
BMSpy Documentation

Release 0.0.6

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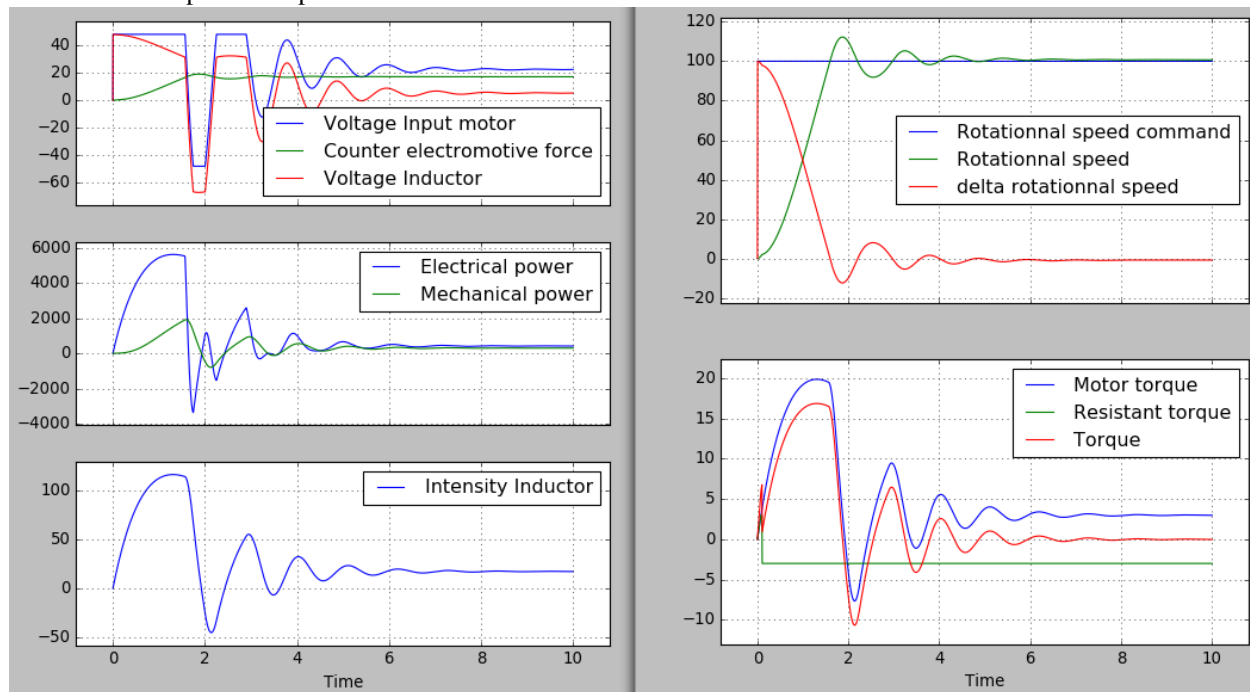
GETTING STARTED

1.1 What is BMS for?

BMS stands for “Block Model Simulator”. It helps defining a `DynamicalSystem`, a collection of variables linked by equations or behaviors.

The values of the model’s variables are computed by the model and can be displayed or post-treated.

Here is for example the output of an electric motor model:



1.2 Installation

The easy way:

```
pip install bms
```

or, if you are running python3:

```
pip3 install bms
```

Alternatively, you can download the source at: <https://pypi.python.org/pypi/bms/> After extracting, execute:

```
python setup.py install
```

If you are running python3:

```
python3 setup.py install
```


DEVELOPMENT

BMS is beeing actively developed! Feel free to interact!

Questions and bugs can be reported on github: <https://github.com/masfaraud/BMSpy/issues>

2.1 Release Notes

see also releases on github: <https://github.com/masfaraud/BMSpy/releases>

2.1.1 Version 0.0.6

- Shinx Documentation
- Variables accessible at time value by DynamicSystem method

2.1.2 Version 0.0.5

- Version number standard change
- Model Saving/Loading from file
- New version of model drawing
- Inputs renamed Signals
- Drag & Drop Model drawer

2.1.3 Version 0.04

- Reorganisation into subpackages of blocks and inputs

2.1.4 Version 0.03

- Bug correction for float time step
- Redefinition of number of steps

2.1.5 Version 0.02

- New blocks such as saturation or coulomb
- Bug fixes

2.1.6 Version 0.01

Initial release

2.2 Roadmap

- Implement computation of derivatives at $t=0$ for inputs
- Implement indicator of convergence when solving at a time step
- Nice model drawing (upgrade existing drag & drop interface)

TUTORIAL

The DynamicSystem Class is a python class defined by BMS core. It allows to define a complete model containing all the data for simulation.

3.1 Defining a model

3.1.1 Defining the inputs

Inputs are special variable in the model which are not computed. See the [inputs list](Inputs) Here we define a ramp named which name is e

```
e=Ramp('e',1.)
```

3.1.2 Defining Variables

Let's define a variable s which will be the output of a first order block

```
s=bms.Variable('s')
```

3.1.3 Defining Blocks

Let's define this block:

```
from bms.blocks.continuous import ODE
block=ODE(e,s,[1],[1,3])
```

3.1.4 Defining the model

```
te=10# time of end in seconds
ns=2000 # number of time steps
model=bms.DynamicSystem(te,ns,[block])
```

The blocks are given in a list as third argument

3.2 Model methods

3.2.1 Simulating

```
model.Simulate()
```

3.2.2 Plotting variables

```
model.PlotVariables()
```

3.2.3 Accessing values

Values of variables at a given time t is accessible by:

```
ds.VariablesValues(t)
```

The time values vector of a variable is accessible via the values attribute:

```
import matplotlib.pyplot as plt
plt.plot(ds.t,e.values)
plt.plot(ds.t,s.values)
```

EXAMPLES

See the project examples folder on github: <https://github.com/masfaraud/BMSpy/tree/master/bms/examples>

REFERENCE

5.1 Core

Core of BMS. All content of this file is imported by bms, and is therefore in bms

This file defines the base of BMS.

class `bms.core.Block` (*inputs, outputs, max_input_order, max_output_order*)

Abstract class of block: this class should not be instanciate directly

InputValues (*it*)

Returns the input values at a given iteration for solving the block outputs

OutputValues (*it*)

class `bms.core.DynamicSystem` (*te, ns, blocks=[]*)

Defines a dynamic system that can simulate itself

Parameters

- **te** – time of simulation's end
- **ns** – number of steps
- **blocks** – (optional) list of blocks defining the model

AddBlock (*block*)

Add the given block to the model and also its input/output variables

CheckModelConsistency ()

Check for model consistency:

- an input variable can't be set as the output of a block
- a variable can't be the output of more than one block

DrawModel ()

PlotVariables (*subplots_variables=None*)

Save (*name_file*)

name_file: name of the file without extension. The extension .bms is added by function

Simulate ()

VariablesValues (*variables, t*)

Returns the value of given variables at time t

Parameters

- **variables** – one variable or a list of variables

- t – time of evaluation

graph

`bms.core.Load` (*file*)

Loads a model from specified file

exception `bms.core.ModelError`

Bases: `exceptions.Exception`

args**message**

class `bms.core.Signal` (*names*)

Bases: `bms.core.Variable`

Abstract class of signal

values

class `bms.core.Variable` (*names=''*, *initial_values=[0]*)

Defines a variable

Parameters **names** – Defines full name and short name.

If names is a string the two names will be identical otherwise names should be a tuple of strings (full_name,short_name)

values

5.2 Signals

5.2.1 Functions

Collection of mathematical function signals

class `bms.signals.functions.Ramp` (*name='Ramp'*, *amplitude=1*, *delay=0*, *initial_value=0*)

Bases: `bms.core.Signal`

Create a ramp such as : $f(t)=(t-\text{delay})*\text{amplitude}+\text{initial_value}$

values

class `bms.signals.functions.SignalFunction` (*name, function*)

Bases: `bms.core.Signal`

User defined function for signal.

Parameters **function** – a function that will give the time values to the signal

values

class `bms.signals.functions.Sinus` (*name='Sinus'*, *amplitude=1*, *w=1*, *phase=0*, *initial_value=0*)

Bases: `bms.core.Signal`

values

class `bms.signals.functions.Step` (*name='Step'*, *amplitude=1*, *delay=0*, *initial_value=0*)

Bases: `bms.core.Signal`

Create a Step of amplitude beginning at time delay

values

5.2.2 Signals

WLTP signals

```
class bms.signals.wltp.WLTP1(name)
    Bases: bms.core.Signal

    WLTP classe 1 cycle Caution! speed in m/s, not in km/h!

    values

class bms.signals.wltp.WLTP2(name)
    Bases: bms.core.Signal

    WLTP classe 2 cycle Caution! speed in m/s, not in km/h!

    values

class bms.signals.wltp.WLTP3(name)
    Bases: bms.core.Signal

    WLTP classe 3 cycle Caution! speed in m/s, not in km/h!

    values
```

5.3 Blocks

5.3.1 Continuous Blocks

Collection of continuous blocks

```
class bms.blocks.continuous.Division(input_variable1, input_variable2, output_variable)
    Bases: bms.core.Block

    output=input1/input2

    InputValues(it)
        Returns the input values at a given iteration for solving the block outputs

    LabelBlock()

    LabelConnections()

    OutputValues(it)

    Solve(it, ts)

class bms.blocks.continuous.FunctionBlock(input_variable, output_variable, function)
    Bases: bms.core.Block

    output=f(input)

    InputValues(it)
        Returns the input values at a given iteration for solving the block outputs

    LabelBlock()

    LabelConnections()

    OutputValues(it)

    Solve(it, ts)
```

```
class bms.blocks.continuous.Gain (input_variable, output_variable, value)
```

Bases: *bms.core.Block*

output=value* input

InputValues (*it*)

Returns the input values at a given iteration for solving the block outputs

LabelBlock ()

LabelConnections ()

OutputValues (*it*)

Solve (*it, ts*)

```
class bms.blocks.continuous.ODE (input_variable, output_variable, a, b)
```

Bases: *bms.core.Block*

a,b are vectors of coefficients such as H, the transfert function of the block, may be written as:
 $H(p)=(a[i]p^{**i})/(b[j]p^{**j})$ (Einstein sum on i,j) p is Laplace's variable

InputValues (*it*)

Returns the input values at a given iteration for solving the block outputs

LabelBlock ()

LabelConnections ()

OutputMatrices (*delta_t*)

OutputValues (*it*)

Solve (*it, ts*)

```
class bms.blocks.continuous.Product (input_variable1, input_variable2, output_variable)
```

Bases: *bms.core.Block*

output=input1*input2

InputValues (*it*)

Returns the input values at a given iteration for solving the block outputs

LabelBlock ()

LabelConnections ()

OutputValues (*it*)

Solve (*it, ts*)

```
class bms.blocks.continuous.Subtraction (input_variable1, input_variable2, output_variable)
```

Bases: *bms.core.Block*

output=input1-input2

InputValues (*it*)

Returns the input values at a given iteration for solving the block outputs

LabelBlock ()

LabelConnections ()

OutputValues (*it*)

Solve (*it, ts*)

```
class bms.blocks.continuous.Sum(input_variable1, input_variable2, output_variable)
    Bases: bms.core.Block

    output=input1+input2

    InputValues(it)
        Returns the input values at a given iteration for solving the block outputs

    LabelBlock()

    LabelConnections()

    OutputValues(it)

    Solve(it, ts)
```

5.3.2 Non-linear Blocks

Collection of non-linear blocks

```
class bms.blocks.nonlinear.Coulomb(input_variable, speed_variable, output_variable, max_value,
                                   tolerance=0)
```

Bases: *bms.core.Block*

Return coulomb force under condition of speed and sum of forces (input)

```
InputValues(it)
    Returns the input values at a given iteration for solving the block outputs

LabelBlock()

OutputValues(it)

Solve(it, ts)
```

```
class bms.blocks.nonlinear.DeadZone(input_variable, output_variable, zone_width)
```

Bases: *bms.core.Block*

```
InputValues(it)
    Returns the input values at a given iteration for solving the block outputs

OutputValues(it)

Solve(it, ts)
```

```
class bms.blocks.nonlinear.Hysteresis(input_variable, output_variable, zone_width,
                                      initial_value)
```

Bases: *bms.core.Block*

```
InputValues(it)
    Returns the input values at a given iteration for solving the block outputs

OutputValues(it)

Solve(it, ts)
```

```
class bms.blocks.nonlinear.Saturation(input_variable, output_variable, min_value, max_value)
```

Bases: *bms.core.Block*

output=min_value if input < min_value output=max_value if input > max_value output=input if min_value < input < max_value

```
InputValues(it)
    Returns the input values at a given iteration for solving the block outputs

LabelBlock()
```

OutputValues (*it*)

Solve (*it*, *ts*)

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