

5th Homework - Solution

- In this homework, we shall exercise the modeling of a simple electrical circuit using bond graphs.
- We shall also model the same electrical circuit using a circuit diagram (a wrapped bond graph).
- We shall finally determine the overhead associated with the wrapping technique.

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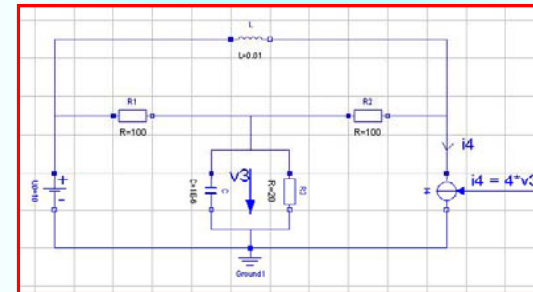
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Electrical Circuit

- Given the following circuit:



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Electrical Circuit II

- The circuit is to be modeled using bond graphs without wrapping.
- Use a sensor (detector) element together with a modulated source element to implement the non-linear current source in the circuit.
- Simulate the circuit during 50 μsec , and plot v_3 as a function of time.

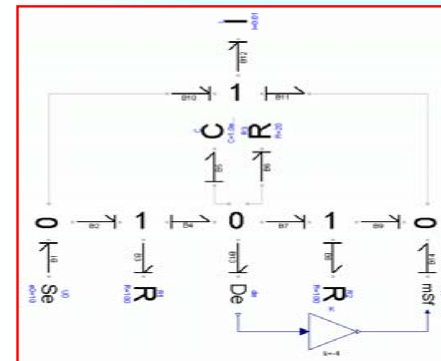
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Bond Graph of Circuit




- Since flow sources in bond-graphic notation are defined with their positive flow pointing *into* the system, we need to make the gain factor negative in order to compensate for the directional sign change.

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Mathematical Modeling of Physical Systems

Simulation Results

Variables

Values

Size

uIn[1]

uOut[1]

uIn[2]

uOut[2]

uIn[3]

uOut[3]

uIn[4]

uOut[4]

uIn[5]

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Plot (1.1)

0.05

0.04

0.03

0.02

0.01

0.00

-0.01

0.00

1.5e-5

3.0e-5


4.5e-5

6.0e-5

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Mathematical Modeling of Physical Systems


Electrical Circuit III

- The circuit is to be modeled using bond graphs with wrapping, i.e., using the bond graph electrical library.
- Simulate the circuit during $50 \mu\text{sec}$, and plot v_3 as a function of time.
- Compare the number of initial and final equations as well as the simulation time with those obtained in the unwrapped bond-graph solution.

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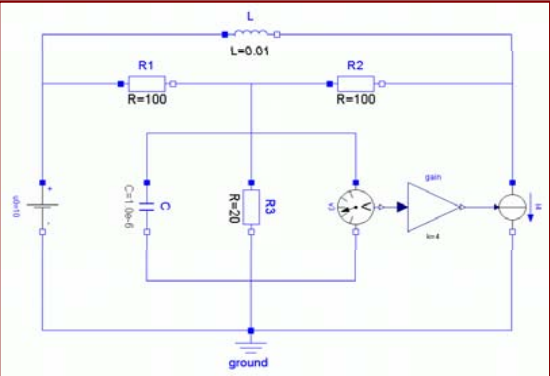


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Mathematical Modeling of Physical Systems


Bond Graph Electrical Library Model



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Mathematical Modeling of Physical Systems

Comparison of Translation Logs

Syntax Error

Translation

Dialog Error

Simulation

Translation of `translatabl_5.bgl`

DrE having 228 scalar unknowns and 228 scalar equations

STATISTICS

Original Model

Number of components: 30

Variables: 208

Constants: 2 (17 scalars)

Parameters: 201 (222 scalars)

Unknowns: 201 (222 scalars)

Overdetermined variables: 2 scalars

Equations: 185

Nominal: 185

Translated Model

Constants: 52 scalars

Free parameters: 7 scalars

Parameter dependent: 2 scalars

Inputs: 0

Outputs: 0

Continuous time states: 2 scalars

Time-varying variables: 12 scalars

Algebraic variables: 194 scalars

Assumed default initial conditions: 2

LogRefInitialConditions: gives more information

Number of mixed real-discrete systems of equations: 0

Sizes of linear systems of equations: 13

Sizes after manipulation of the linear systems: 13

Sizes of nonlinear systems of equations: 13

Sizes after manipulation of the nonlinear systems: 13

Number of numerical Jacobians: 0

Finished

27 equations StopTime=5e-005

Finished

Syntax Error

Translation

Dialog Error

Simulation

Translation of `translatabl_5.bgl`

DrE having 441 scalar unknowns and 441 scalar equations

STATISTICS

Original Model

Number of components: 67

Variables: 425

Constants: 0

Parameters: 17 (17 scalars)

Unknowns: 408 (441 scalars)

Overdetermined variables: 4 scalars

Equations: 317

Nominal: 147

Translated Model

Constants: 190 scalars

Free parameters: 5 scalars

Parameter dependent: 12 scalars

Inputs: 0

Outputs: 0

Continuous time states: 2 scalars

Time-varying variables: 18 scalars

Algebraic variables: 272 scalars

Assumed default initial conditions: 2

LogRefInitialConditions: gives more information

Number of mixed real-discrete systems of equations: 0

Sizes of linear systems of equations: 13

Sizes after manipulation of the linear systems: 13

Sizes of nonlinear systems of equations: 13

Sizes after manipulation of the nonlinear systems: 13

Number of numerical Jacobians: 0

Finished

27 equations StopTime=5e-005

Finished

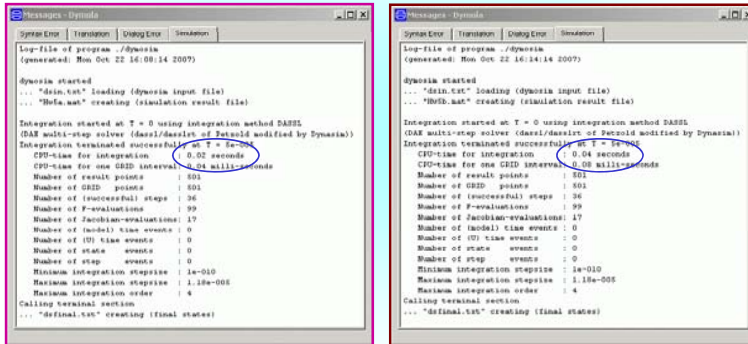
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Comparison of Simulation Logs



Graphical Model

BG Electrical Model

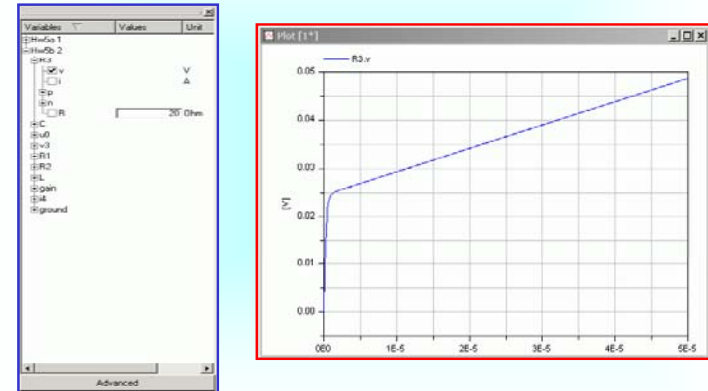
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Simulation Results



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