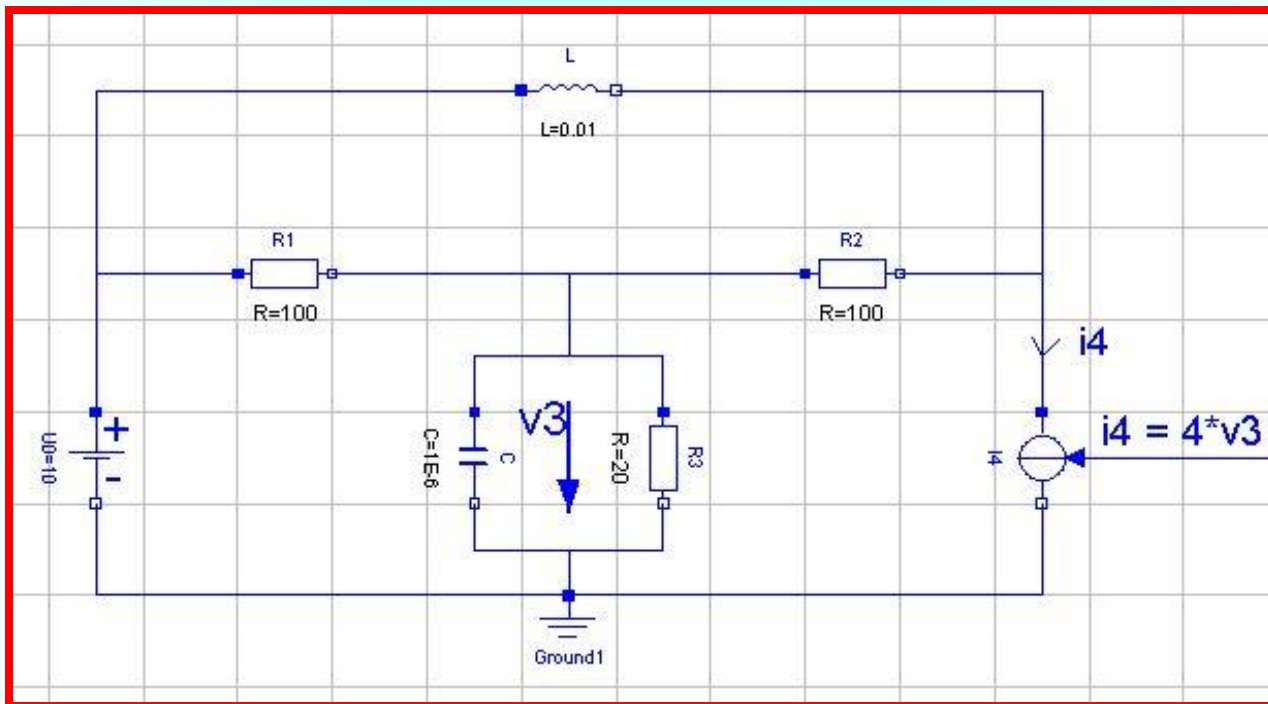


5th Homework - Solution

- 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.

Electrical Circuit

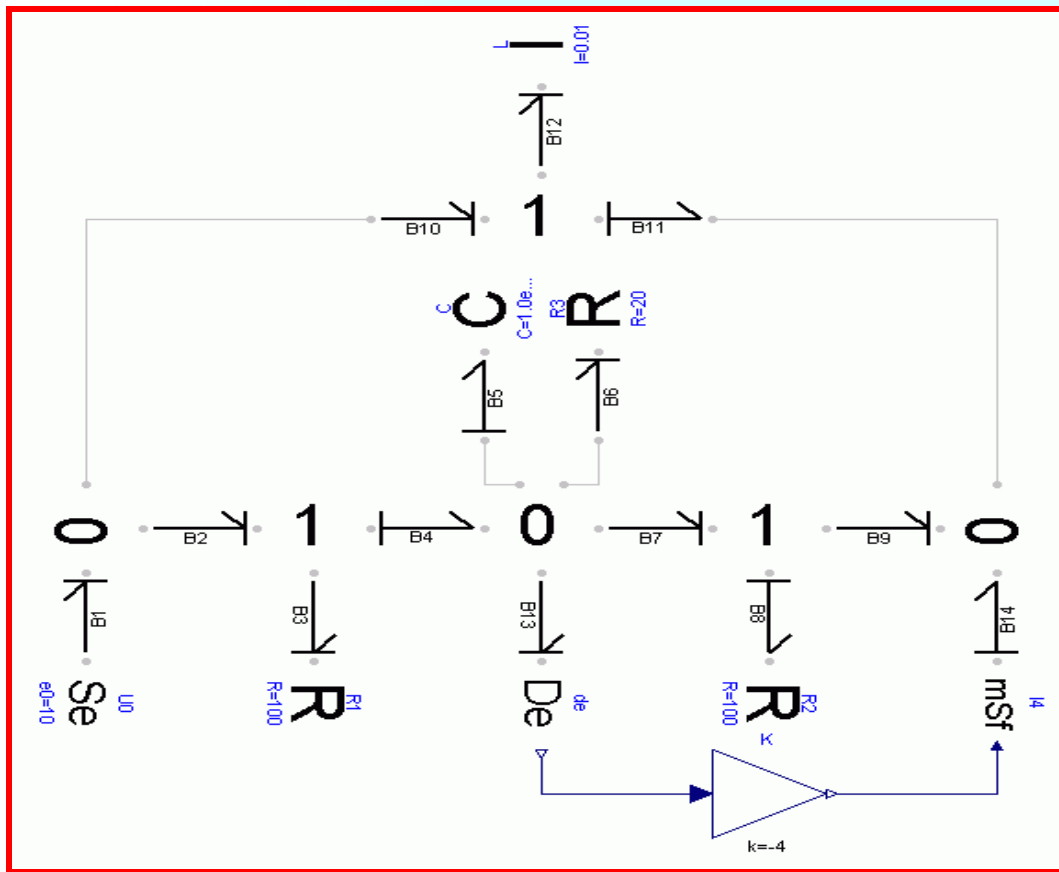
- Given the following circuit:



Electrical Circuit II

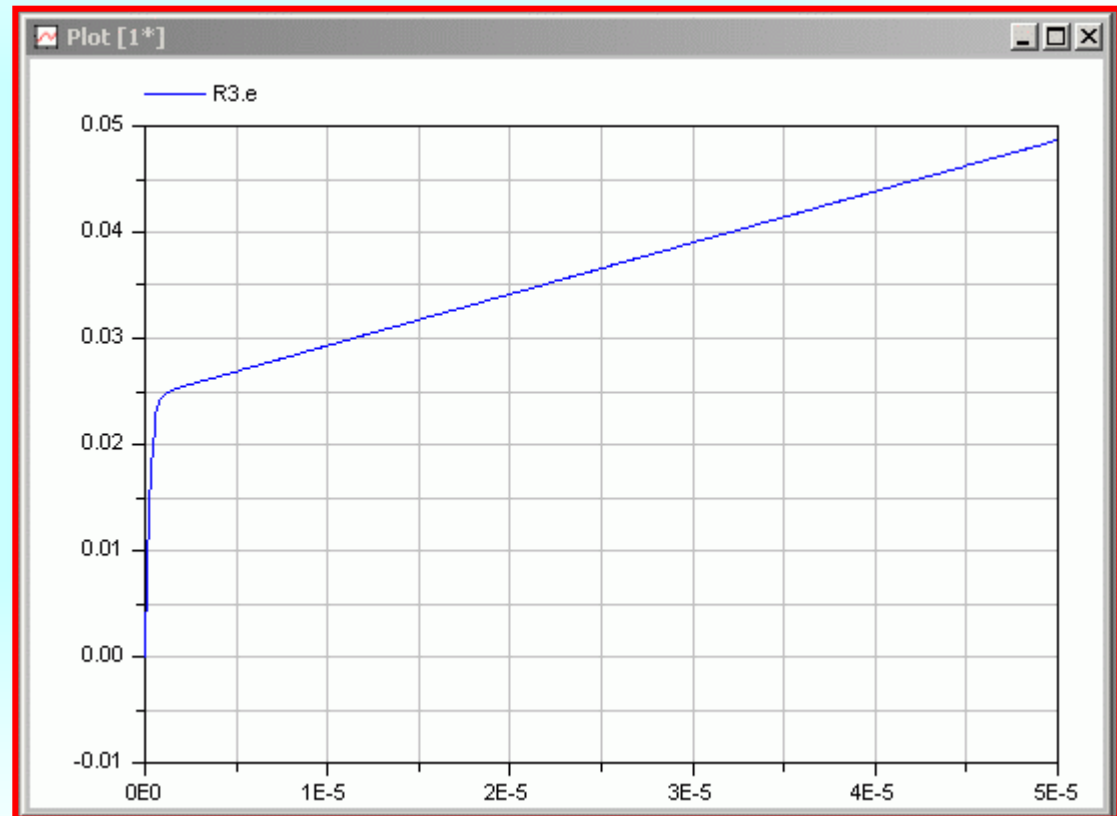
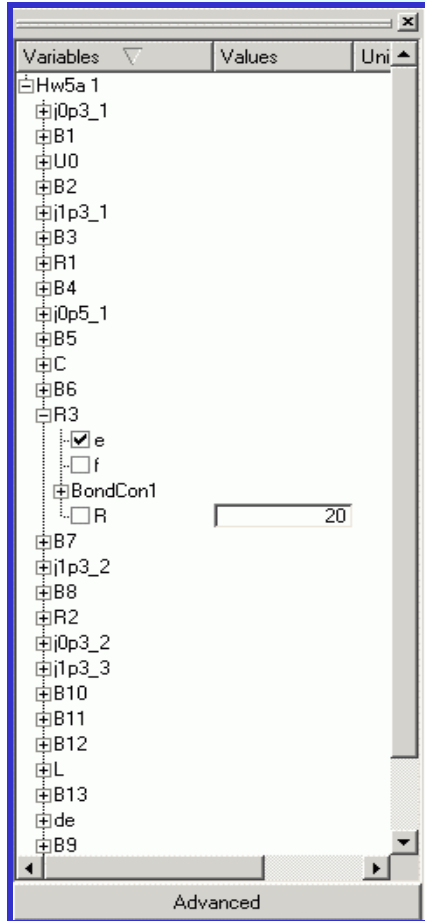
- The circuit is to be modeled using bond graphs without wrapping.
- Use a sensor (detector) element together with a modulated source element to implement the non-linear current source in the circuit.
- Simulate the circuit during $50 \mu\text{sec}$, and plot v_3 as a function of time.

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.

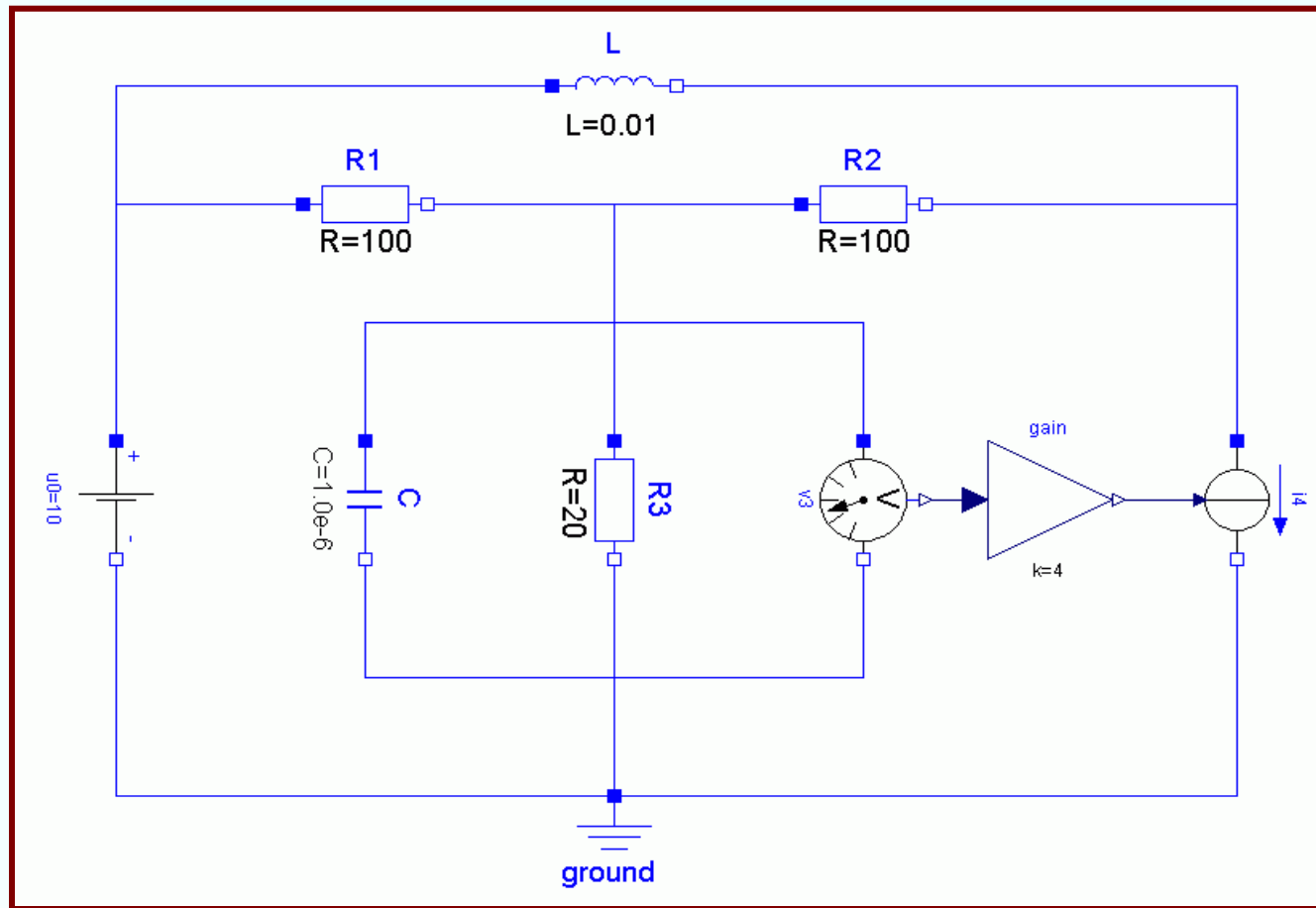
Simulation Results



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.

Bond Graph Electrical Library Model



Comparison of Translation Logs

```

Messages - Dymola
Syntax Error | Translation | Dialog Error | Simulation

Translation of Homework 5.Hw5a:
DAE having 229 scalar unknowns and 229 scalar equations.

STATISTICS

Original Model
Number of components: 30
Variables: 208
  Constants: 0
  Parameters: 7 (7 scalars)
  Unknowns: 201 (229 scalars)
  Differentiated variables: 2 scalars
Equations: 165
Nontrivial: 96

Translated Model
Constants: 62 scalars
Free parameters: 7 scalars
Parameter depending: 2 scalars
Inputs: 0
Outputs: 0
Continuous time states: 2 scalars
Time-varying variables: 12 scalars
Alias variables: 155 scalars
Assumed default initial conditions: 2
LogDefaultInitialConditions=true; gives more information
Number of mixed real/discrete systems of equations: 0
Sizes of linear systems of equations: {}
Sizes after manipulation of the linear systems: {}
Sizes of nonlinear systems of equations: {}
Sizes after manipulation of the nonlinear systems: {}
Number of numerical Jacobians: 0

Finished
// experiment StopTime=5e-005
Finished
  
```

Bond Graph Model

```

Messages - Dymola
Syntax Error | Translation | Dialog Error | Simulation

Translation of Homework 5.Hw5b:
DAE having 441 scalar unknowns and 441 scalar equations.

STATISTICS

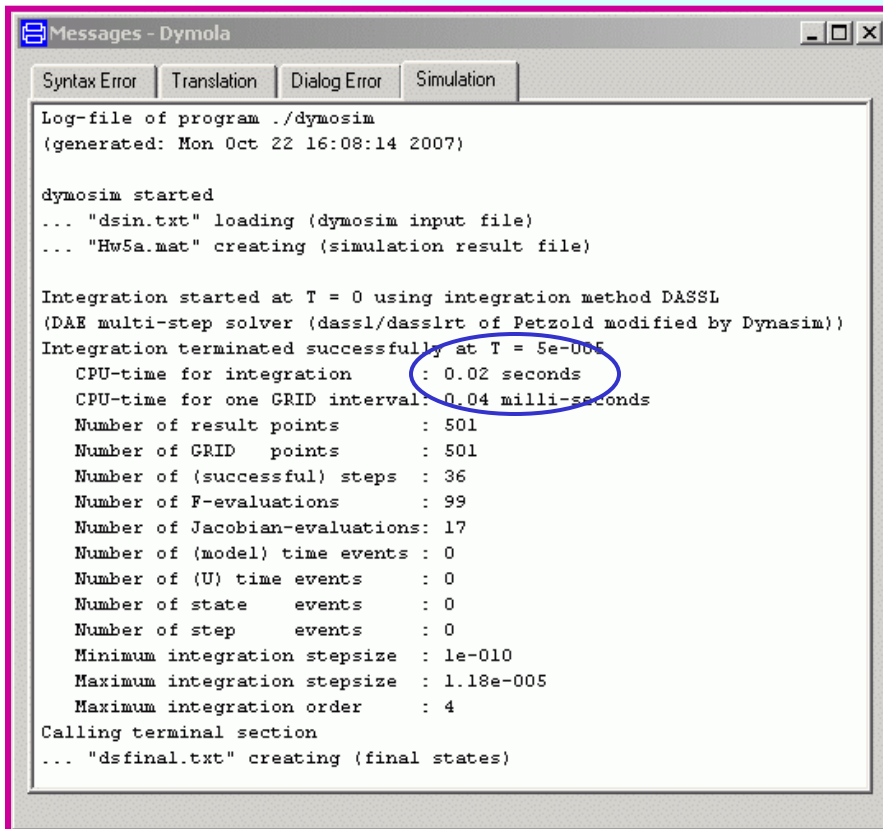
Original Model
Number of components: 67
Variables: 426
  Constants: 0
  Parameters: 17 (17 scalars)
  Unknowns: 409 (441 scalars)
  Differentiated variables: 4 scalars
Equations: 317
Nontrivial: 167

Translated Model
Constants: 155 scalars
Free parameters: 9 scalars
Parameter depending: 12 scalars
Inputs: 0
Outputs: 0
Continuous time states: 16 scalars
Time-varying variables: 16 scalars
Alias variables: 272 scalars
Assumed default initial conditions: 2
LogDefaultInitialConditions=true; gives more information
Number of mixed real/discrete systems of equations: 0
Sizes of linear systems of equations: {}
Sizes after manipulation of the linear systems: {}
Sizes of nonlinear systems of equations: {}
Sizes after manipulation of the nonlinear systems: {}
Number of numerical Jacobians: 0

Finished
// experiment StopTime=5e-005
Finished
  
```

BG Electrical Model

Comparison of Simulation Logs



Messages - Dymola

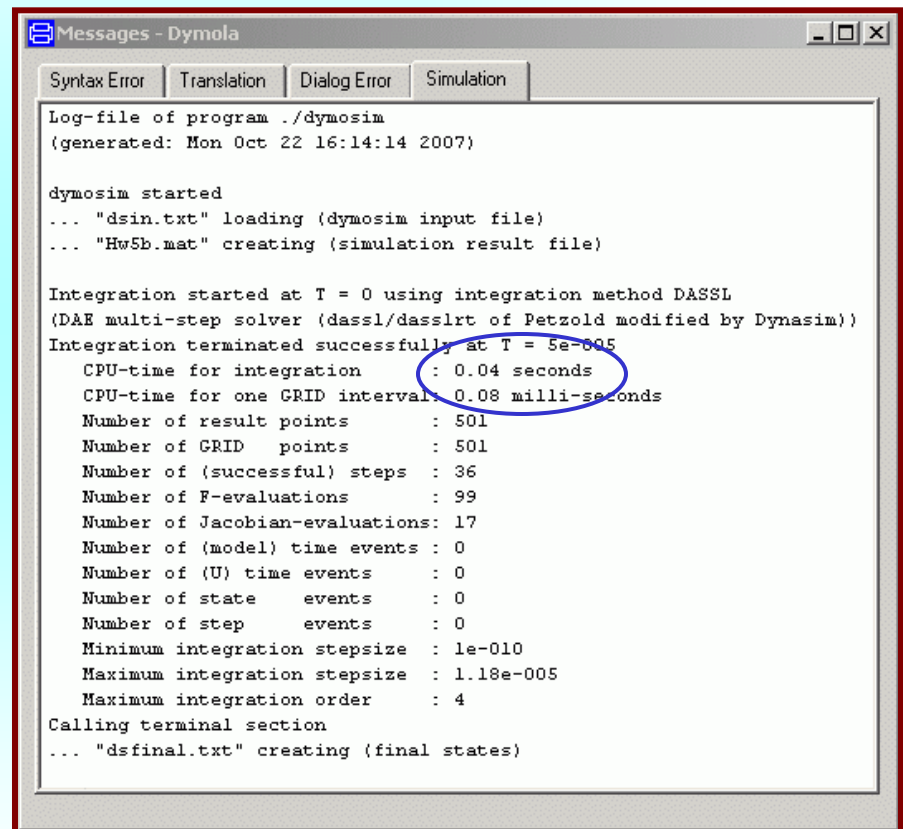
Syntax Error Translation Dialog Error Simulation

```
Log-file of program ./dymosim
(generated: Mon Oct 22 16:08:14 2007)

dymosim started
... "dsin.txt" loading (dymosim input file)
... "Hw5a.mat" creating (simulation result file)

Integration started at T = 0 using integration method DASSL
(DAE multi-step solver (dassl/dasslrt of Petzold modified by Dynasim))
Integration terminated successfully at T = 5e-005
CPU-time for integration : 0.02 seconds
CPU-time for one GRID interval: 0.04 milli-seconds
Number of result points : 501
Number of GRID points : 501
Number of (successful) steps : 36
Number of F-evaluations : 99
Number of Jacobian-evaluations: 17
Number of (model) time events : 0
Number of (U) time events : 0
Number of state events : 0
Number of step events : 0
Minimum integration stepsize : 1e-010
Maximum integration stepsize : 1.18e-005
Maximum integration order : 4
Calling terminal section
... "dsfinal.txt" creating (final states)
```

Graphical Model



Messages - Dymola

Syntax Error Translation Dialog Error Simulation

```
Log-file of program ./dymosim
(generated: Mon Oct 22 16:14:14 2007)

dymosim started
... "dsin.txt" loading (dymosim input file)
... "Hw5b.mat" creating (simulation result file)

Integration started at T = 0 using integration method DASSL
(DAE multi-step solver (dassl/dasslrt of Petzold modified by Dynasim))
Integration terminated successfully at T = 5e-005
CPU-time for integration : 0.04 seconds
CPU-time for one GRID interval: 0.08 milli-seconds
Number of result points : 501
Number of GRID points : 501
Number of (successful) steps : 36
Number of F-evaluations : 99
Number of Jacobian-evaluations: 17
Number of (model) time events : 0
Number of (U) time events : 0
Number of state events : 0
Number of step events : 0
Minimum integration stepsize : 1e-010
Maximum integration stepsize : 1.18e-005
Maximum integration order : 4
Calling terminal section
... "dsfinal.txt" creating (final states)
```

BG Electrical Model

Simulation Results

