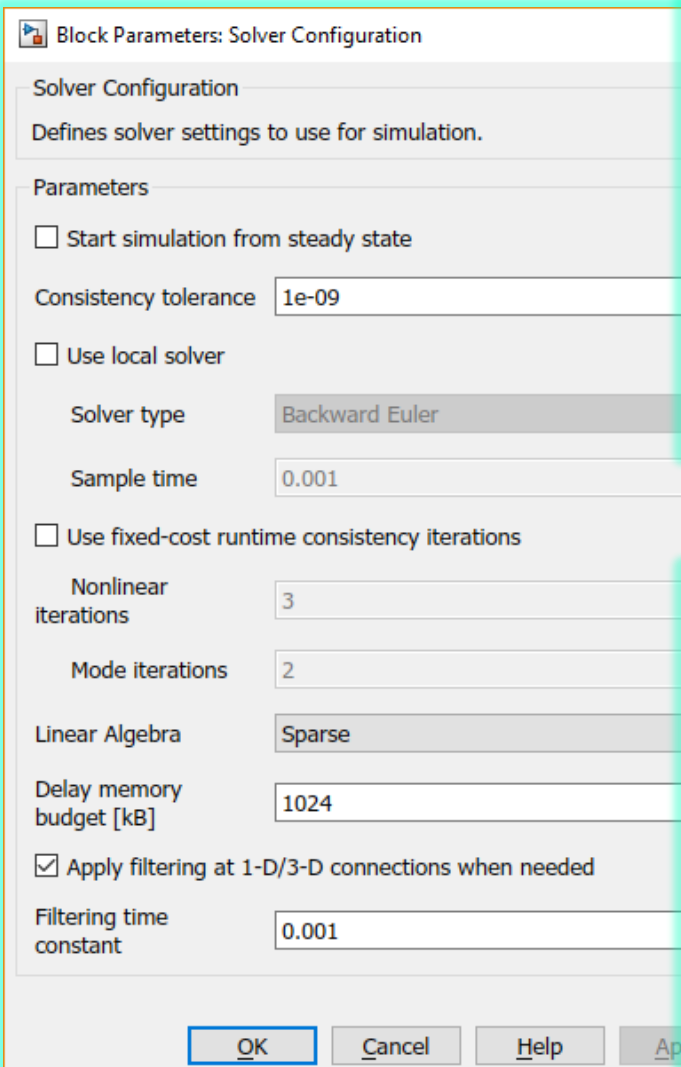


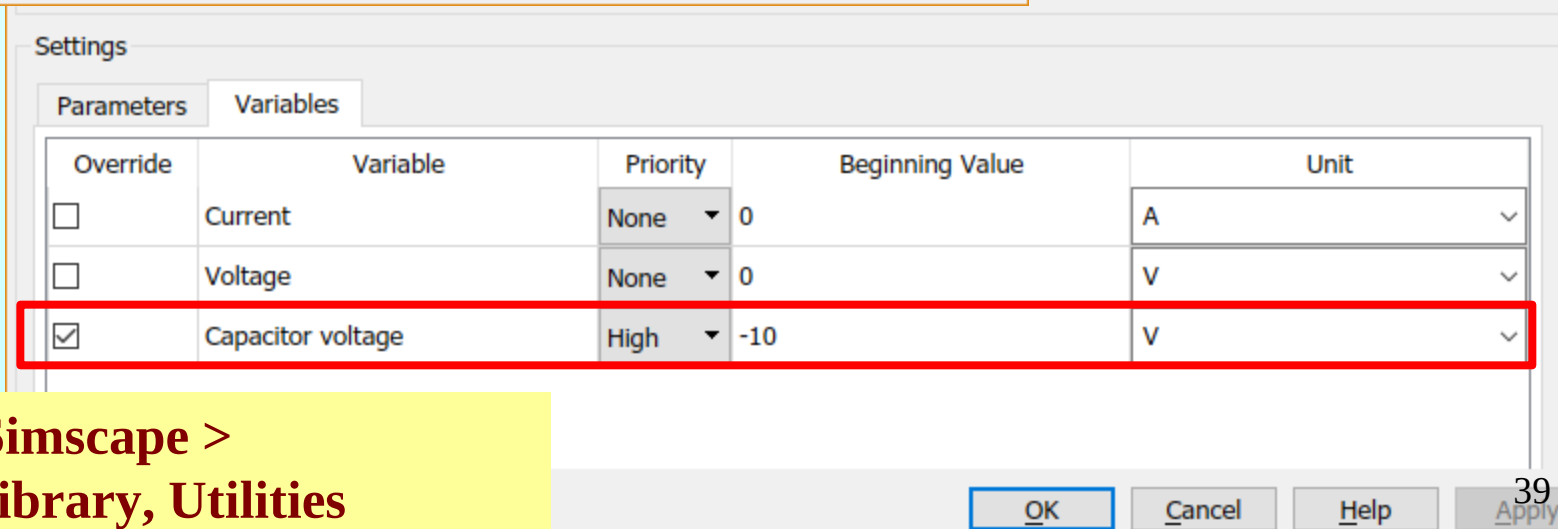
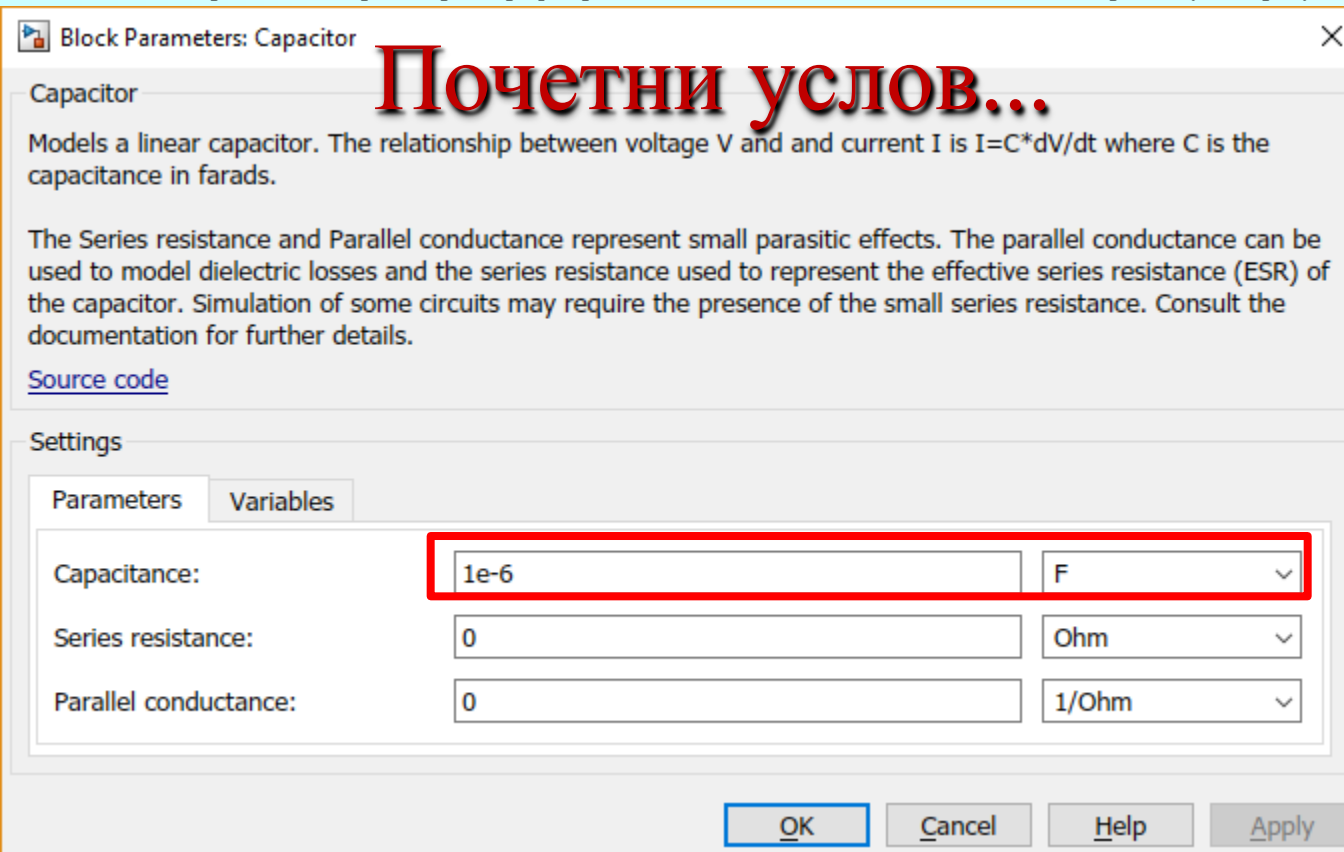
**MATLAB > Simscape >
Foundation Library, Utilities**

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

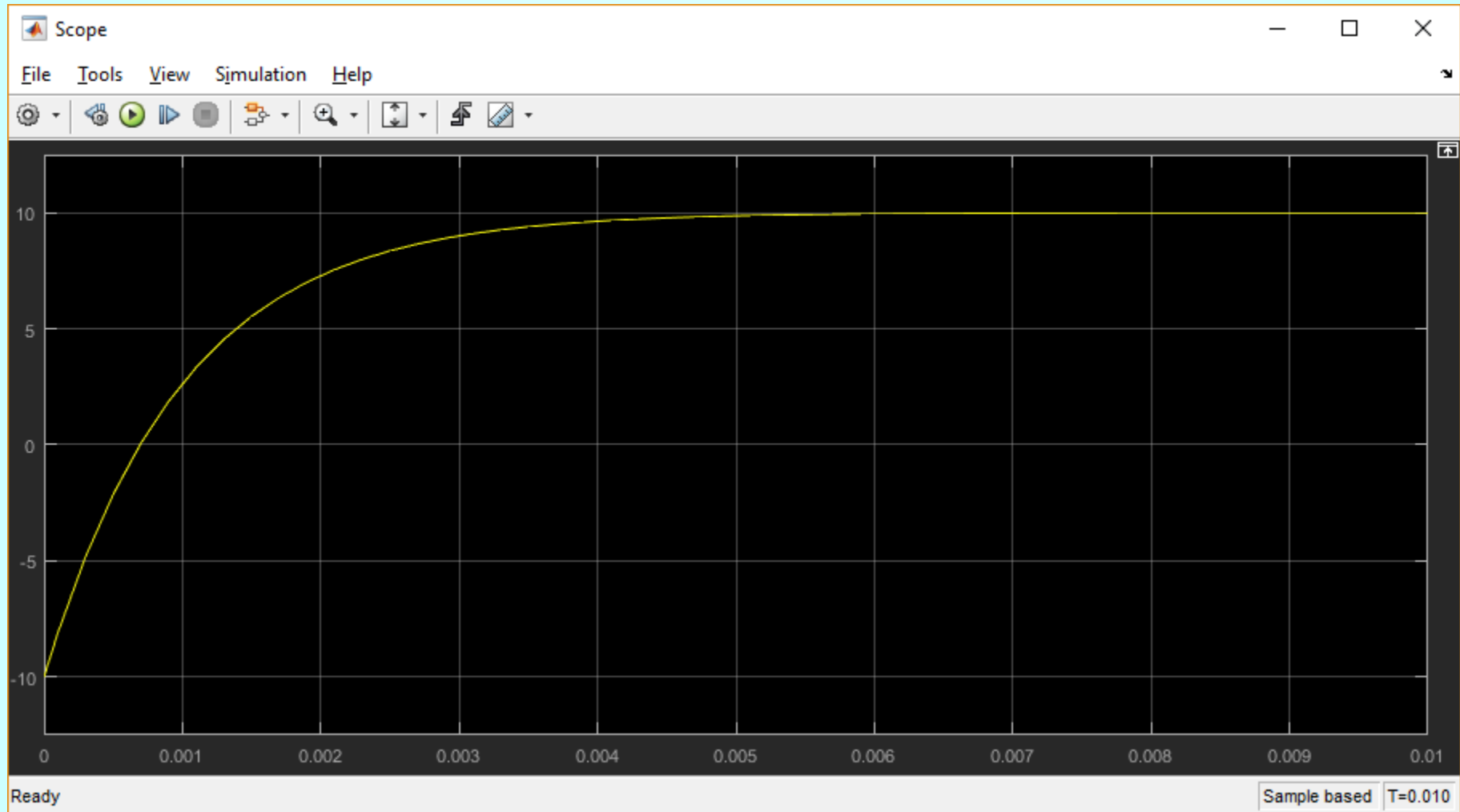


**MATLAB > Simscape >
Foundation Library, Utilities**





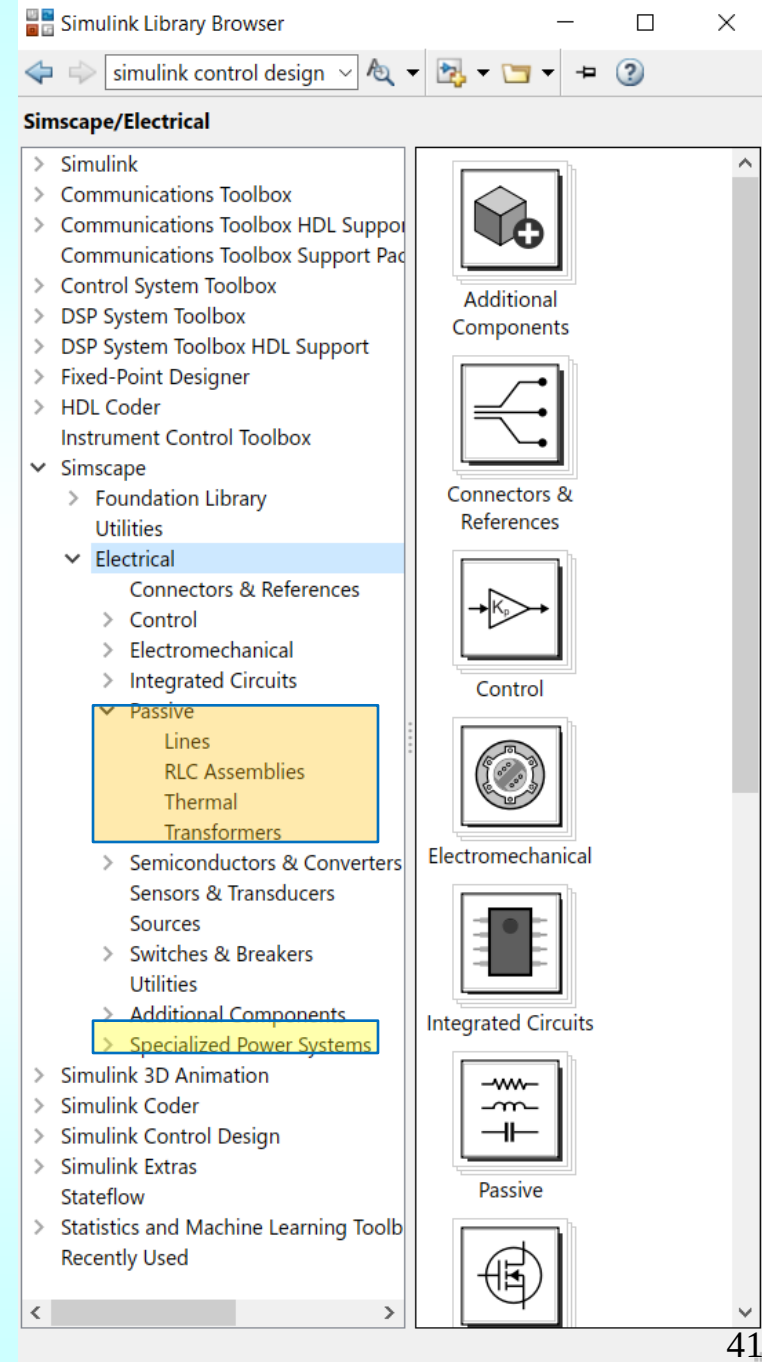
Налажење одзива...



**MATLAB > Simscape >
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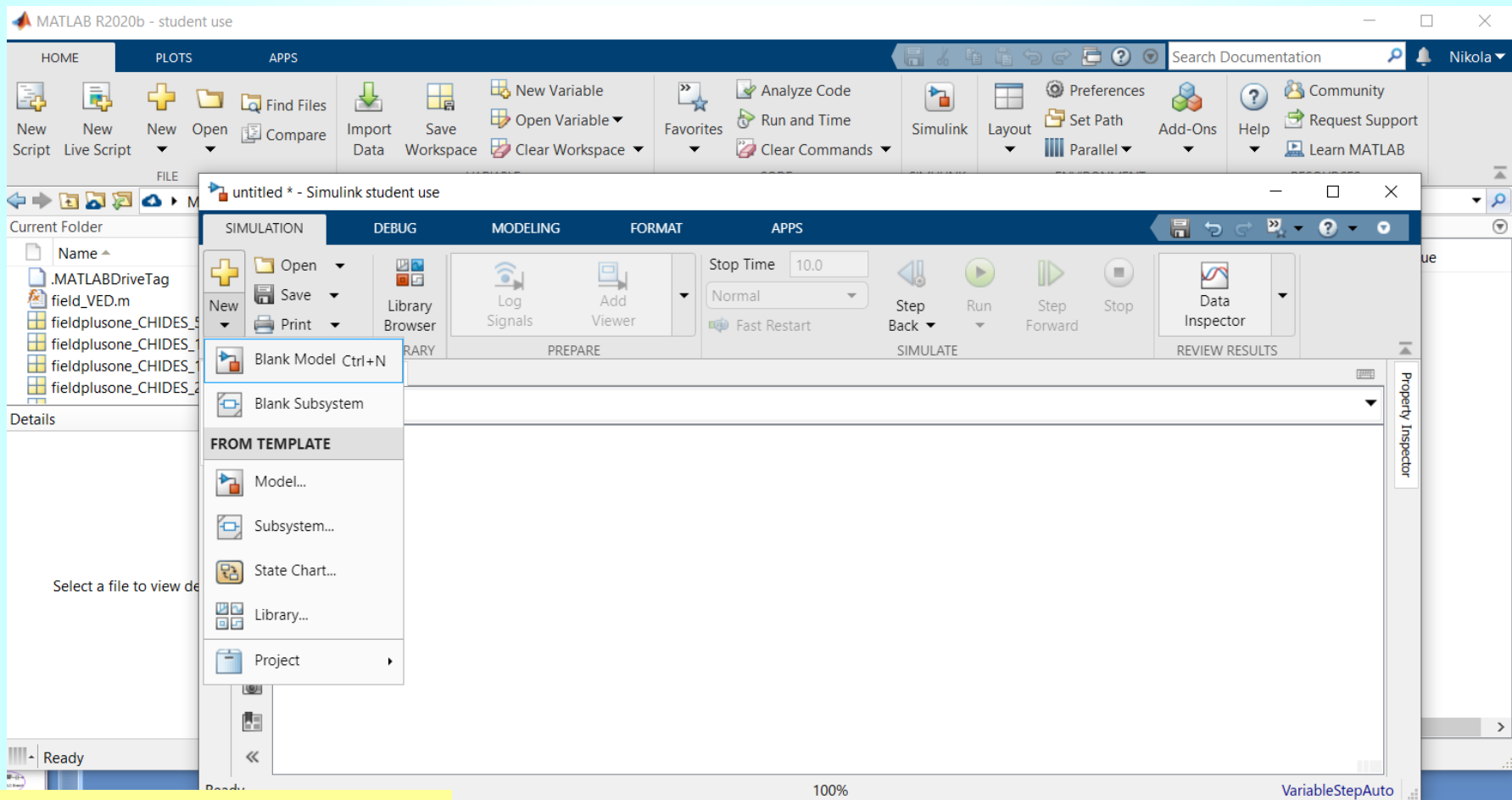
Simulink > Simscape > Electrical

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

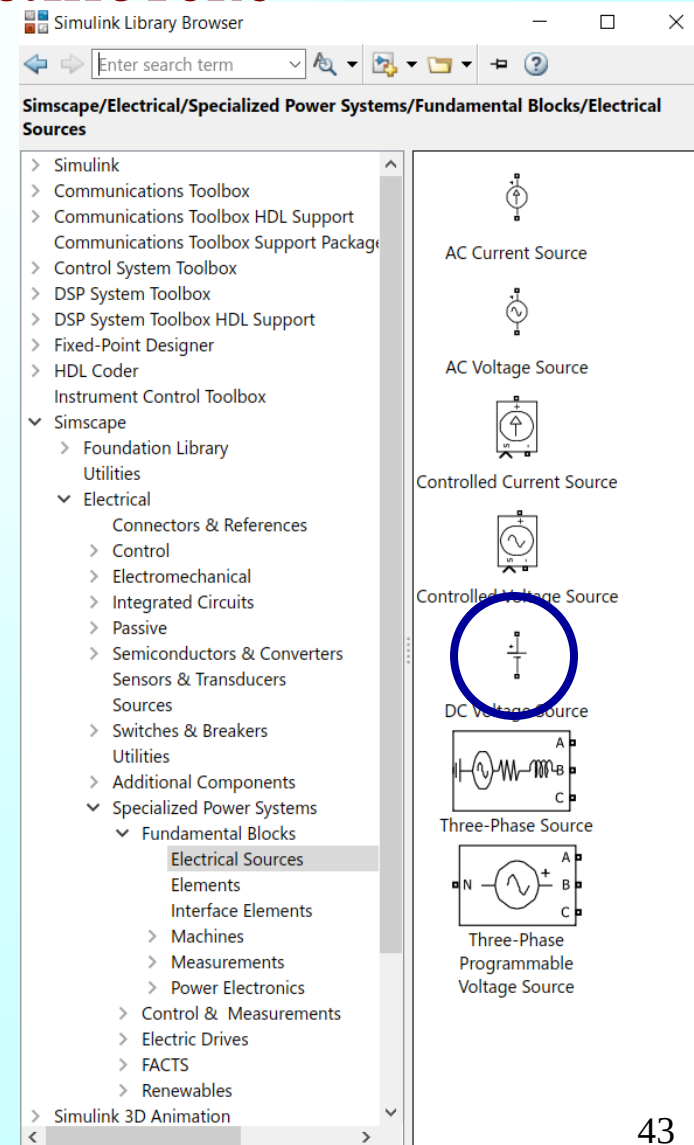
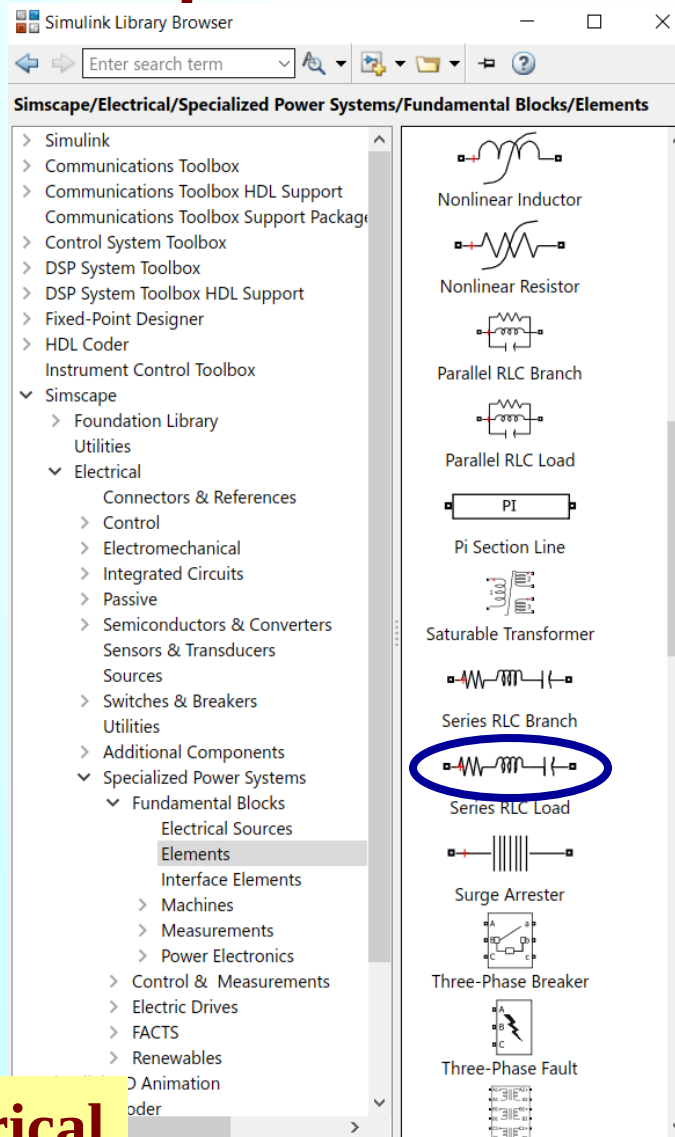


Simscape > Electrical

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

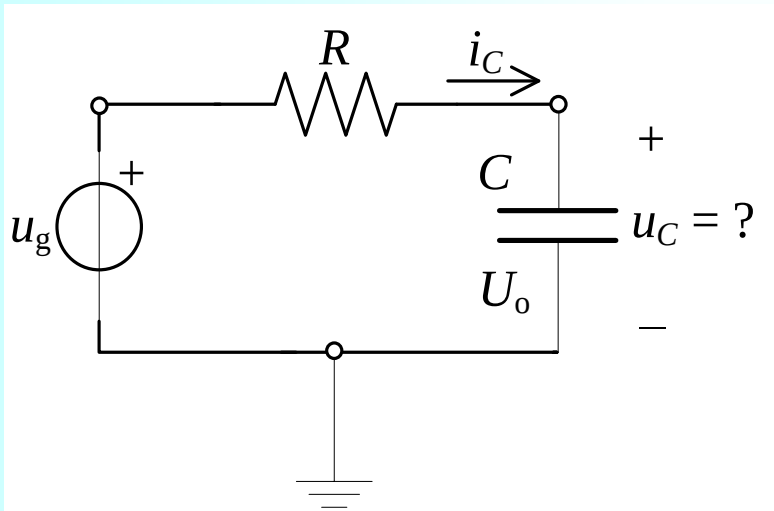


Симулација електричног кола коришћењем **Simscape>Electrical** библиотеке



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

коло је образовано у тренутку $t_0 = 0$

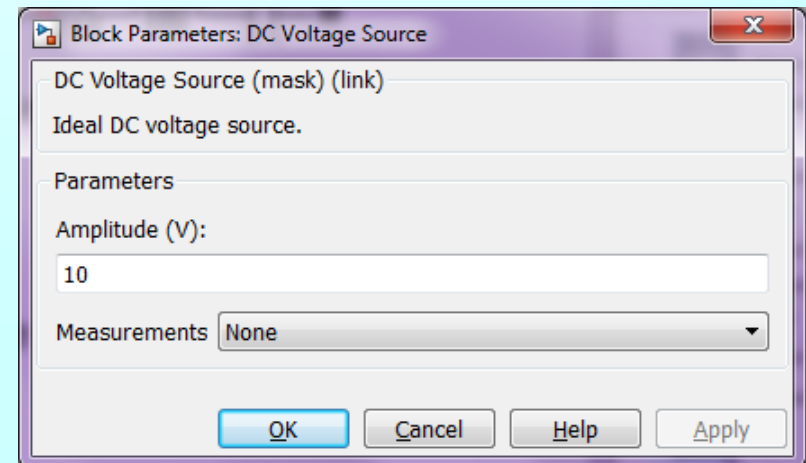
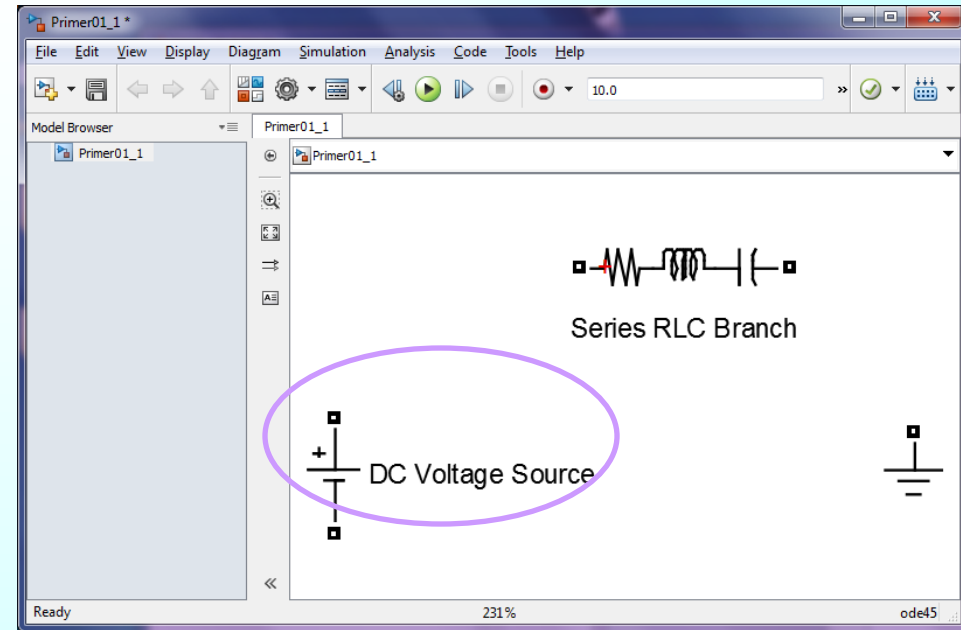


$$R = 1\text{ k}\Omega$$

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

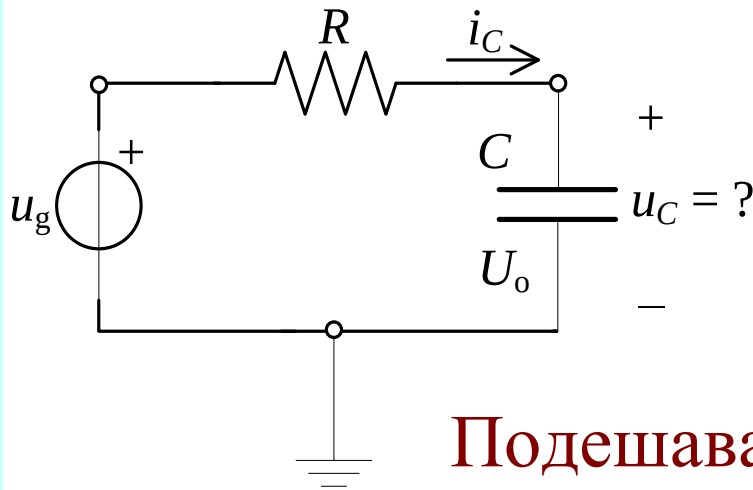
$$u_g(t) = U h(t), U = 10\text{ V}$$

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



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

коло је образовано у тренутку $t_0 = 0$



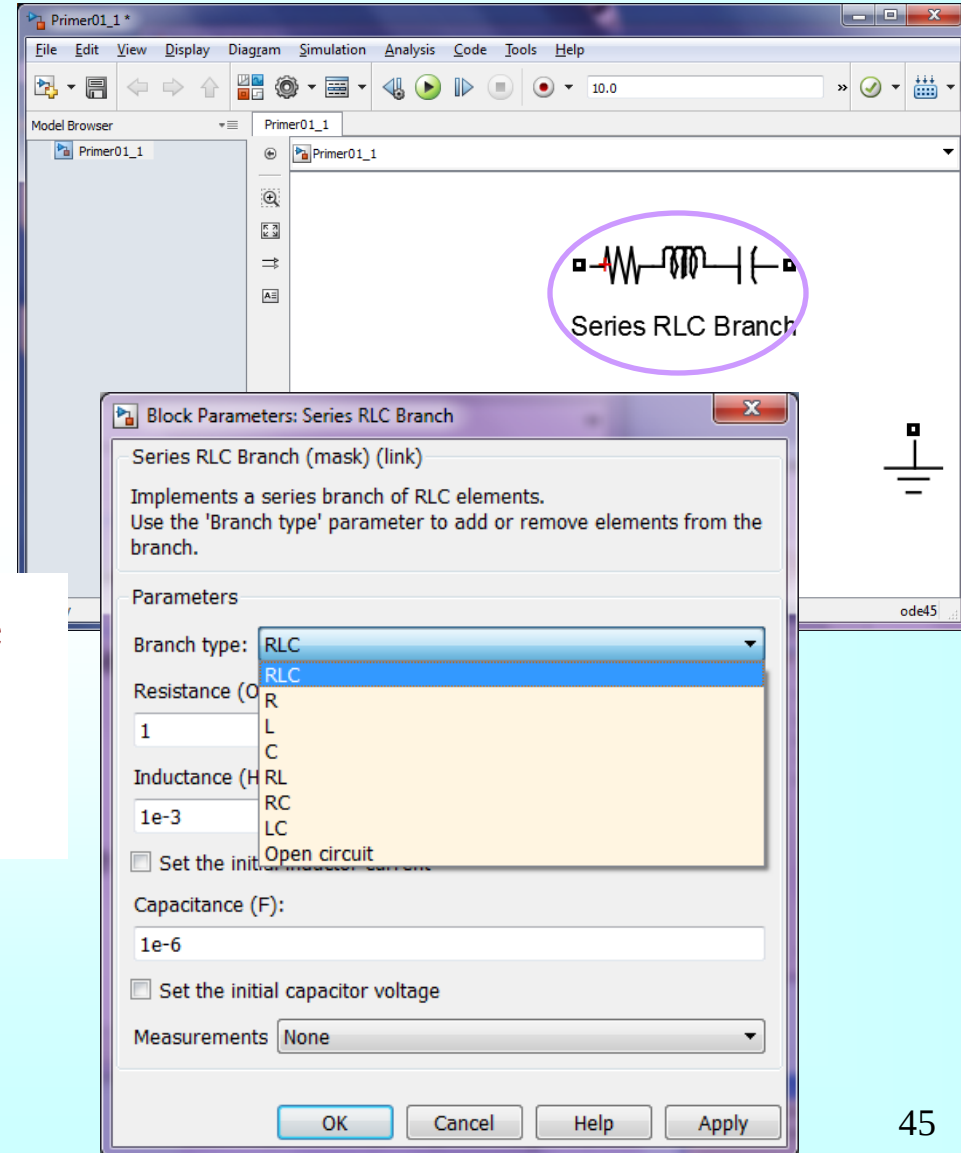
$$R = 1\text{k}\Omega$$

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

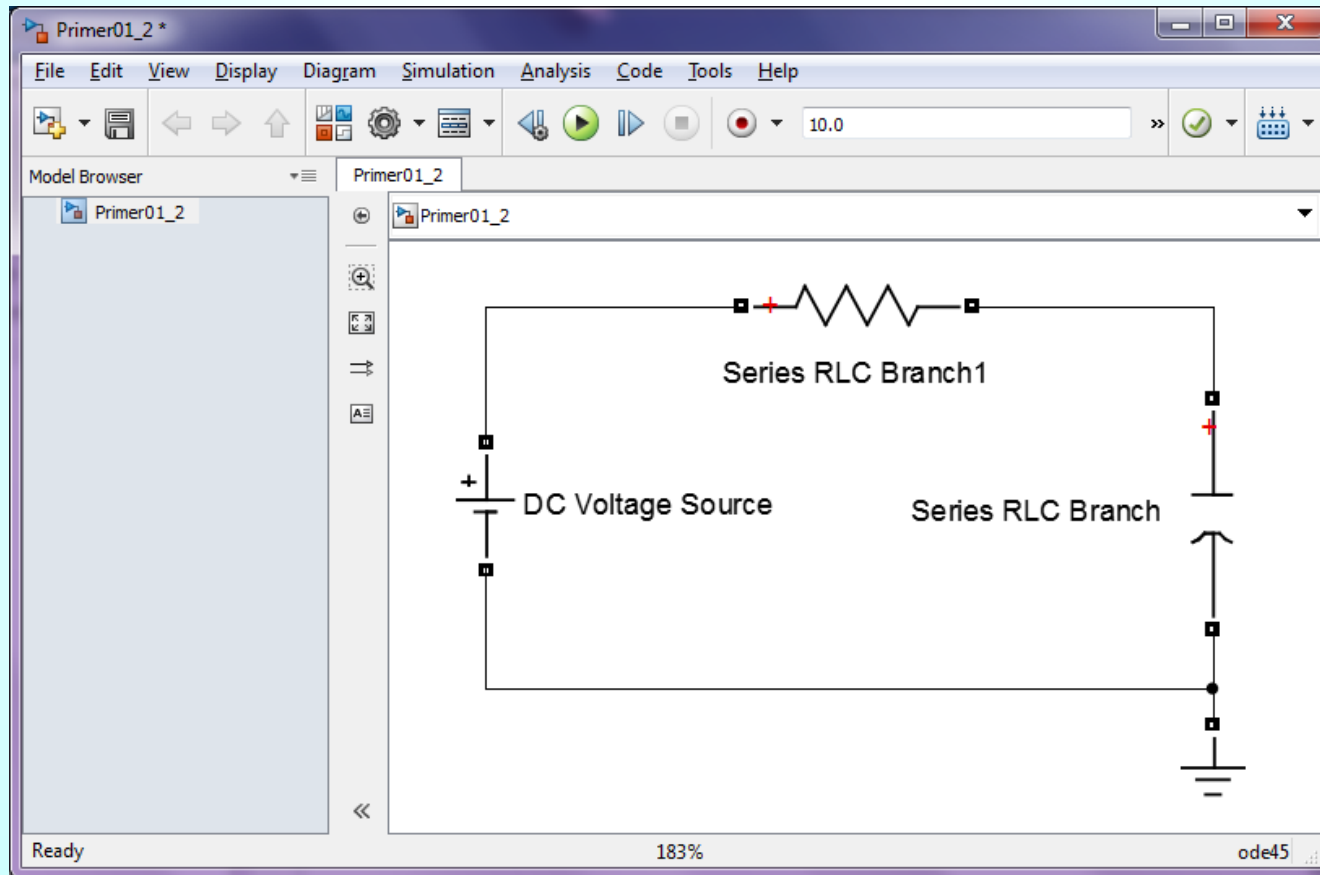
$$u_g(t) = U h(t), U = 10\text{ V}$$

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

Подешавање
параметара
симулације

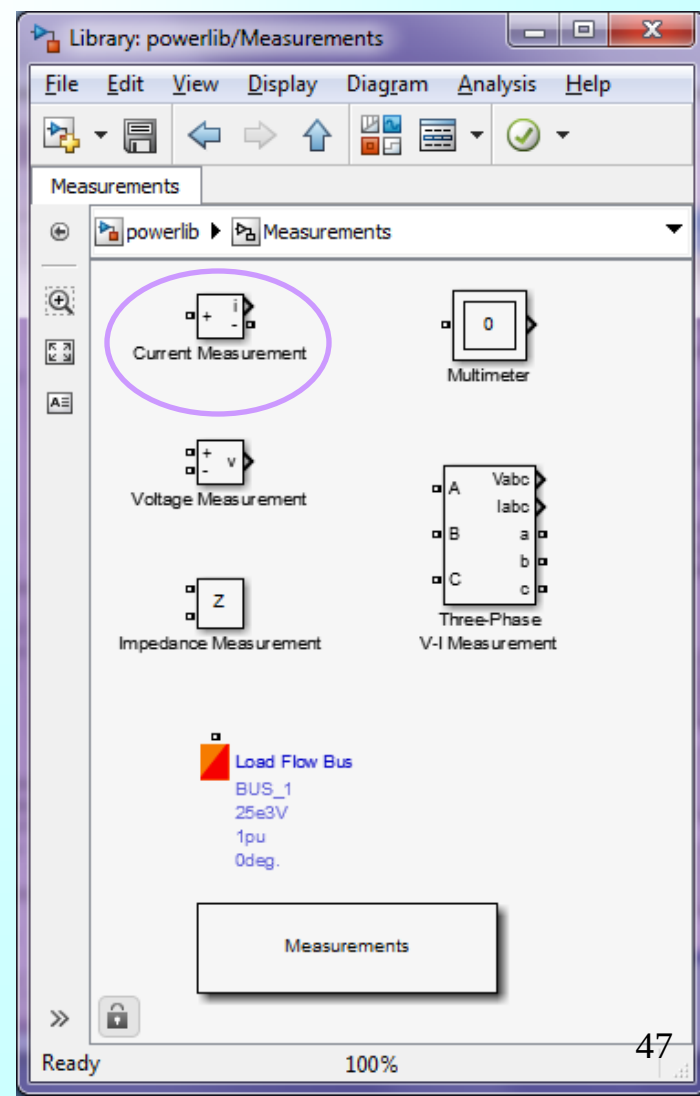
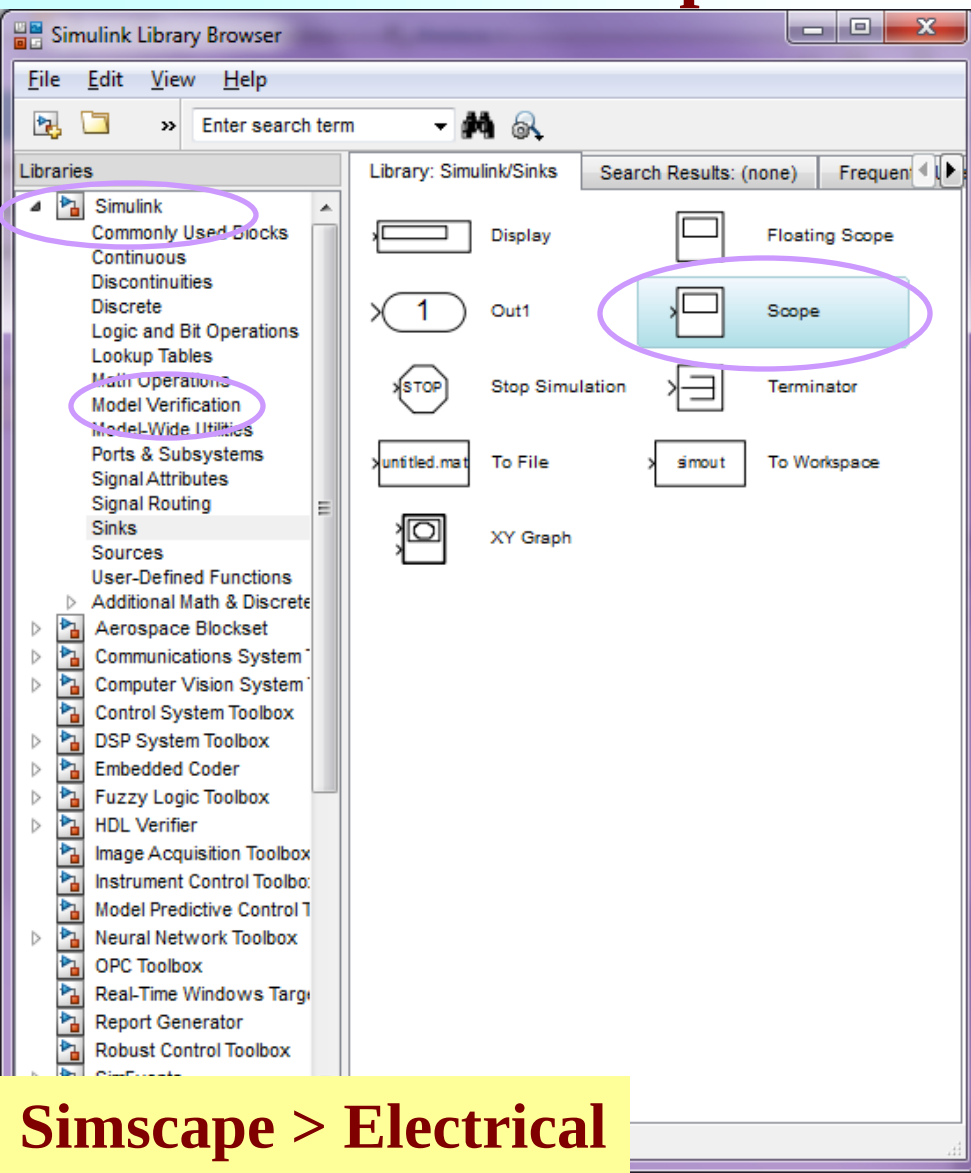


Симулација електричног кола коришћењем **Simscape>Electrical** библиотеке



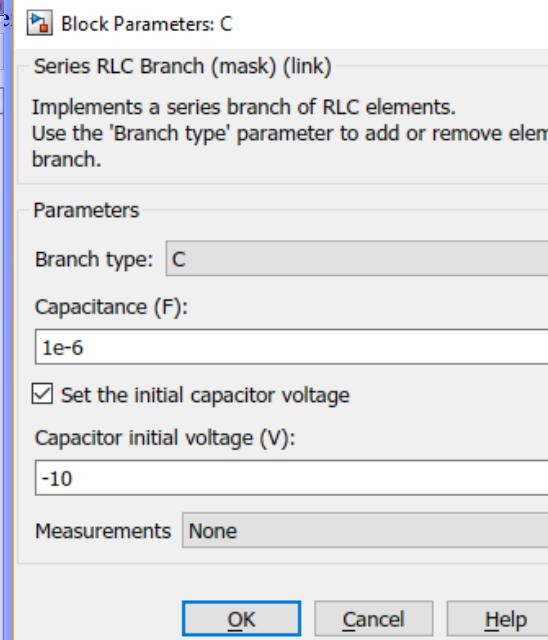
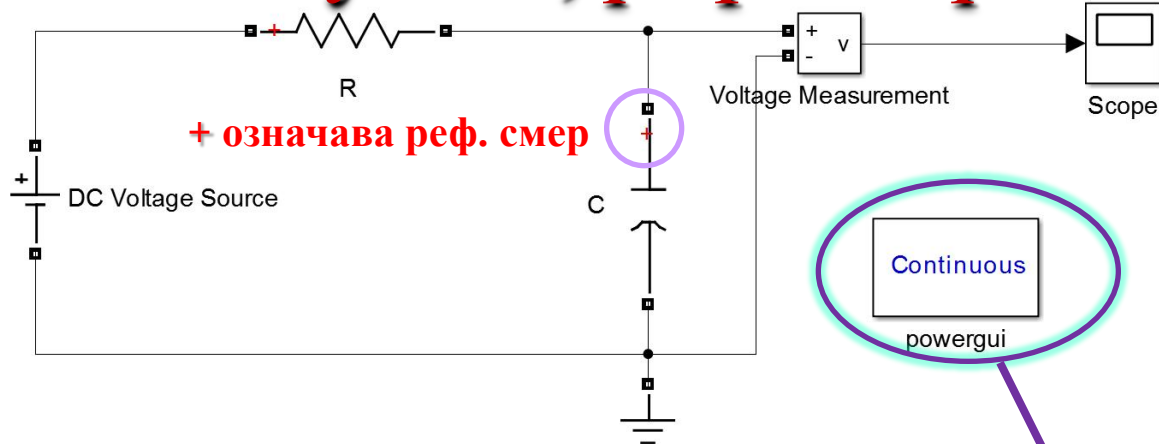
Како се мери напон?

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



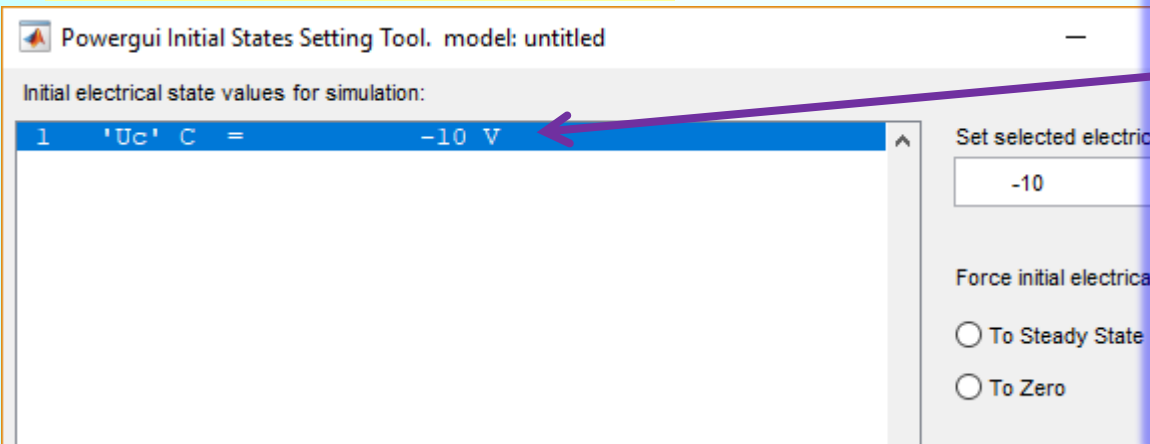
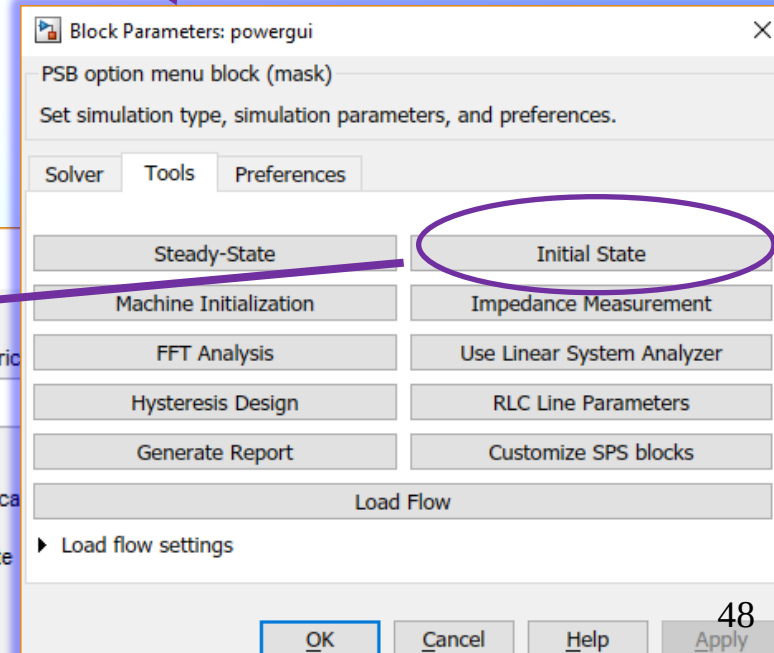
Почетни услов, реф. смер...

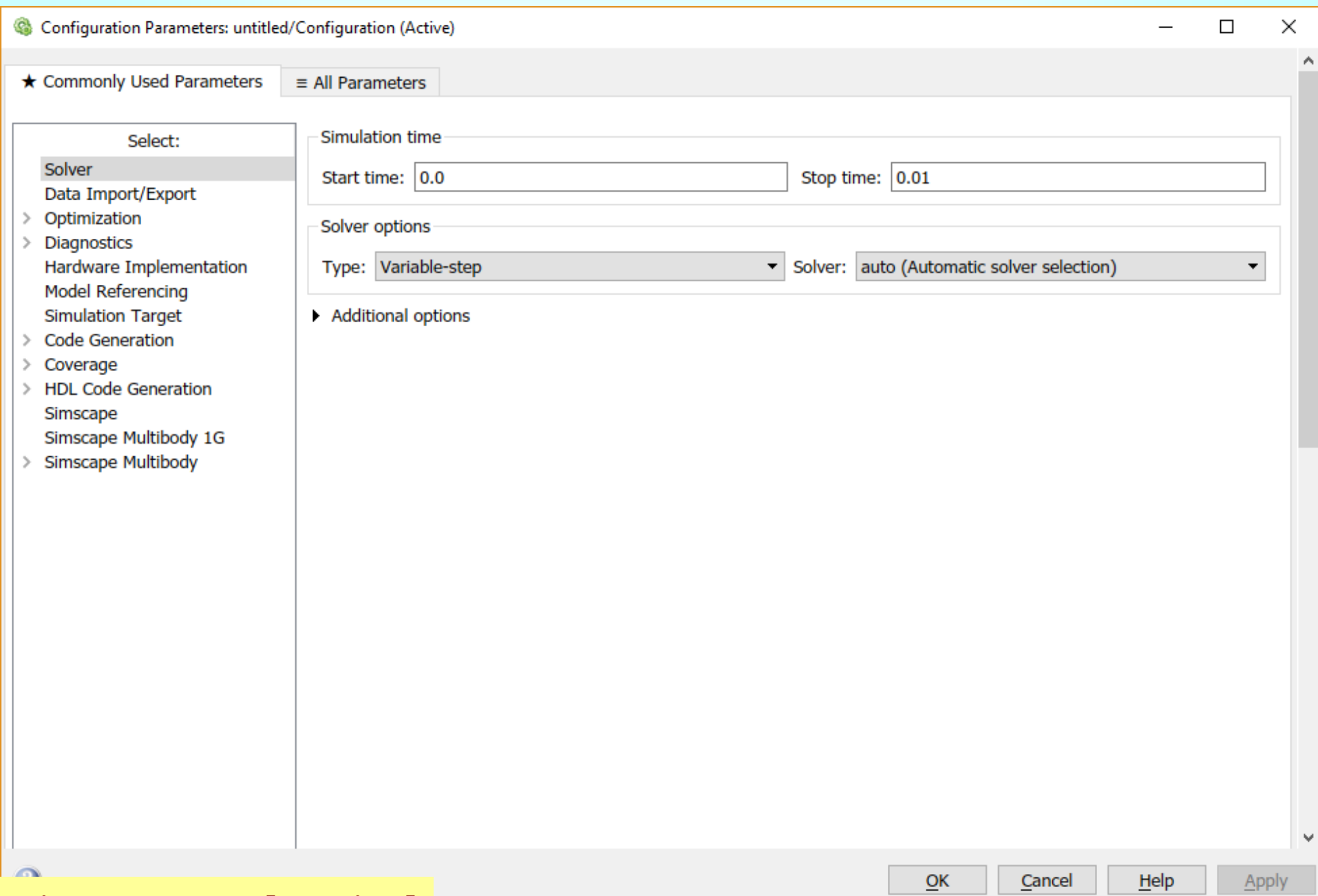
+ означава реф. смер



Плоче кондензатора се разликују!!!

Simscape > Electrical





Configuration Parameters: untitled/Configuration (Active)

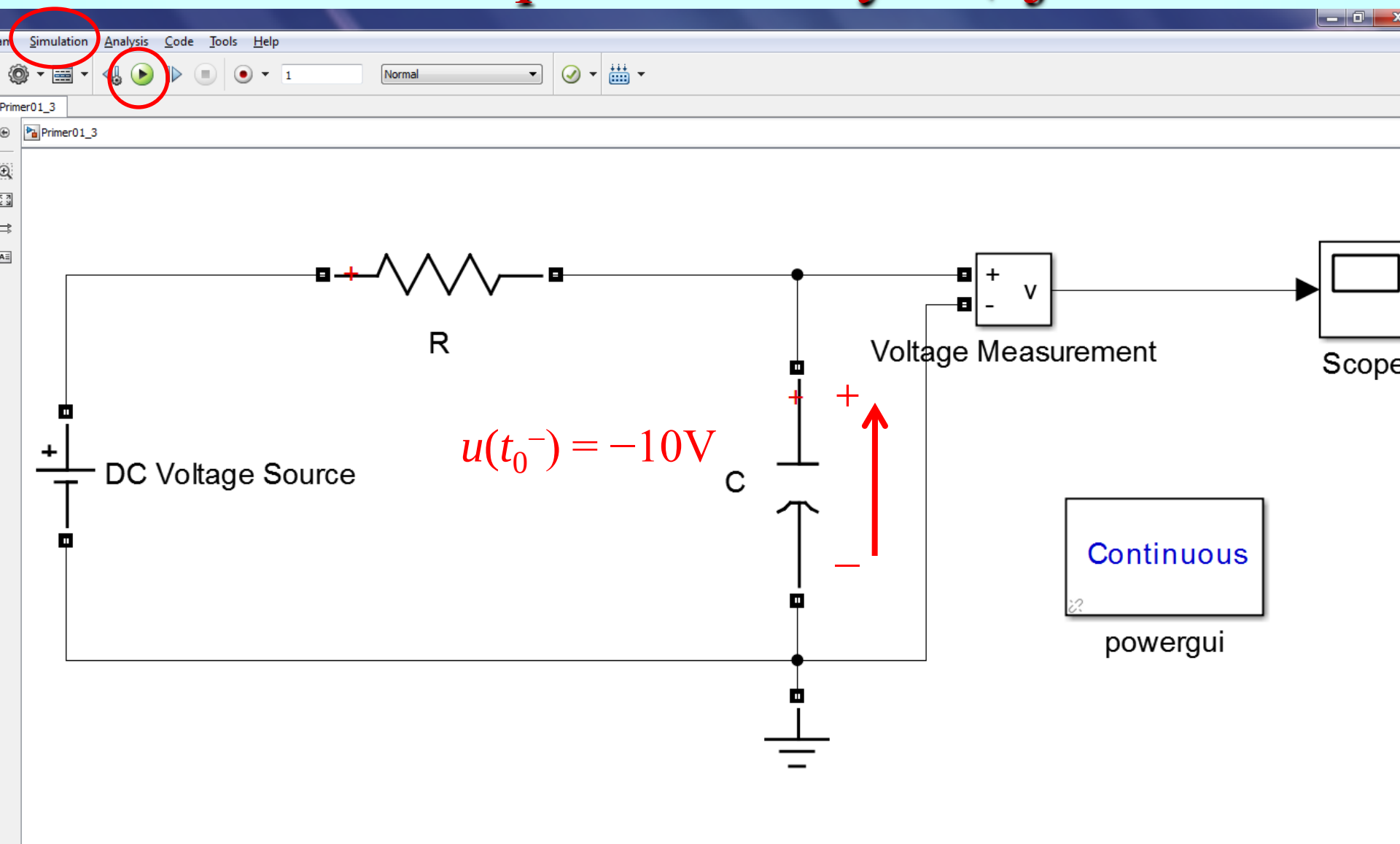
★ Commonly Used Parameters ≡ All Parameters

Category:

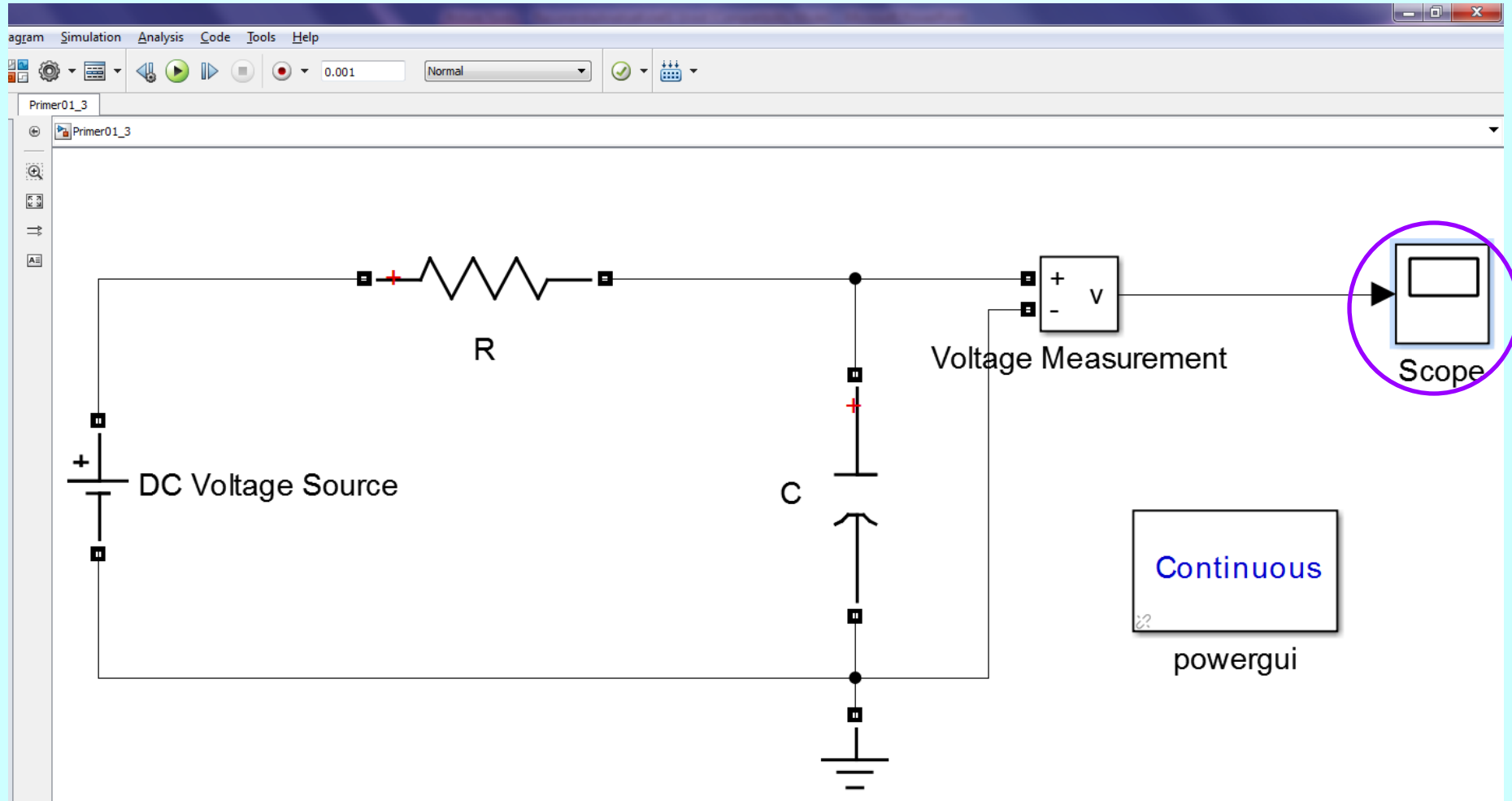
Parameter	Value	Command-Line Name
Solver ▶ Simulation time		
Start time Simulation start time. Note that the values that you specify as block i...	0.0	StartTime
Stop time Simulation stop time.	0.01	StopTime
Solver ▶ Solver options		
Type Choose a variable or fixed-step solver.	Variable-step	SolverType
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

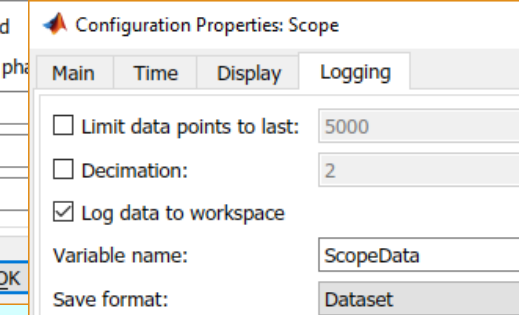
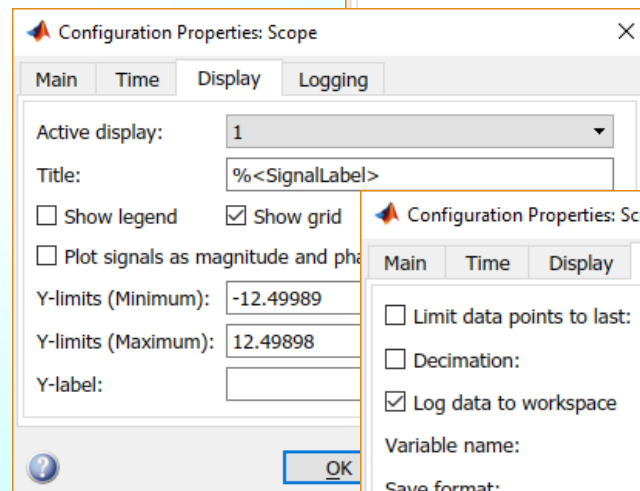
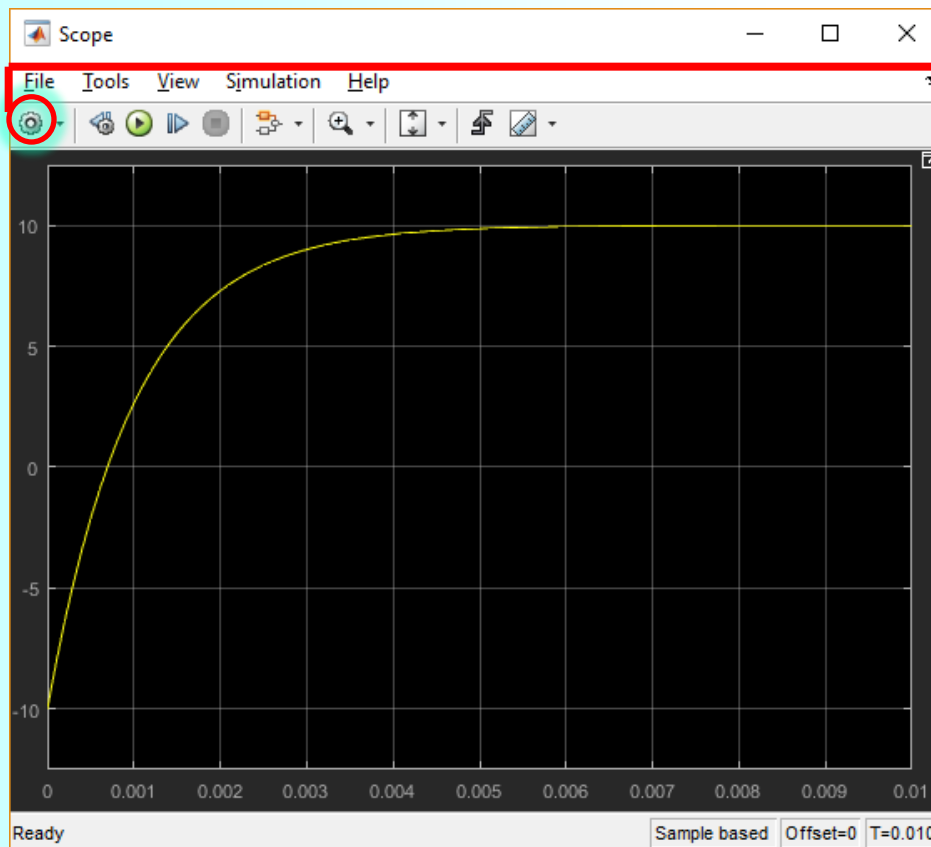
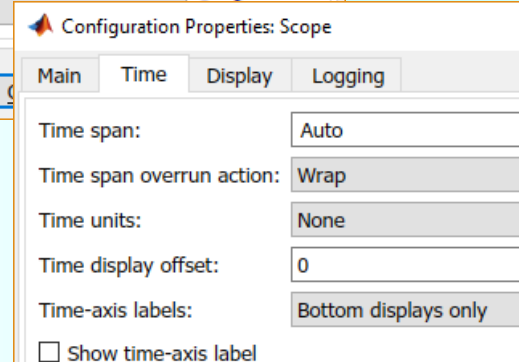
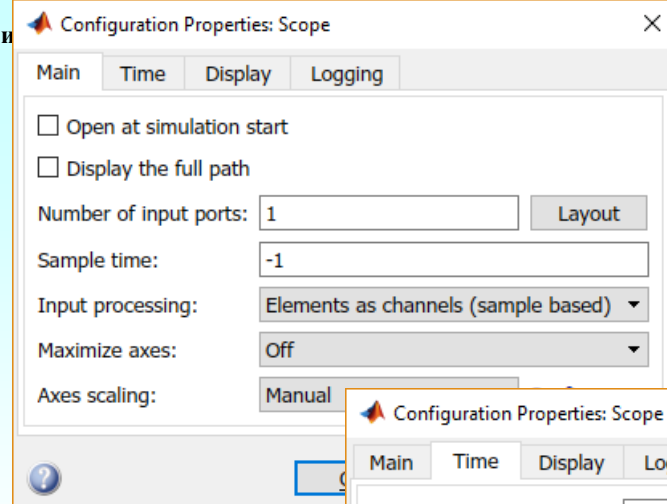
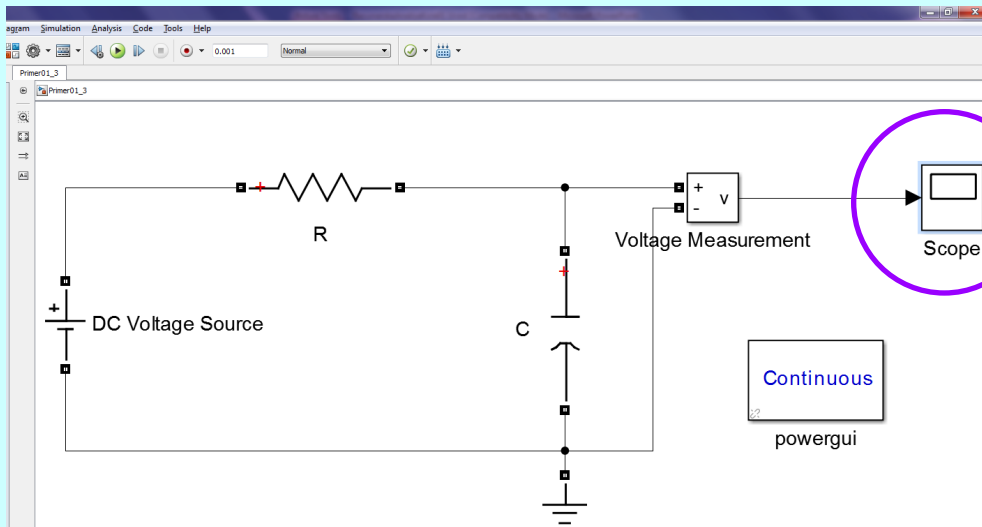
OK Cancel Help Apply

Покретање симулације...



Налажење одзива... Осцилоскоп





Simscape > Electrical

Configuration Parameters: untitled/Configuration (Active)

★ Commonly Used Parameters ≡ All Parameters

Category: All

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

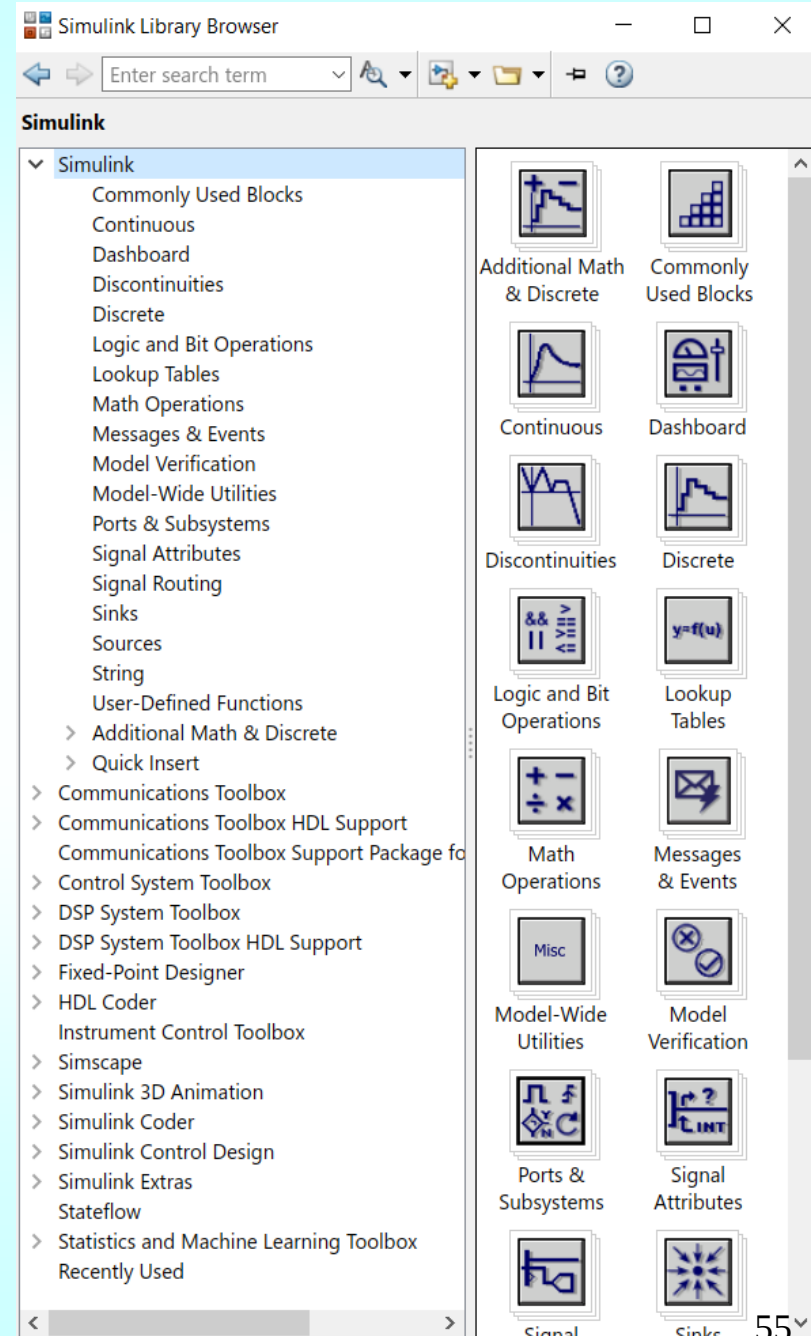
$\tau = RC = 1\text{ms}$

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

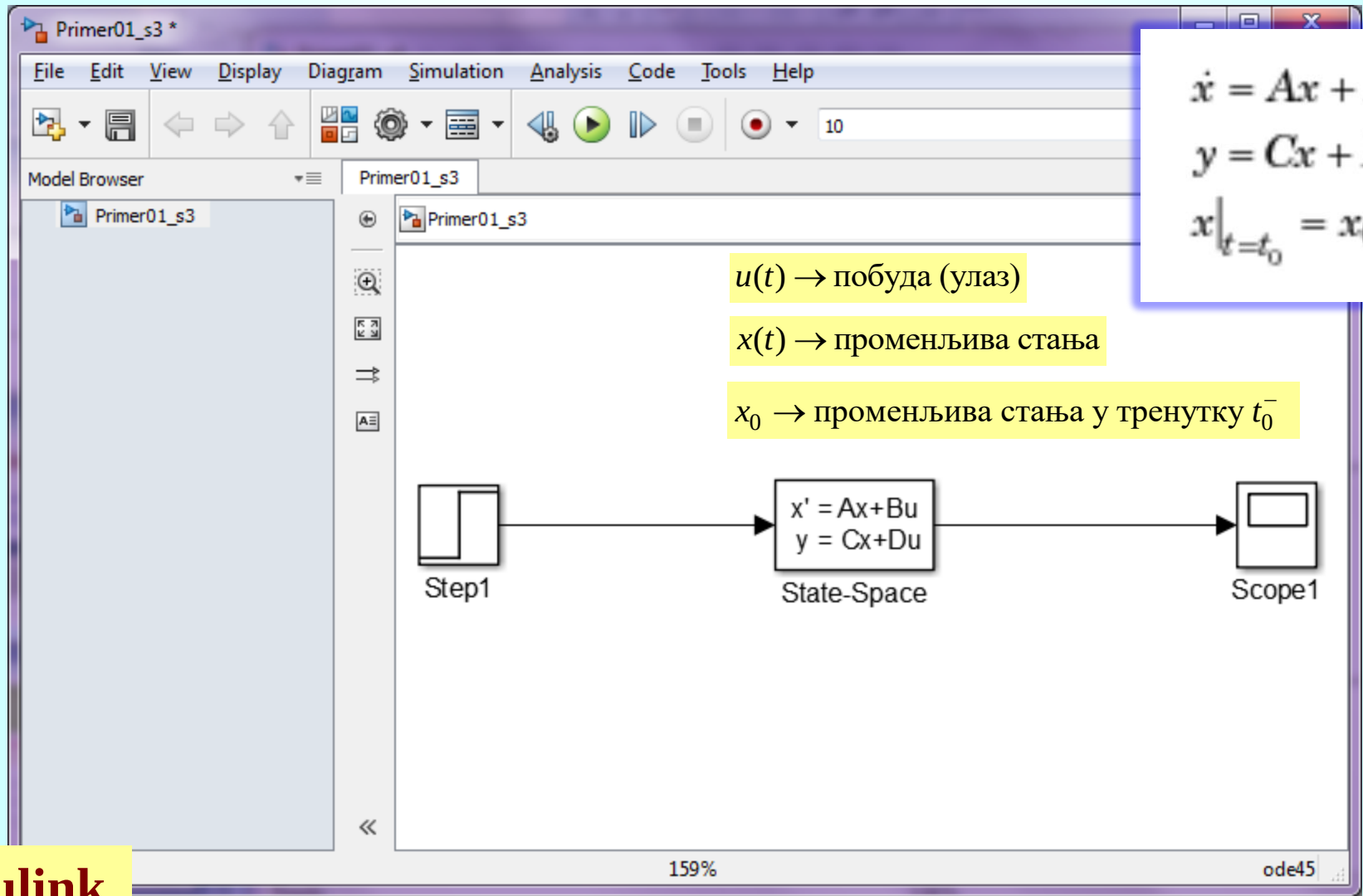
OK Cancel Help Apply

Simulink

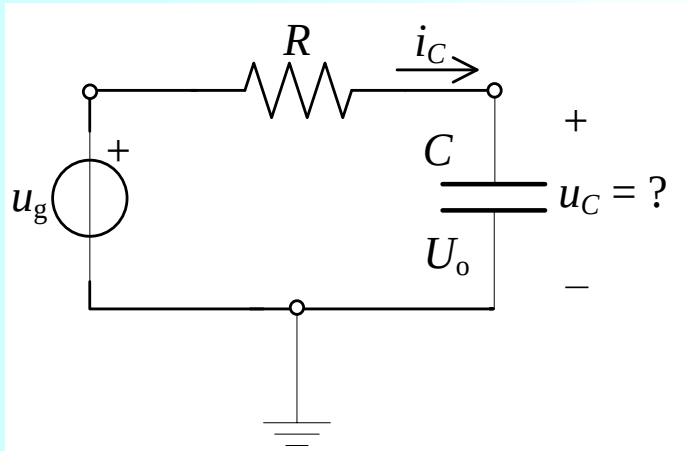
- Решавање кола може се извршити његовим свођењем на систем линеарних диференцијалних једначина
- Дати систем може се представити једноставним блоком са више улаза и излаза



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



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



коло је образовано у тренутку $t_0 = 0$

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

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

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

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

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

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

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

$$u_g(t) = R i_C + u_C(t)$$

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

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

$$\begin{aligned} \dot{x} &= Ax + Bu \\ y &= Cx + Du \\ x|_{t=t_0} &= x_0, \end{aligned}$$

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

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

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

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

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

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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

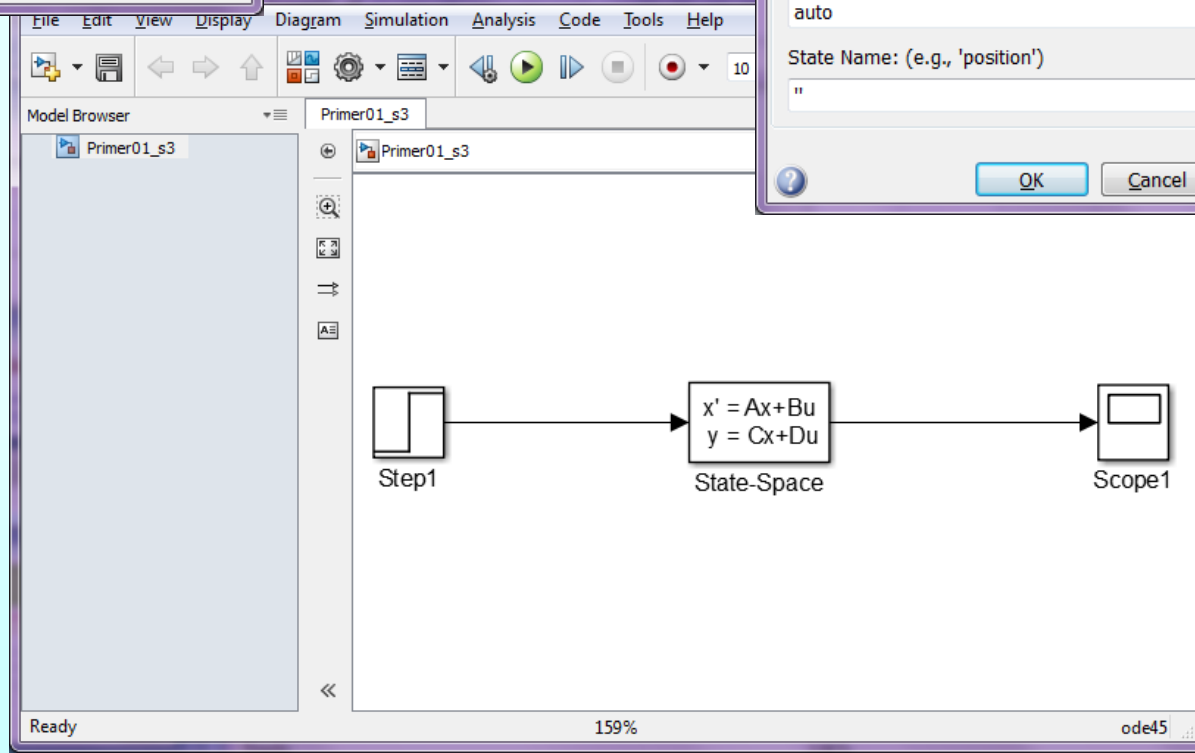
Absolute tolerance:

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

Баста, доцент, 19Е032ПРТК, Универзитет у И

Симулација електричног кола као уопштеног система коришћењем Simulink-а

Source Block Parameters: Step1

Step

Output a step.

Parameters

Step time:
0

Initial value:
0

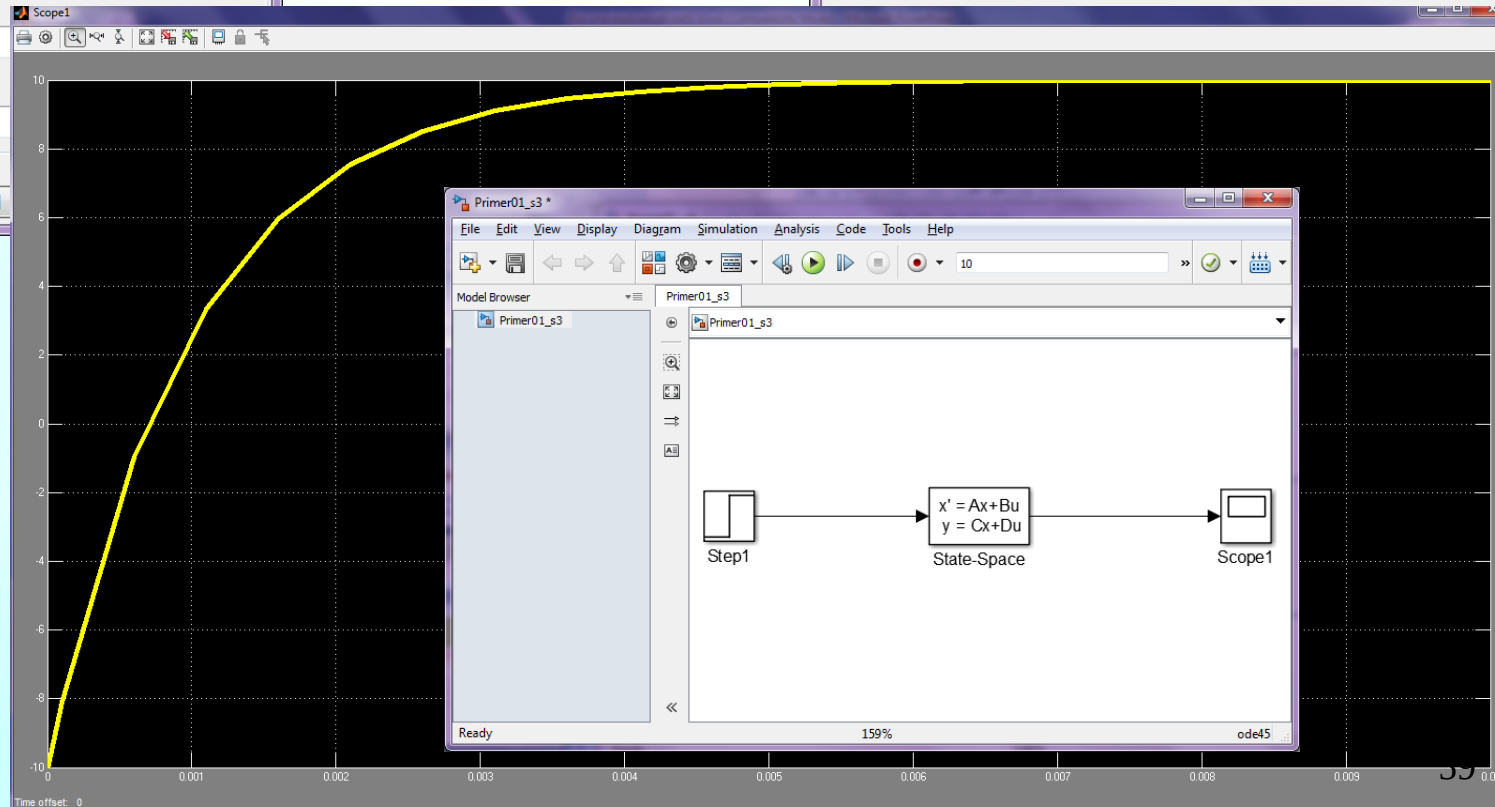
Final value:
10

Sample time:
0

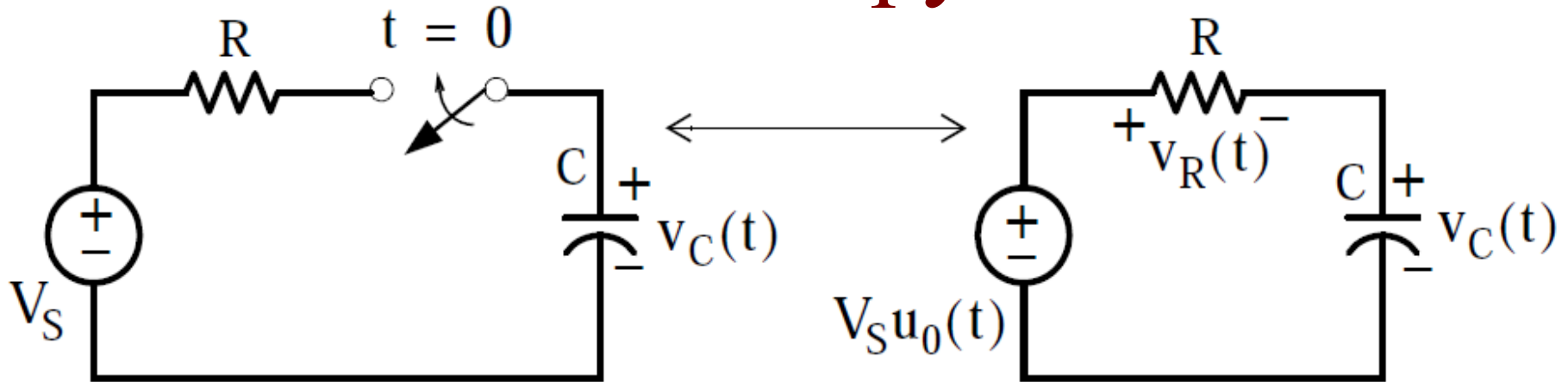
☒ Interpret vector parameters as 1-D

☒ Enable zero-crossing detection

Simulink



Решимо “ручно”



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

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

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

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

$$t > 0$$

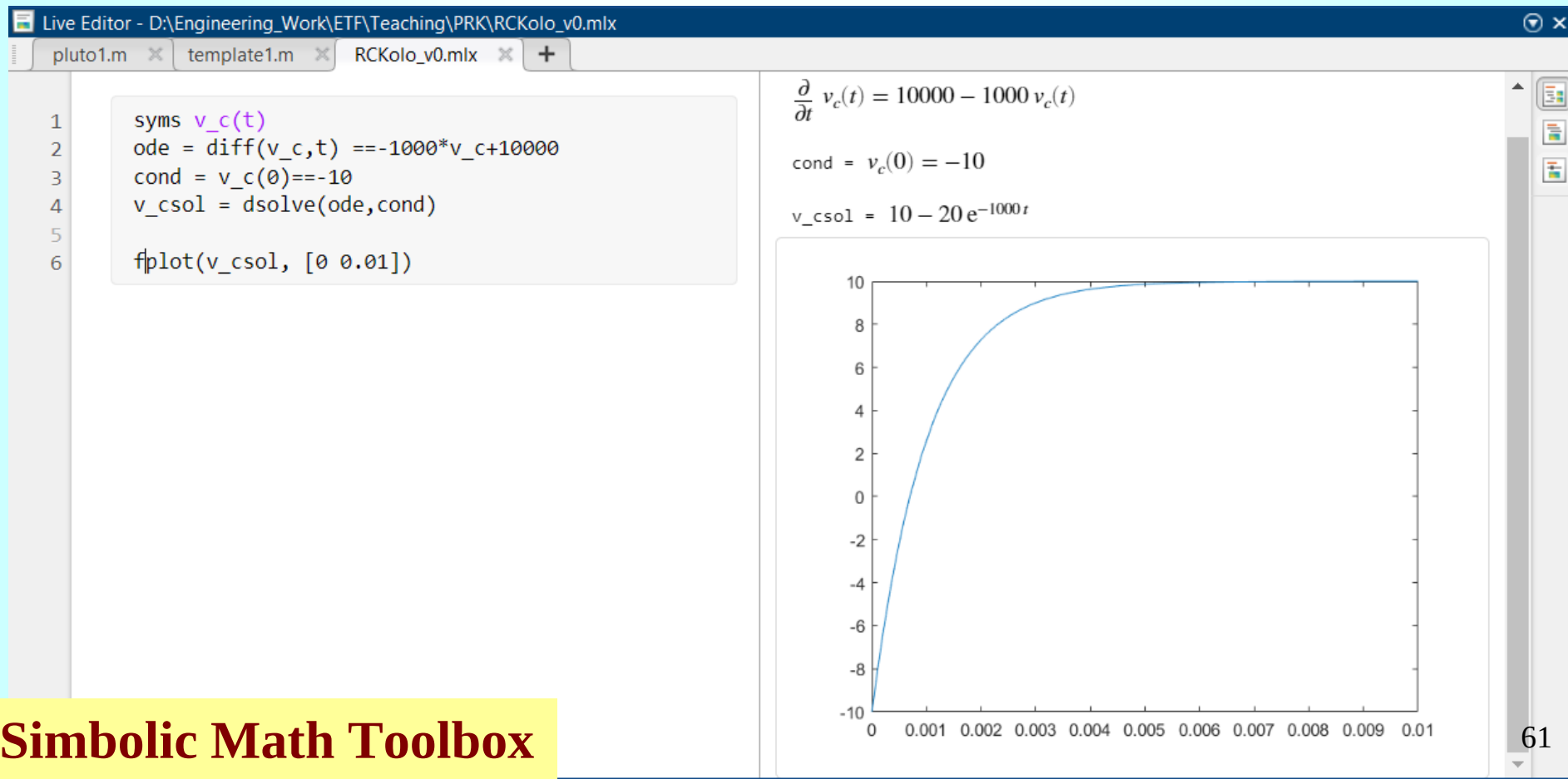
$$RC \frac{dv_C}{dt} + v_C = V_S$$

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

MATLAB

Symbolic Math Toolbox (Live Script)

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



wxMaxima

wxMaxima 20.06.6 [unsaved*]

File Edit View Cell Maxima Equations Algebra Calculus Simplify List Plot Numeric Help

Maths

Mathematical Symbols

Plot using Draw

2D	3D
Expression	Implicit Plot
Parametric Plot	Points
Diagram title	Axis
Contour	Plot name
Line color	Fill color
Grid	Accuracy

```
(%i1) jednachine: [ug=R·iC+uC, iC=C·'diff(uC,t)];
(%o1) [ug=uC+R iC, iC=C (d/dt uC)]

(%i2) jednachineDuC: jednachine, 'diff(uC,t)=DuC;
(%o2) [ug=uC+R iC, iC=C DuC]

(%i3) JednachineIzvoda: eliminate(jednachineDuC,
[iC]);
(%o3) [-ug+uC+C DuC R]

(%i4) jednachineStanja: linsolve(JednachineIzvoda, DuC);
(%o4) [DuC=(ug-uC)/(C R)]

(%i5) jednachineDiff: jednachineStanja, DuC='diff(uC, t);
(%o5) [d/dt uC=(ug-uC)/(C R)]
```

```
(%i6) zamene: [ug=U];
(%o6) [ug=U]

(%i7) vrednosti: [R=1000, C=10^(-6), U=10, U0=-10];
(%o7) [R=1000, C= $\frac{1}{1000000}$ , U=10, U0=-10]

(%i8) JednacineDiffZamena: jednacineDiff, zamene;
(%o8) [ $\frac{d}{dt} uC = \frac{U - uC}{C R}$ ]

(%i9) ode2(JednacineDiffZamena, uC, t);

(%o9)  $uC = e^{-\frac{t}{C R}} \left( U e^{\frac{t}{C R}} + c \right)$ 

(%i10) ic1(% , t=0, uC=U0);
(%o10)  $uC = e^{-\frac{t}{C R}} \left( U e^{\frac{t}{C R}} + U0 - U \right)$ 

(%i11) uCt: ev(% , vrednosti);
(%o11)  $uC = e^{-1000 t} \left( 10 e^{1000 t} - 20 \right)$ 

(%i17) wxplot2d(rhs(uCt), [t,0,0.01],
[xlabel," t [s] "],
[ylabel," uC [V] "],
[xtics, 0, 0.002, 0.01],
[legend, "Napon kondenzatora"], grid2d)$
```

