Exercises to Introductory Modelica Tutorial

1 Short Introduction to Graphical Modeling

Install OpenModelica and start OpenModelica OMNotebook. Also and start the OpenModelica Connectic
Graphical Connection Editor called OMedit..
Do the RL-Circuit exercise in the course slides.

2 Simple Textual Modeling Exercises

2.1 HelloWorld

Simulate and plot the following example with one differential equation and one initial condition. Start by
in the cell and pushing shift-enter.

```
model HelloWorld "A simple equation"
  parameter Real a = -1;
  Real x(start=1);
equation
  der(x)= a*x;
end HelloWorld;
```

```
{HelloWorld}
```

Push shift-tab for command completion, fill in the name HelloWorld, and simulate it!

```
simulate(HelloWorld, startTime=0, stopTime=1, numberOfIntervals=500,
tolerance=1e-10)
```

```
[done]
```

Push shift-tab for command completion, fill in a variable name (x), and plot it!

```
plo
```

```
true
```

2.2 Try DrModelica with VanDerPol

Locate the VanDerPol model in DrModelica (link from Section 2.1), run it, change it slightly, and re-run i
Change the endTime to 10, then simulate and plot.
Change the lambda parameter to 10, then simulate for 50 seconds and plot. Why is the plot looking like th

2.3 DAE Example

Simulate and plot following example which includes an algebraic equation with no derivatives.

```
class DAEexample
  Real x(start=0.9, fixed=true);
  Real y(start=0);
equation
  der(y)+(1+0.5*sin(y))*der(x) = sin(time);
  x - y = exp(-0.9*x)*cos(y);
end DAEexample;
```

```
{DAEexample}
```

Simulate the example

```
simulate(DAEexample, stopTime = 1)
```

```
[done]
```

Plot the results. Notice that while the start value of x is fixed, the start value of y is not fixed. Non-fixed s values are treated by the simulator as "guess" values. During initializiation this guess value will be tried a starting value, but the simulator can change them in order to produce a set of consistent initial condition.I linear system of equations needs to be solved during initialization, such guess values will be used by the simulator as a starting point (guess value) for root-finding algorithms such as Newton's method..

```
plot({x,y})
```

```
true
```

2.4 A Simple Systems of Equations

Develop a Modelica model that solves the equation system below with initial conditions. Hint: initial con are often specified using the **start** attribute.

$\dot{x} = 2 * x * y - 3 * x$

$\dot{y} = 5 * y - 7 * x * y$

$x(0) = 2$

$y(0) = 3$

```
model ...
```

2.5 Functions

a) Write a function, sum2, which calculates the sum of Real numbers, for a vector of arbitrary size.

```
function sum2
...
end sum2;
```

```
{sum2}
```

b) Write a function, average, which calculates the average of Real numbers, in a vector of arbitrary size. T function average should make use of a function call to sum2

```
function average
...
```

```
end average;
```

```
{average}
```

Test the functions

```
average({1,2,3})
```

```
2.0
```

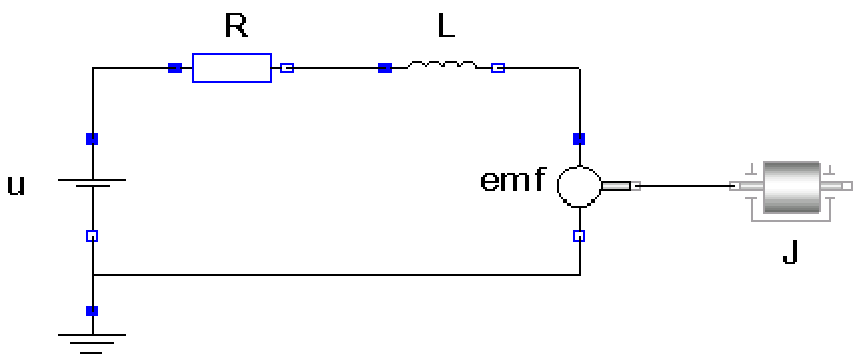
2.6 Hybrid Modeling with BouncingBall

Locate the BouncingBall model in one of the hybrid modeling sections of DrModelica (the when-Equatio
in Section 2.9), run it, change it slightly, and re-run it.

3 Simple Graphical Design Using the Graphical Connection Editor

3.1 DC Motor

Make a simple DC-motor using the Modelica standard library that has the following structure:




```
model ...
```

```
[1:7]: error: unexpected token: .
```

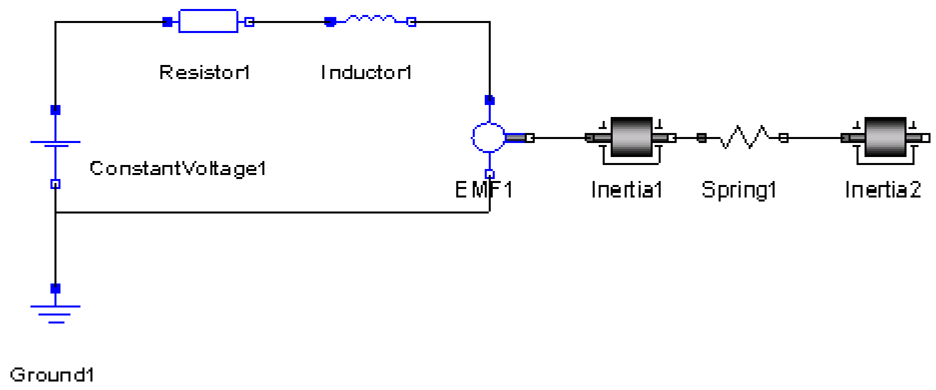
You can simulate and plot the model directly from the graphical editor. Simulate for 15s and plot the varia
the outgoing rotational speed on the inertia axis and the voltage on the voltage source (denoted u in the fi
the same plot.

Option: You can also save the model, load it and simulate it using OMShell or OMNotebook. You can als the graphical editor text view and copy/paste the model into a cell in OMNotebook.

Hint: if you use the plot command in OMNotebook and you have difficulty finding the names of the varia plot, you can flatten the model by calling instantiateModel, which exposes all variable names.

3.2 Spring and Inertia (Extra)

Add a torsional spring to the outgoing shaft and another inertia element. Simulate again and see the result Adjust some parameters (right-click on corresponding model component icon) to make a rather stiff sprin

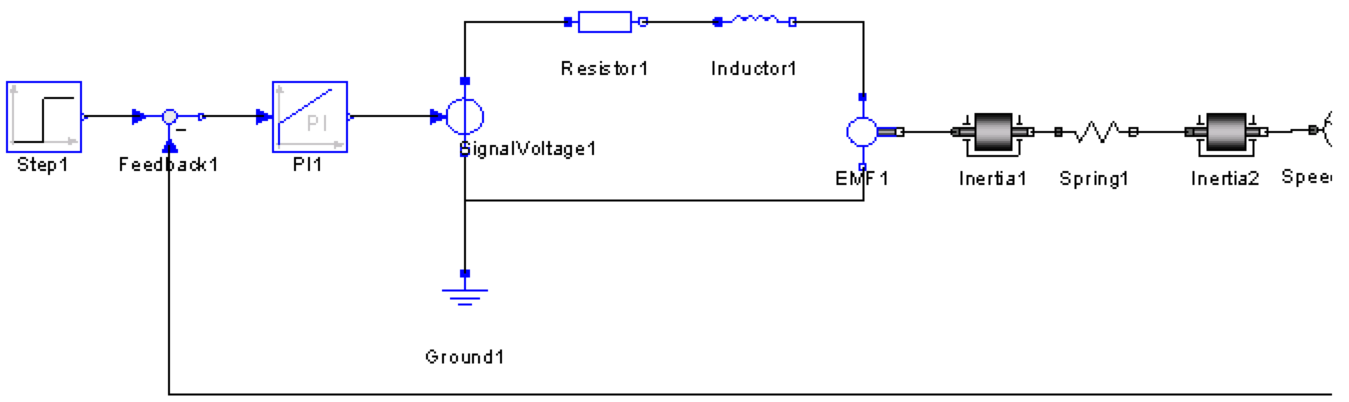



```
model ...
```

```
[1:7]: error: unexpected token: .
```

3.3 Adding controller (extra)

Add a PI controller to the system and try to control the rotational speed of the outgoing shaft. Verify the re using a step signal for input. Tune the PI controller by changing its parameters. Right-click on the PI Cont Icon to change parameters.




```
model ...
```

```
[1:7]: error: unexpected token: .
```