

Опыт использования OpenModelica

Сениченков Ю.Б.

Универсальность

- ▶ ООМ
- ▶ ООМ + математические модели
- ▶ ООМ + математические модели+ имитационные модели

Универсальные среды

- ▶ Matlab-Simulink, [Matlab \(для студентов\)](#),
- ▶ Maple-Maplesim ([Try MapleSim free for 15 days with no obligation](#))
- ▶ Mathematica-SystemModeler ([Try SystemModeler for Free, free 30-day trial of SystemModeler via download](#))
- ▶ Dymola, [OpenModelica](#)
- ▶ AnyDynamics (professional), [AnyDynamics](#)

Объектно-ориентированное
моделирование

Matlab

<https://www.mssoft.ru/Makers/MathWorks/MATLAB/>

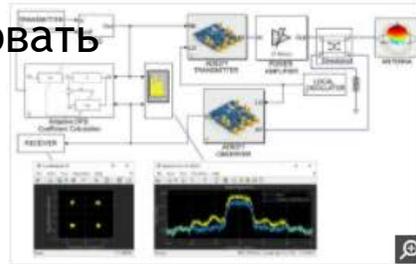
- ▶ MATLAB – это высокоуровневый язык технических расчетов, интерактивная среда разработки алгоритмов и современный инструмент анализа данных.
- ▶ MATLAB по сравнению с традиционными языками программирования (C/C++, Java, Pascal, FORTRAN) позволяет на порядок сократить время решения типовых задач и значительно упрощает разработку новых алгоритмов.
- ▶ Ядро MATLAB позволяет максимально просто работать с матрицами реальных, комплексных и аналитических типов данных и со структурами данных и таблицами поиска.
- ▶ MATLAB содержит встроенные функции линейной алгебры (LAPACK, BLAS), быстрого преобразования Фурье (FFTW), функции для работы с полиномами, функции базовой статистики и численного решения дифференциальных уравнений; расширенные математические библиотеки для Intel MKL.

Matlab - Simulink

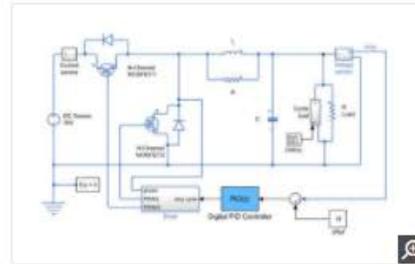


Simulink is for Every Project

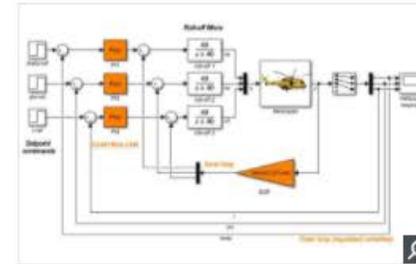
Кубики можно
ТОЛЬКО
ИСПОЛЬЗОВАТЬ



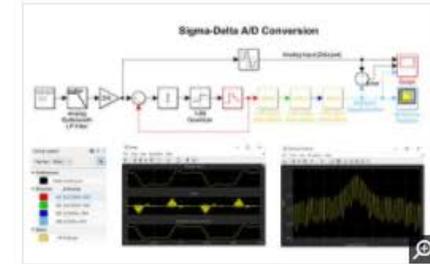
Wireless Communications



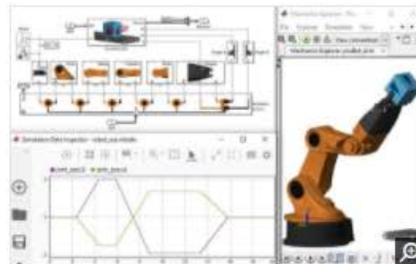
Power Electronics



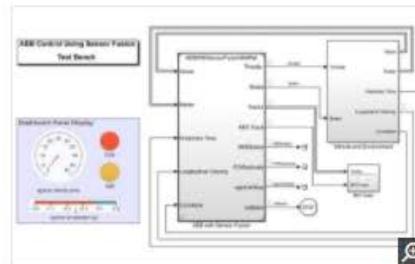
Control Systems



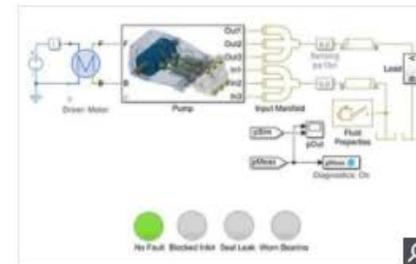
Signal Processing



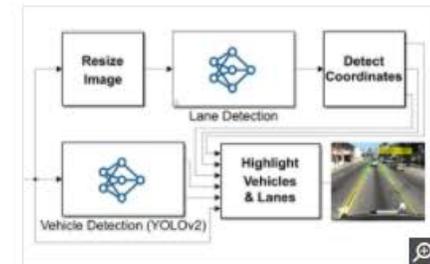
Autonomous Systems and Robotics



Advanced Driver Assistance Systems



Digital Twins

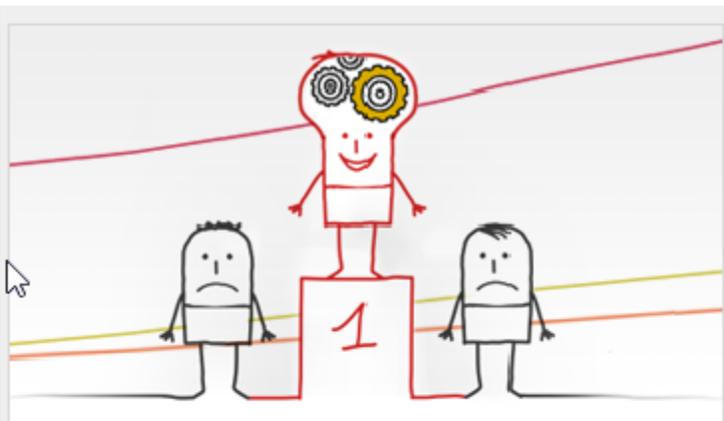


Artificial Intelligence



WOLFRAM SYSTEM MODELER

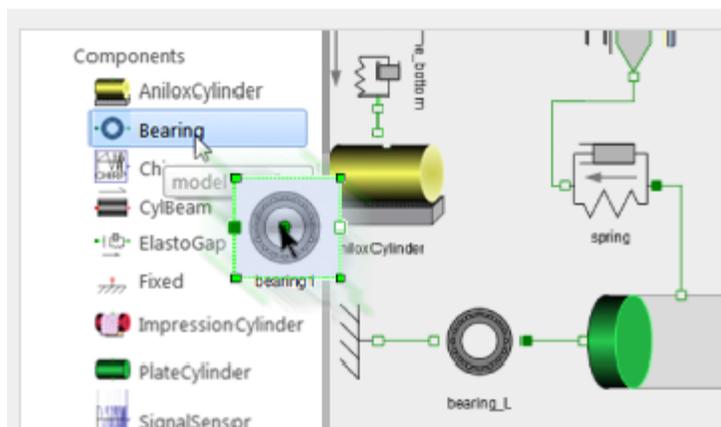
Движущая сила к пониманию, инновациям и результатам



Сравнение SystemModeler

Узнайте о преимуществах SystemModeler по сравнению с конкурентами.

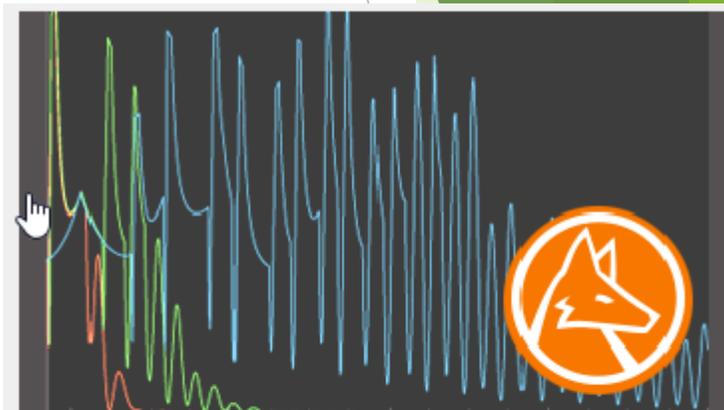
Wolfram SystemModeler является наиболее полной средой для моделирования физических систем. В отличие от других сред моделирования, SystemModeler не требует для работы установки никаких дополнительных модулей и полностью поддерживает язык Modelica. SystemModeler, также, поддерживает работу с языком Wolfram Language для создания единого рабочего цикла моделирования, симуляций и анализа. [Less](#)



Создание моделей

Интуитивно и быстро создавайте модели в SystemModeler, используя drag-and-drop подход. Выбирайте нужные компоненты, например, транзисторы или пружины, и размещайте их внутри рабочей области.

[More](#)



Широкие возможности для анализа

Выполняйте символьные и численные расчеты, работая с уравнениями моделей и результатами симуляций. Используйте всю мощь языка Wolfram Language для анализа моделей. [More](#)

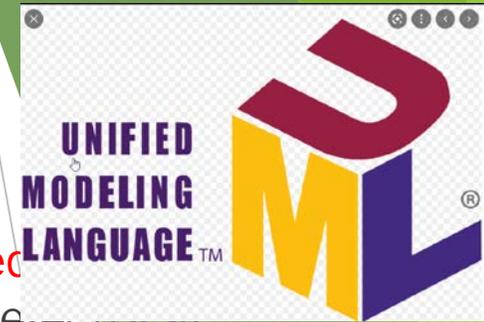
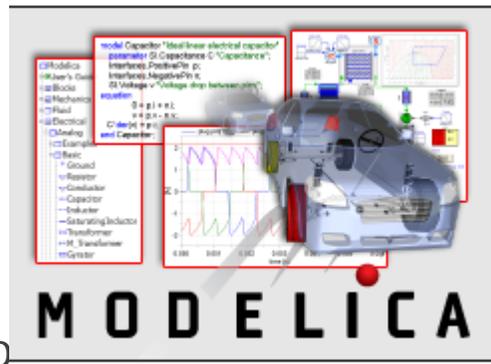
 [Wolfram SystemModeler: начало работы с Mathematica](#)

Что использовать

- ▶ Промышленность - что хотите, лишь бы Вам было хорошо.
- ▶ Образование - то, что позволит научить студента осознанно выбирать нужный инструмент для решения конкретной задачи.
 - ООМ,
 - Математические пакеты и библиотеки,
 - Среды моделирования,
 - В рамках отведенных на это часов
!!!!!!

Что использовать

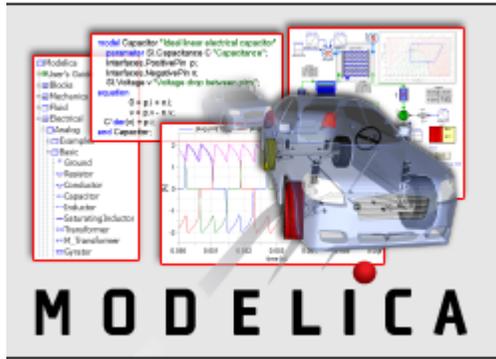
- ▶ Промышленность - что хотите, лишь бы Вам было хорошо.
- ▶ Образование - то, что позволит научить студента осознанно выбирать нужный инструмент для решения конкретной задачи.
 - ООМ,
 - Математические пакеты и библиотеки,
 - Среды моделирования,
 - В рамках отведенных на это часов
!!!!!!



- ▶ The Modelica Language is a non-proprietary, oriented, equation based **conveniently model complex physical systems containing**, e.g., mechanical, electrical, electronic, hydraulic, thermal, control, electric power or process-oriented subcomponents. See also, overview in [pdf](#), [ppt](#) format and [Modelica Language Specification 3.5](#).
- ▶ ~~Modelica Simulation Environments are available [commercially and free of charge](#)~~, such as CATIA Systems, Dymola, JModelica.org, LMS AMESim, MapleSim, Modelon Impact, MWorks, OpenModelica, SimulationX, and Wolfram SystemModeler. Modelica models can be imported conveniently into Simulink using export features of Dymola, MapleSim, and SimulationX.

OpenModelica

Кубики можно не только использовать, но и модифицировать!



Инкапсуляция
Наследование
Полиморфизм
Пакеты

Libraries

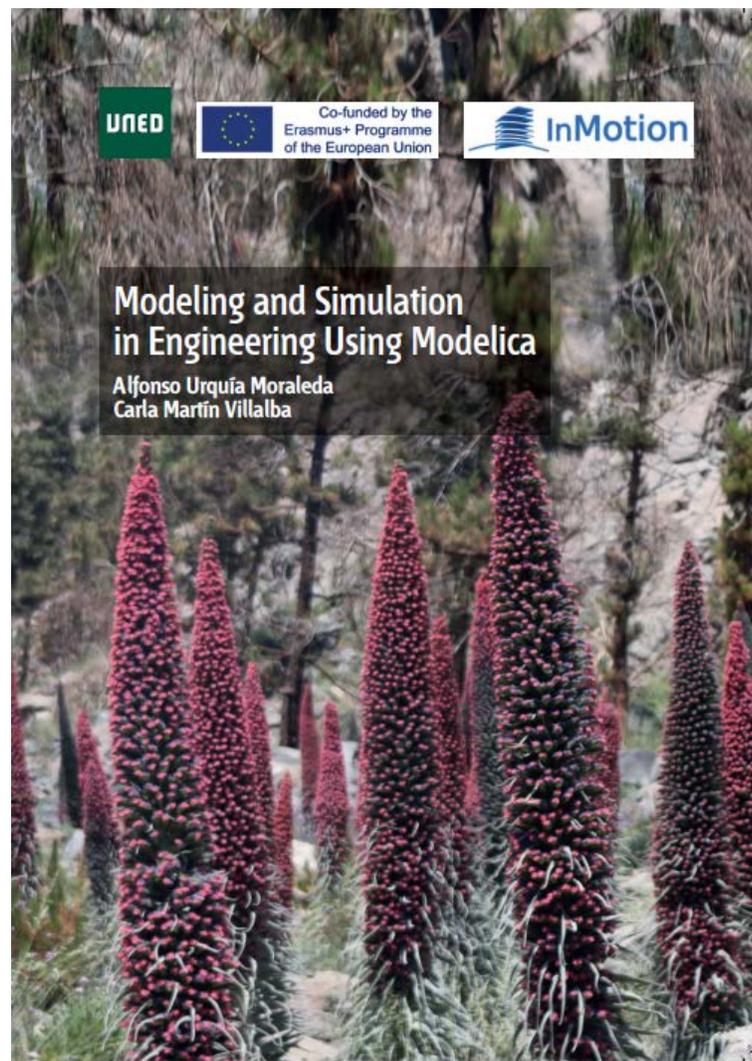
- >  OpenModelica
- >  ModelicaReference
- >  ModelicaServices
- >  Complex
- ✓  Modelica
 - >  UsersGuide
 - >  **Blocks**
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 - >  Clocked
 - >  StateGraph
 - >  Electrical
 - >  Magnetic
 - >  Mechanics
 - >  Fluid
 - >  Media
 - >  Thermal
 - >  Math
 - >  ComplexMath
 - >  Utilities
 - >  Constants
 - >  Icons
 - >  Units

OpenModelica Matlab interface

<https://www.openmodelica.org/doc/OpenModelicaUsersGuide/latest/ommatlab.html>

- ▶ OMMatlab is architected to combine both the solving strategy and model building. So domain experts (people writing the models) and computational engineers (people writing the solver code) can work on one unified tool that is industrially viable for optimization of Modelica models, while offering a flexible platform for algorithm development and research.

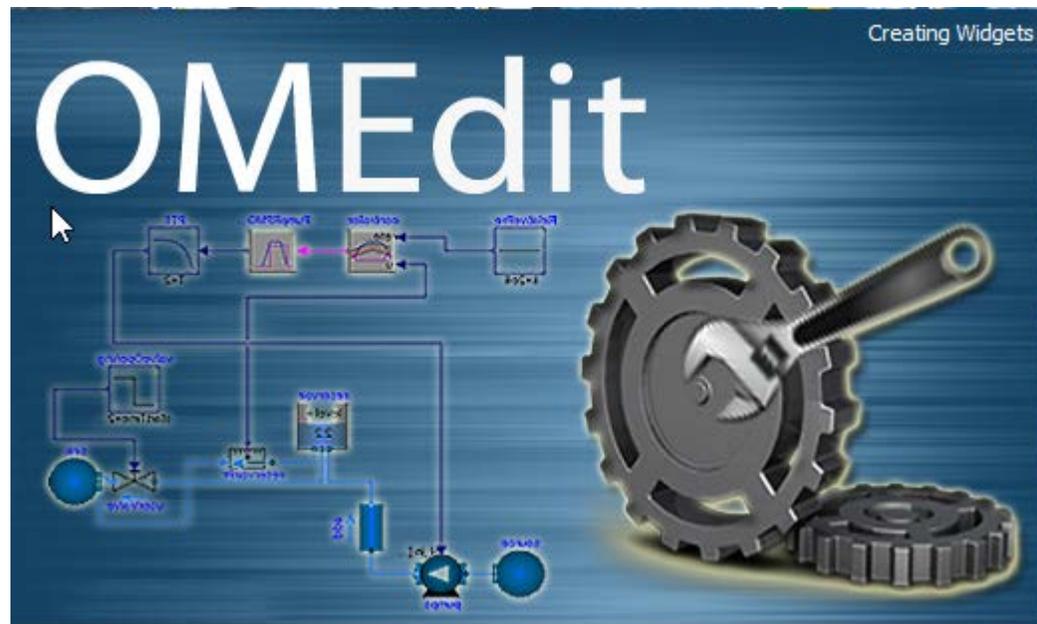
Книги проекта InMotion



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





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 - > Electrical
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 - > Mechanics
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 - > Thermal
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OMEdit - OpenModelica Connection Editor

Recent Files

- C:/Users/senyb/Downloads/ScheglovEditSen.mo
- E:/New folder/hhj.mo
- C:/Users/senyb/Downloads/Lab3D_Base_OOM.mo
- C:/Users/senyb/Downloads/Lab3D_Base_OOM/Lab3D_Ba
- C:/Users/senyb/Modelica_examples/Lect_1.mo
- C:/Users/senyb/Modelica_examples/Switch_RC.mo
- C:/Users/senyb/Downloads/switch.mo
- C:/Users/senyb/Документы/Mod_Modelica/Modelica/sw
- C:/Users/senyb/Документы/Mod_Modelica/Modelica/R
- C:/Users/senyb/Документы/Mod_Modelica/Modelica/RC
- C:/Users/senyb/Документы/Mod_Modelica/Modelica/Dc
- C:/Users/senyb/Документы/Mod_Modelica/Modelica/ev
- C:/Users/senyb/Документы/Mod_Modelica/Modelica/fir

Clear Recent Files

Latest News

- September 4, 2021: OpenModelica 1.18.0 released!
- July 12, 2021: OpenModelica 1.18.0-dev.beta1 released!
- Join the Modelica Conference 2021!
- March 23, 2021: OpenModelica 1.17.0 released!
- February 26, 2021: OpenModelica 1.16.5 released!
- February 22, 2021: OpenModelica 1.16.4 released!
- HUBCAP Open Calls
- December 21, 2020: OpenModelica 1.16.2 released!
- November 17, 2020: OpenModelica 1.16.1 released!
- November 9. An OpenModelica overview article has been published in the MIC J

Reload

For more details visit our website www.openmodelica.org

Create New Modelica Class Open Model/Library File(s)

Documentation Browser



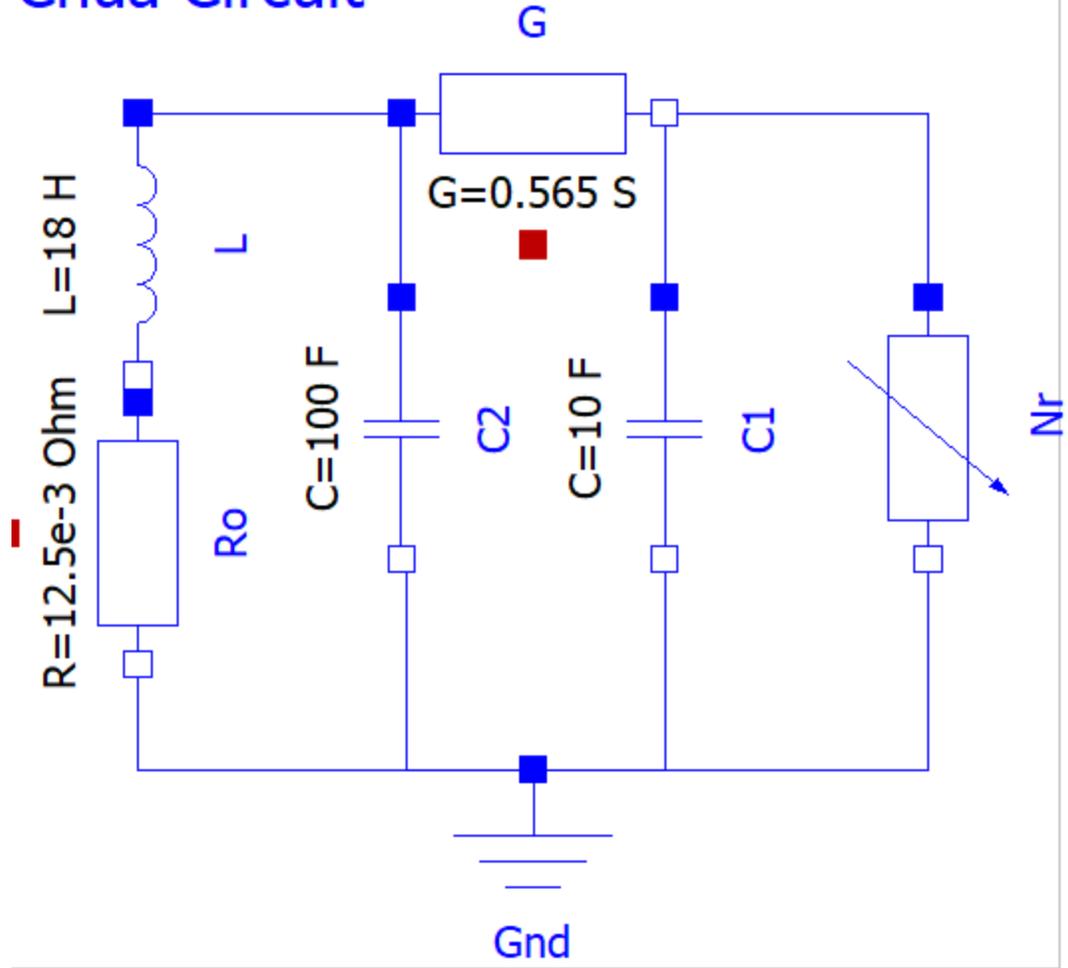
Messages Browser

- All Notifications Warnings Errors
- [1] 16:38:33 Scripting Notification
Automatically loaded package Complex 4.0.0 due to uses annotation.
- [2] 16:38:33 Scripting Notification
Automatically loaded package ModelicaServices 4.0.0 due to uses annotation.

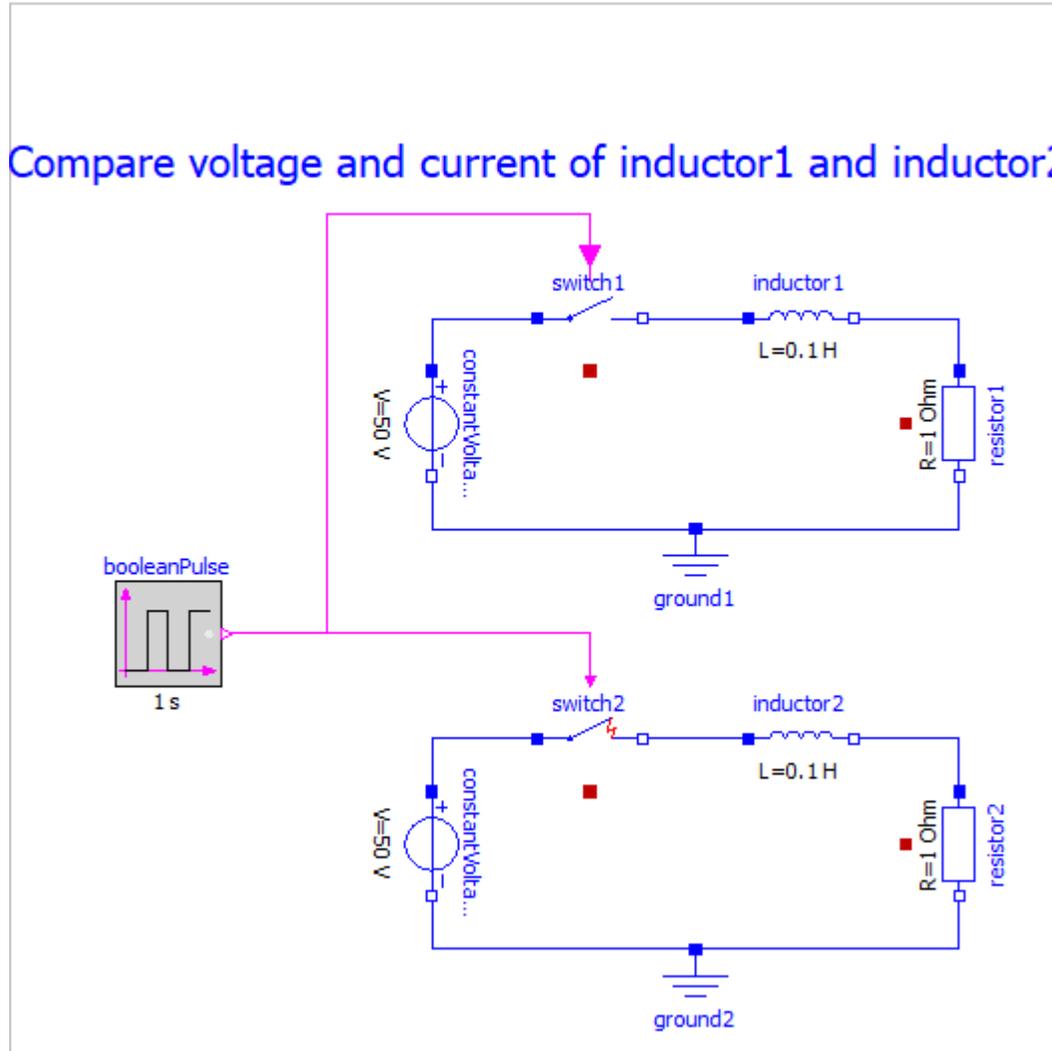
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 - >  Math
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- >  StateGraph

- Electrical
 - Analog
 - Digital
 - Batteries
 - Machines
 - Polyphase
 - PowerConverters
 - QuasiStatic
 - Spice3

Chua Circuit



Compare voltage and current of inductor1 and inductor2



- ▼ **kg** Units
 - > **i** UsersGuide
 - > **SI** SI
 - > **...** NonSI
 - > **→** Conversions
 - > **i** Icons

- ▼ **kg** Units
 - > **i** UsersGuide
 - ▼ **SI** SI
 - T** Angle
 - T** SolidAngle
 - T** Length
 - T** PathLength
 - T** Position
 - T** Distance
 - T** Breadth
 - T** Height
 - T** Thickness
 - T** Radius
 - T** Diameter
 - T** Area
 - T** Volume
 - T** Time
 - T** Duration
 - T** AngularVelocity

File Edit View Simulation Debug SSP Sensitivity Optimization Tools Help

Libraries Browser

Filter Classes

Libraries

- OpenModelica
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 - Examples
 - Continuous
 - Integrator
 - LimIntegrator
 - Derivative
 - FirstOrder
 - SecondOrder
 - PI
 - PID
 - LimPID
 - TransferFunction
 - StateSpace
 - Der
 - LowpassButterworth
 - CriticalDamping
 - Filter

```

351 block FirstOrder "First order transfer function block (=
    1 pole)"
352   import Modelica.Blocks.Types.Init;
353   parameter Real k(unit="1")=1 "Gain";
354   parameter SI.Time T(start=1) "Time Constant";
355   parameter Init initType=Init.NoInit
356 >   "Type of initialization (1: no init, 2: steady
state, 3/4: initial output)" annotation(Evaluate=true,
358   parameter Real y_start=0 "Initial or guess value of
output (= state)"
359   annotation (Dialog(group="Initialization"));
360
361   extends Interfaces.SISO(y(start=y_start));
362
363   initial equation
364     if initType == Init.SteadyState then
365       der(y) = 0;
366     elseif initType == Init.InitialState or initType ==
Init.InitialOutput then
367       y = y_start;
368     end if;
369   equation
370     der(y) = (k*u - y)/T;
371 >   annotation ( ... );
423 end FirstOrder;
424

```

Documentation Browser

Modelica.Blocks.Continuous.FirstOrder

First order transfer function block (= 1 pole)

Information

This block defines the transfer function between the input u and the output y as *first order* system:

$$y = \frac{k}{T \cdot s + 1} \cdot u$$

If you would like to be able to change easily between different transfer functions (FirstOrder, SecondOrder, ...) by changing parameters, use the general block **TransferFunction** instead and model a first order SISO system with parameters $b = \{k\}$, $a = \{T, 1\}$.

Example:

```

parameter: k = 0.3, T = 0.4
results in:

```

$$y = \frac{0.3}{0.4 \cdot s + 1.0} \cdot u$$

File Edit View Simulation Debug SSP Sensitivity Optimization Tools Help



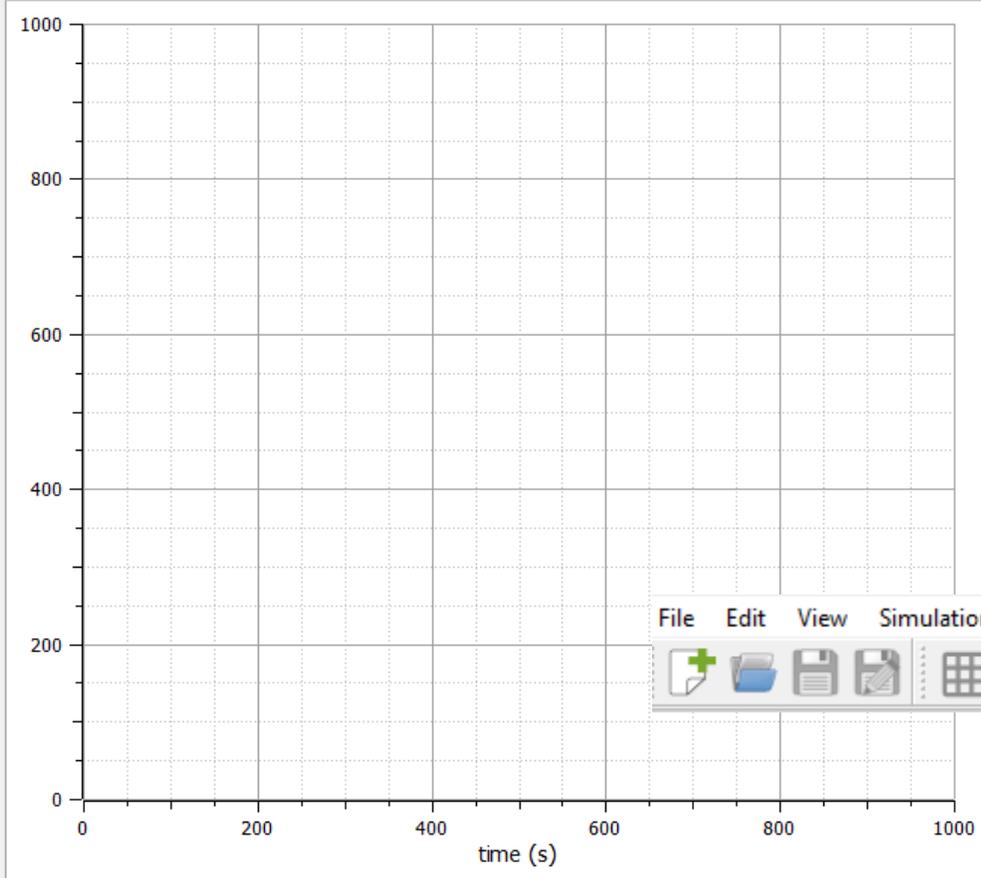


Libraries Browser

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 - LimIntegrator
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 - LowpassButterworth
 - CriticalDamping
 - Filter
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- > Interfaces
- > Logical
- > Math
- > MathInteger
- > MathBoolean
- > Nonlinear
- > Routing

Plot : 1
 Auto Scale | Fit in View | Save | Print | Grid | Detailed Grid | No Grid | Log X | Log Y | Setup



Variables Browser

Filter Variables

Simulation Time Unit: s

Time: 0.0 Speed: 1

Variables	Value	Display Unit	Description
(Active)...rstOrder			
<input type="checkbox"/> T	1.0	s	Time Constant
<input type="checkbox"/> der(y)	0		der(Connector of Real output signal)
<input type="checkbox"/> initType	1		Type of initialization (1: no init, 2: steady state, 3/4: initial output)
<input type="checkbox"/> k	1.0	1	Gain
<input type="checkbox"/> u			Connector of Real input signal
<input type="checkbox"/> y	0		Connector of Real output signal
<input type="checkbox"/> y_start	0.0		Initial or guess value of output (= state)



Messages Browser

All Notifications Warnings Errors

[1] 16:38:33 Scripting Notification
 Automatically loaded package Complex 4.0.0 due to uses annotation.

[2] 16:38:33 Scripting Notification
 Automatically loaded package ModelicaServices 4.0.0 due to uses annotation.

[1] 16:57:39 Translation Warning
 [Modelica.Blocks.Continuous: 354; 5-354:49]:
[Parameter T has no value, and is fixed during initialization \(fixed=true\), using available start value \(start=1.0\) as default value.](#)

[2] 16:57:39 Translation Warning
 Assuming fixed start value for the following 1 variables:
 output y:VARIABLE(start = y_start fixed = true) "Connector of Real output signal" type: Real

Re-simulation - Modelica.Blocks.Continuous.FirstOrder

General Interactive Simulation Translation Flags Simulation Flags Output Archived Simulations

Simulation Interval

Start Time: secs

Stop Time: secs

Number of Intervals:

Interval: secs

Integration

Method:

Tolerance:

Jacobian:

DASSL/IDA Options

Root Finding

Restart After Event

Initial Step Size:

Maximum Step Size:

Maximum Integration Order:

C/C++ Compiler Flags (Optional):

Integration

Method:

Tolerance:

Jacobian:

DASSL/IDA Options

Root Finding

Restart After Event

Initial Step Size:

- euler
- heun
- rungekutta
- impeuler
- trapezoid
- imprungekutta
- irksco
- dassl**
- ida
- cvoid

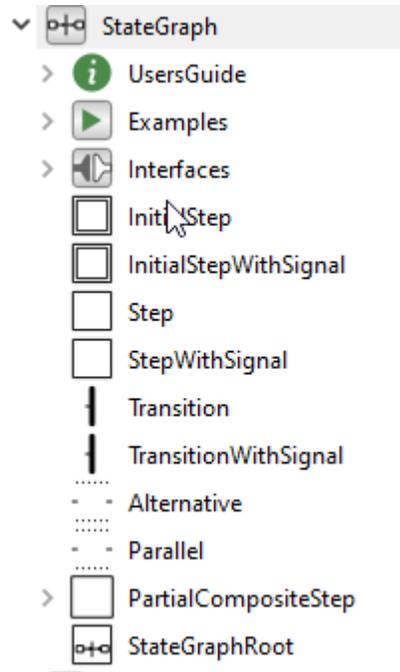
II Simulation of continuous-time models

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Modelica.StateGraph

Library of hierarchical state machine components to model discrete event and reactive systems

Information

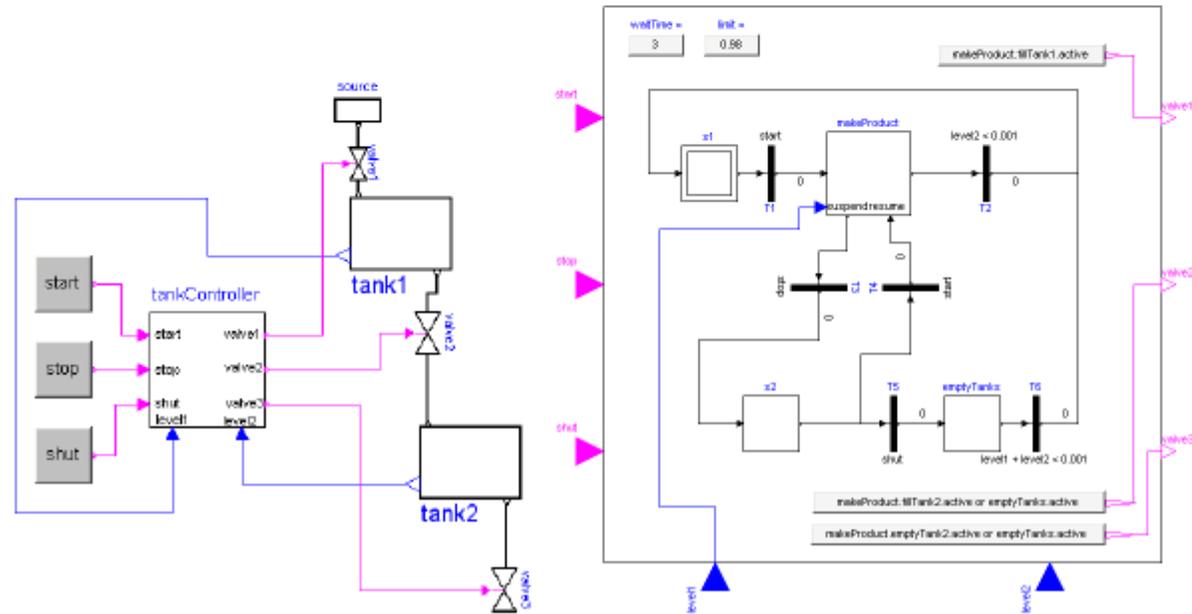
Note, there is a much improved version of this library called "Modelica_StateGraph2". If this library is not yet distributed with your Modelica tool, you can download it from https://github.com/modelica/Modelica_StateGraph2. In the [Users Guide](#) a detailed comparison is given. It is highly recommended to use Modelica_StateGraph2 instead of Modelica.StateGraph.

Library **StateGraph** is a **free** Modelica package providing components to model **discrete event** and **reactive** systems in a convenient way. It is based on the JGrafchart method and takes advantage of Modelica features for the "action" language. JGrafchart is a further development of Grafcet to include elements of StateCharts that are not present in Grafcet/Sequential Function Charts. Therefore, the StateGraph library has a similar modeling power as StateCharts but avoids some deficiencies of StateCharts.

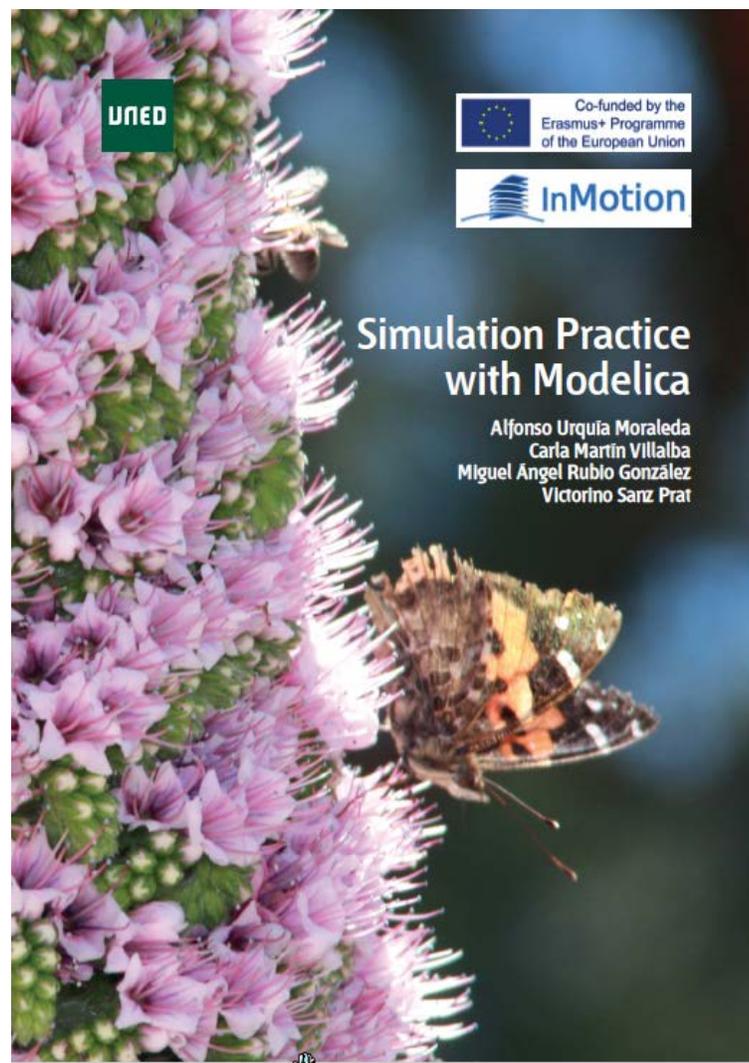
For an introduction, have especially a look at:

- [StateGraph.UsersGuide](#) discusses the most important aspects how to use this library.
- [StateGraph.Examples](#) contains examples that demonstrate the usage of this library.

A typical model generated with this library is shown in the next figure where on the left hand side a two-tank system with a tank controller and on the right hand side the top-level part of the tank controller as a StateGraph is shown:



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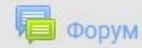
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Курс ООМ для инженеров

Общая информация



Форум



Ссылка на вебинарную комнату курса



<https://dl.spbstu.ru/course/view.php?id=2532>



Посещаемость

Лекции



Математическое моделирование сложных динамических систем: сборник заданий.



Колесов Ю.Б., Сениченков Ю.Б. Математическое моделирование сложных динамических систем : учебное пособие.



Компонентное моделирование сложных динамических систем : учебное пособие.



Компонентное моделирование сложных динамических систем : сборник заданий.



Modeling Simulation Engineering Using Modelica



Simulation Practice With Modelica



Презентация 1



Презентация 2



Презентация 3



Презентация _4

гибридные системы



Презентация 5

Modelica

Основы объектно-ориентированного моделирования Сениченков Юрий Борисович

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Презентация 5

Modelica



-  [01 - Introduction Modelica.pdf](#)
-  [Modelica.pptx](#)
-  [ModelicaTutorial14.pdf](#)
-  [modelicatutorialfritzon.pdf](#)

Скачать папку

Редактировать

Лабораторные

 Лабораторные работы_1

 Задание_1

Тексты заданий в папке Лабораторная работа 1

Выполняется в OpenModelica и Anydynamics

 Лабораторная работа 3

AnyDynamics,OpenModelica

 Лабораторная работа 2

качественная теория на плоскости

 Задание 2

Дискретные системы

 Задание 3

задачи из журнала SNE

 Задание 4

Согласовать с преподавателем

 Лабораторная №5

 Задание 5

Отчет

Ла64_Основы_OOM

Lab4_Base_OOM

Ла64_основы_OOM

ФЕДЕРАЛЬНОЕ ГОСУДАРСТВЕННОЕ АВТОНОМНОЕ
ОБРАЗОВАТЕЛЬНОЕ УЧРЕЖДЕНИЕ

ВЫСШЕГО ОБРАЗОВАНИЯ

«САНКТ-ПЕТЕРБУРГСКИЙ ПОЛИТЕХНИЧЕСКИЙ
УНИВЕРСИТЕТ ПЕТРА ВЕЛИКОГО»

Институт компьютерных наук и технологий

Высшая школа программной инженерии



ПОЛИТЕХ

Санкт-Петербургский
политехнический университет
Петра Великого

Лабораторная работа №4

по дисциплине «Основы объектно-ориентированного моделирования»

I

Студент гр. 3540202/10201

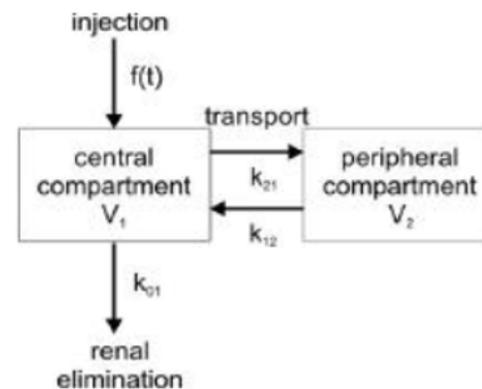
Ю.А. Пелёвина

Руководитель

Ю.Б. Сениченков

Постановка задачи

Дана следующая структура модели



Которую можно выразить следующей системой уравнений

$$dx_1/dt = f(t) - (k_{01} + k_{21})x_1 + k_{12}x_2 \quad (1)$$

$$dx_2/dt = k_{21}x_1 - k_{12}x_2 \quad (2)$$

$$f(t) = D/\tau, \quad 0 \leq t < \tau \quad (3)$$

$$c(t) = x_1(t) / V_1 \quad (4)$$

Задание а

Смоделировать систему со следующими параметрами $k_{01}=0.0041$, $k_{12}=0.0585$, $k_{21}=0.0498$, and $V_1=7.3$; $x_1(0) = x_2(0) = 0$. Сделать прогон системы на 240 единиц модельного времени для трёх случаев параметров для функции инъекции:

- $D_1 = 2500$, $\tau_1 = 0.5$ min
- $D_2 = 2500$, $\tau_2 = 3$ min
- $D_3 = 2500$, $\tau_3 = 240$ min

Решим задачу а

AnyDynamics

tau=0.5

Однокомпонентный случай



Многокомпонентный случай



Однокомпонентный случай



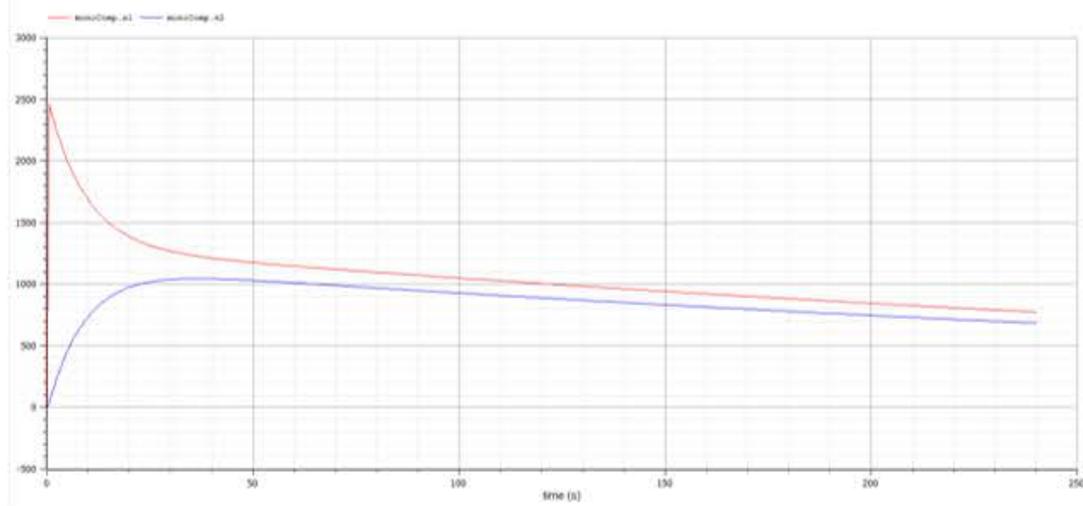
Многокомпонентный случай



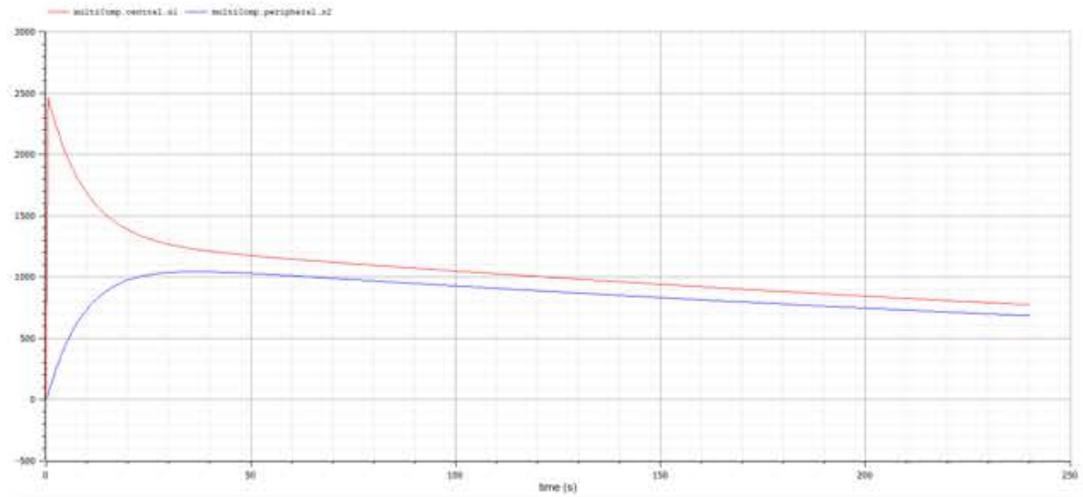
tau=240

Однокомпонентный случай

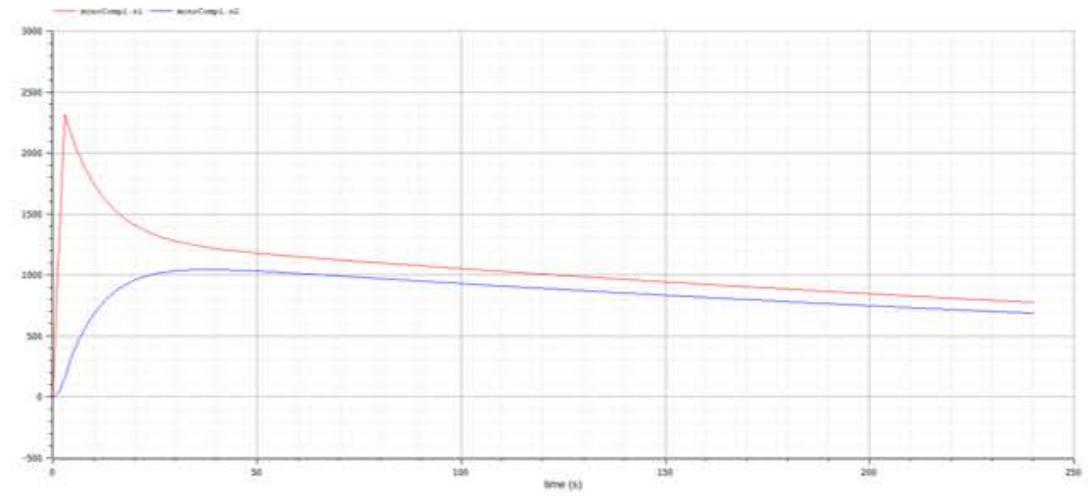
Однокомпонентный случай



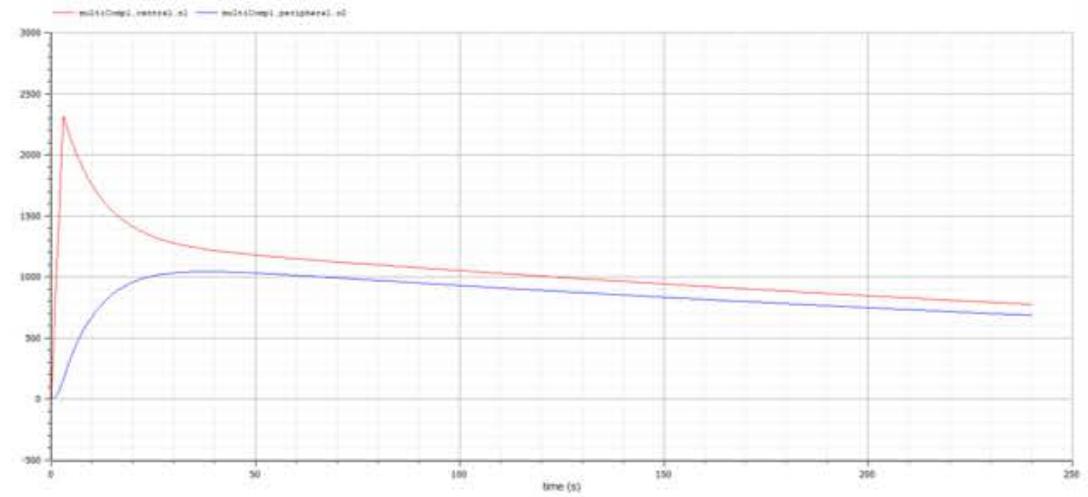
Многокомпонентный случай



$\tau=3$



Многокомпонентный случай



$\tau=240$

Однокомпонентный случай