



WEC-Sim Training Course



Online Training Materials

PRESENTED BY

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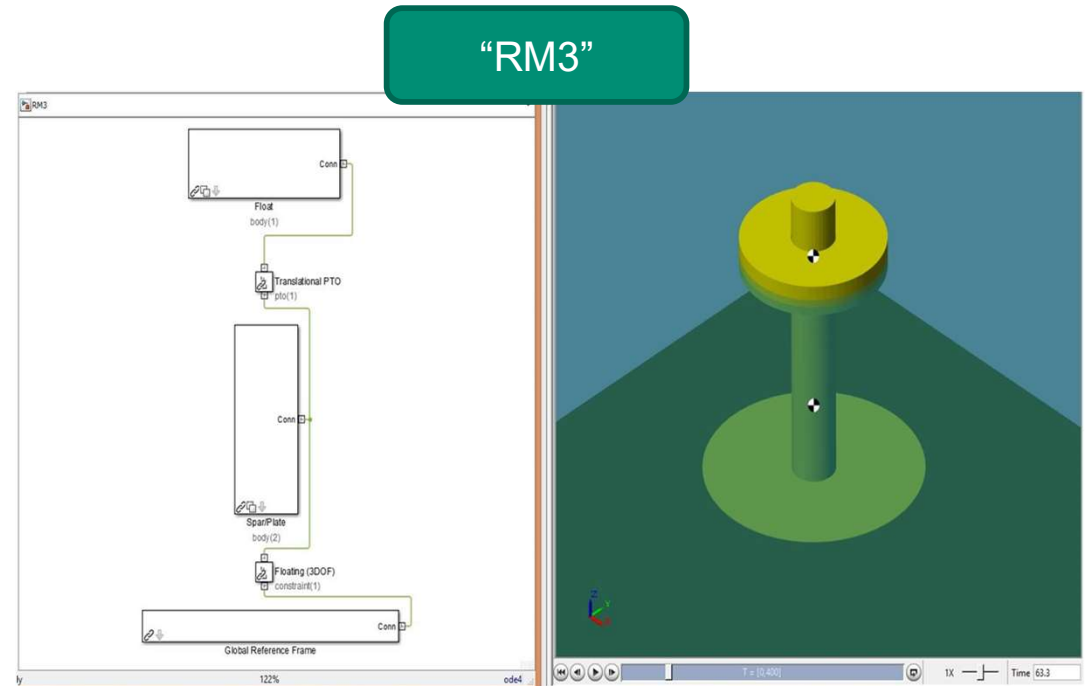


Tutorial

Get started with WEC-Sim

This presentation will give a demonstration of how to run the reference model 3 (RM3) WEC in WEC-Sim

1. **What is WEC-Sim? What is RM3?**
2. **Check WEC-Sim is installed**
3. **Run BEMIO**
4. **Build Simulink Model**
5. **Write wecSimInputFile.m**
6. **Run WEC-Sim**
7. **Visualize Outputs**



What is WEC-Sim?

WEC-Sim (Wave Energy Converter Simulator)

- Simulates WECs in operational sea states, based on linear potential flow theory
- Takes frequency-domain hydrodynamic coefficients (e.g. from BEM codes such as WAMIT or Capytaine) as an input
- Uses Cummins' equation to convert these frequency-domain coefficients into time-domain forces – enabling us to model nonlinear constraints, subsystems, moorings, etc.
- Developed in MATLAB/Simulink, using Simscape Multibody
 - Available at <https://github.com/WEC-Sim/WEC-Sim>
- First Release: v1.0 in June 2014
- Current Release: v5.0.1 in Sept 2022



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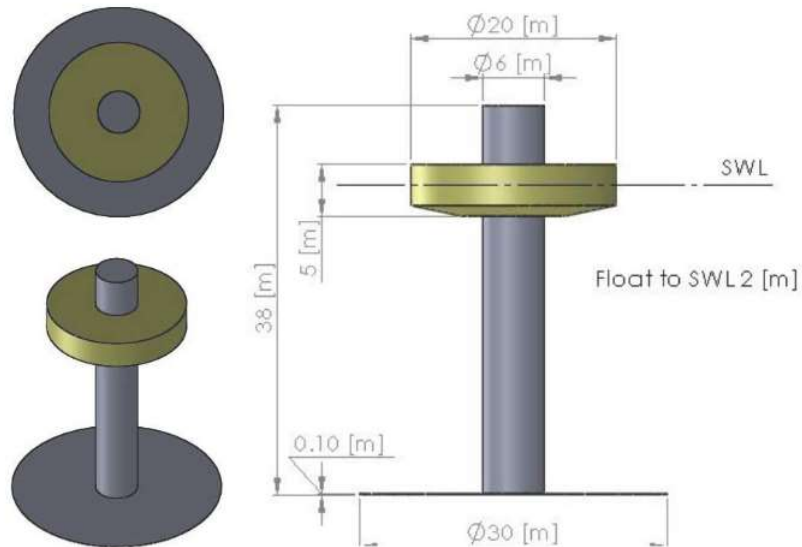
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Reference Model 3 (RM3)

Device Geometry

The Reference Model 3 (RM3) is a two-body point absorber consisting of a float and a reaction plate.



WEC-Sim Model Files

Listed below are the files required to run the RM3 simulation in WEC-Sim. Optionally, users may supply a userDefinedFunctions.m file for post-processing

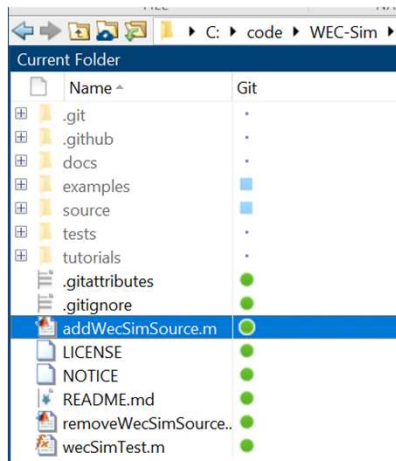
File Type	File Name	Directory
Input File	wecSimInputFile.m	\$WECSIM/tutorials/rm3/
Simulink Model	rm3.slx	\$WECSIM/tutorials/rm3/
Hydrodynamic Data	rm3.h5	\$WECSIM/tutorials/rm3/hydroData/
Geometry Files	float.stl & plate.stl	\$WECSIM/tutorials/rm3/geometry/

Recommendation: copy the tutorials/rm3 folder from the WEC-Sim repo into a new location

<https://wec-sim.github.io/WEC-Sim/master/user/tutorials.html#two-body-point-absorber-rm3>

Check that WEC-Sim is installed

- 1 Navigate to your WEC-Sim folder and run the script 'addWecSimSource.m':



- 2 Then check that WEC-Sim has been added to your MATLAB path:

```
Command Window
>> addWecSimSource
>> path

MATLABPATH

C:\code\WEC-Sim\source
C:\code\WEC-Sim\source\functions
C:\code\WEC-Sim\source\functions\BEMIO
C:\code\WEC-Sim\source\functions\coordTransformation
C:\code\WEC-Sim\source\functions\moorDyn
C:\code\WEC-Sim\source\functions\paraview
C:\code\WEC-Sim\source\functions\simulink
C:\code\WEC-Sim\source\functions\simulink\mask
C:\code\WEC-Sim\source\functions\simulink\model
C:\code\WEC-Sim\source\lib
C:\code\WEC-Sim\source\lib\PTO-Sim
C:\code\WEC-Sim\source\lib\PTO-Sim\BlockFigures
C:\code\WEC-Sim\source\lib\WEC-Sim
C:\code\WEC-Sim\source\objects
```

RM3 Tutorial: Step 1. Run BEMIO

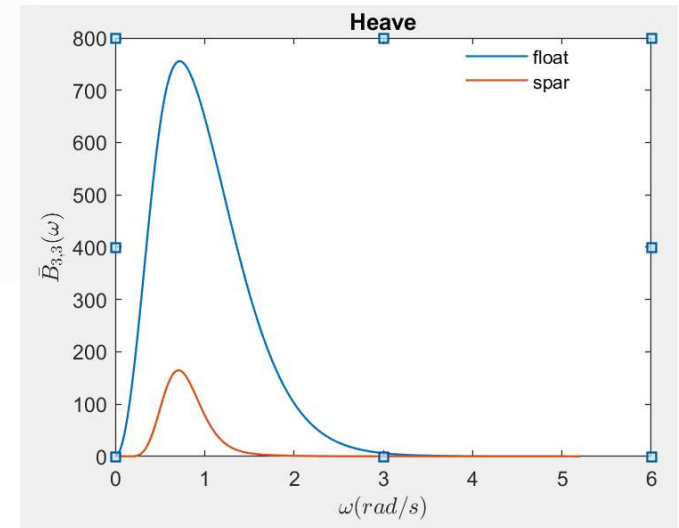
Run BEMIO

Hydrodynamic data for each RM3 body must be parsed into a HDF5 file using BEMIO. BEMIO converts hydrodynamic data from WAMIT, NEMOH or AQWA into a HDF5 file, *.h5 that is then read by WEC-Sim. The RM3 tutorial includes data from a WAMIT run, rm3.out, of the RM3 geometry in the \$WECSIM/tutorials/rm3/hydroData/ directory. The RM3 WAMIT rm3.out file and the BEMIO bemio.m script are then used to generate the rm3.h5 file.

This is done by navigating to the \$WECSIM/tutorials/rm3/hydroData/ directory, and typing ``bemio`` in the MATLAB Command Window:

```
>> bemio
```

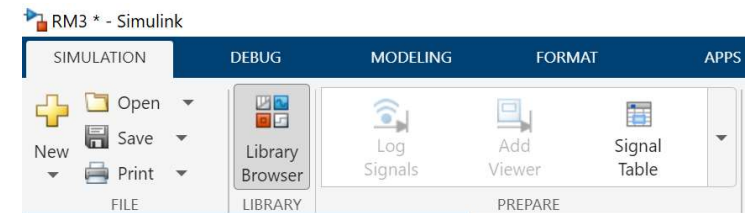
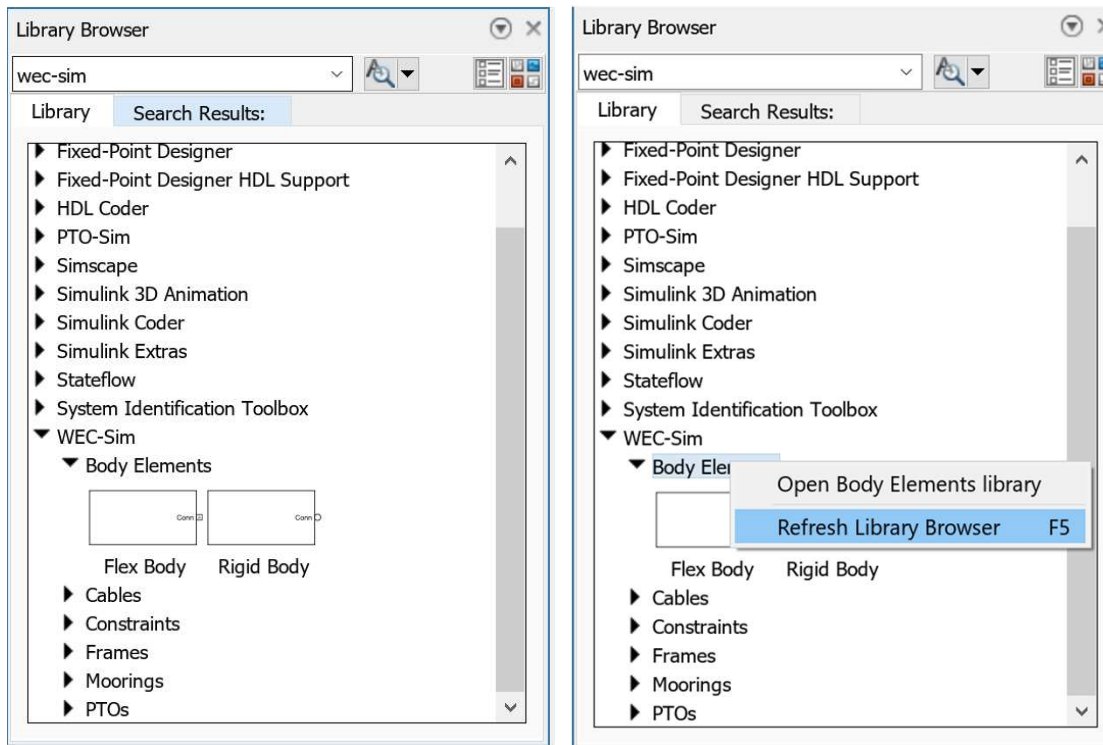
```
bemio.m x +
1 hydro = struct();
2
3 hydro = readWAMIT(hydro, 'rm3.out', []);
4 hydro = radiationIRF(hydro, 60, [], [], [], []);
5 hydro = radiationIRFSS(hydro, [], []);
6 hydro = excitationIRF(hydro, 157, [], [], [], []);
7 writeBEMIOH5(hydro)
8 plotBEMIO(hydro)
```



<https://wec-sim.github.io/WEC-Sim/master/user/tutorials.html#two-body-point-absorber-rm3>

RM3 Tutorial: Step 2. Build Simulink Model

- i. Open RM3.slx (it should be blank)
- ii. Open the Library Browser



The Library Browser may need to be refreshed to show blocks within the WEC-Sim library.

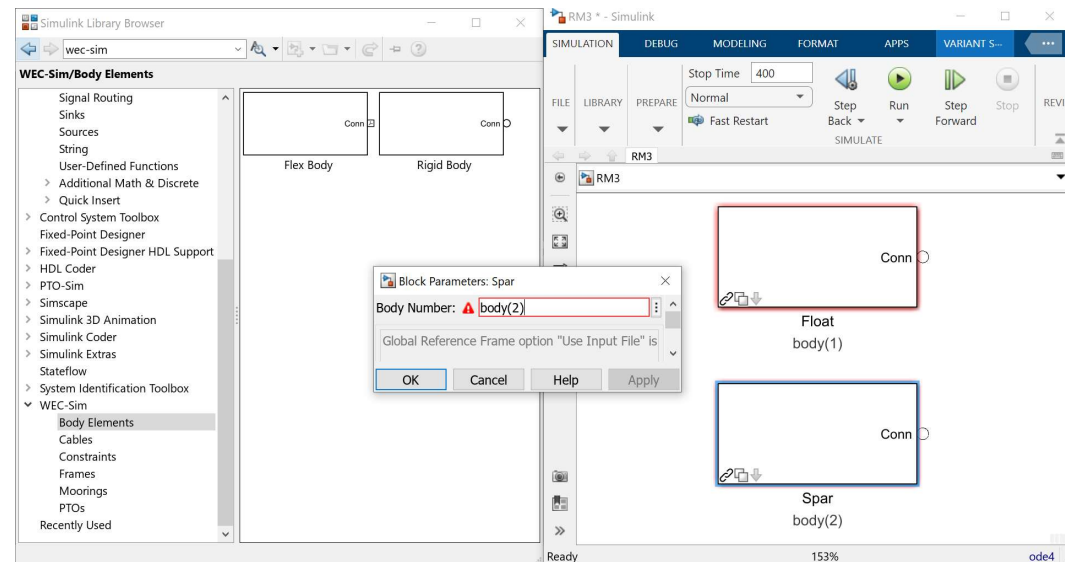
<https://wec-sim.github.io/WEC-Sim/master/user/tutorials.html#two-body-point-absorber-rm3>

RM3 Tutorial: Step 2. Build Simulink Model

ii. Add Rigid Body Blocks

- Place two **Rigid Body** blocks from *Body Elements* in *WEC-Sim Library* in the Simulink model file, one for each RM3 rigid body.
- Double click on the **Rigid Body** block, and rename each instance of the body. The first body must be called `body(1)`, and the second body should be called `body(2)`.

*"Variable 'body' does not exist"
warning is okay (for now)*



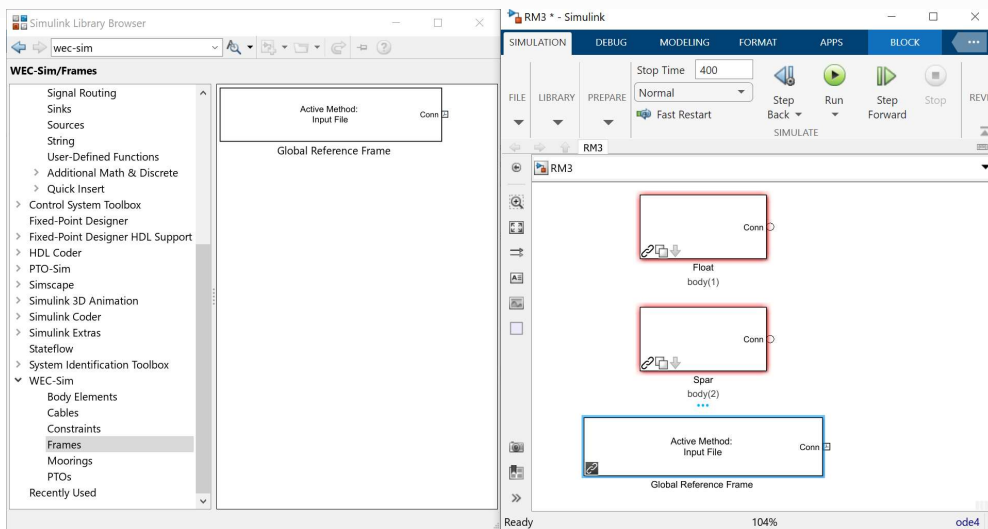
<https://wec-sim.github.io/WEC-Sim/master/user/tutorials.html#two-body-point-absorber-rm3>

RM3 Tutorial: Step 2. Build Simulink Model

iii. Add Global Reference Frame

- Place the **Global Reference Frame** from *Frames* in the *WEC-Sim Library* in the Simulink model file. The global reference frame acts as the seabed.

*“Variable ‘body’ does not exist”
warning is okay (for now)*

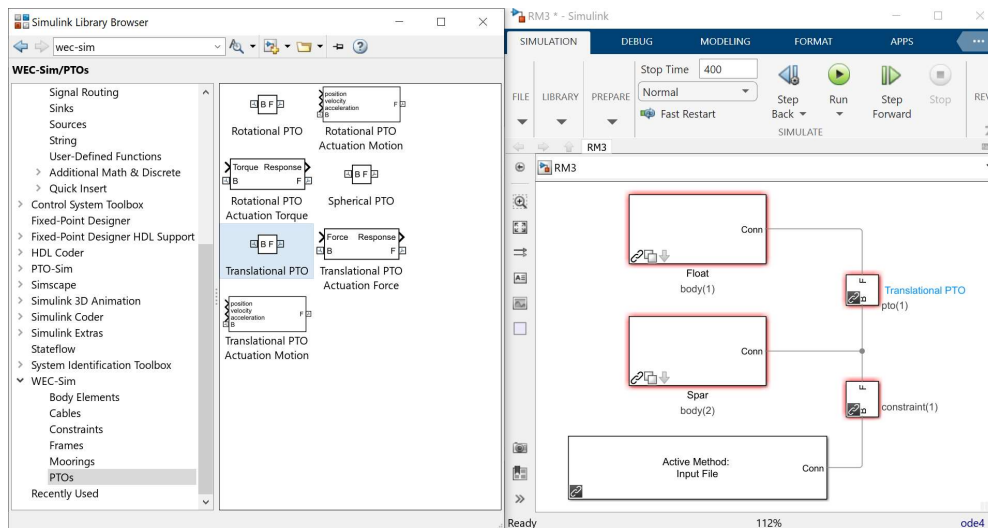


<https://wec-sim.github.io/WEC-Sim/master/user/tutorials.html#two-body-point-absorber-rm3>

RM3 Tutorial: Step 2. Build Simulink Model

iv. Add 3DOF Constraint and Translational PTO

- Place the **Floating (3DOF)** block from *Constraints* to connect the plate to the seabed. This constrains the plate to move in 3DOF relative to the **Global Reference Frame**.
- Place the **Translational PTO** block from *PTOs* to connect the float to the spar. This constrains the float to move in heave relative to the spar, and allows definition of PTO damping.



- **B** stands for **Base**
- **F** stands for **Follower**
- It is very important to use the correct base and follower
- **Base** port towards the **Global Reference Frame**; **Follower** port away

"Variable 'pto' does not exist" warning is okay (for now)



<https://wec-sim.github.io/WEC-Sim/master/user/tutorials.html#two-body-point-absorber-rm3>

RM3 Tutorial: Step 3. Write *wecSimInputFile.m*

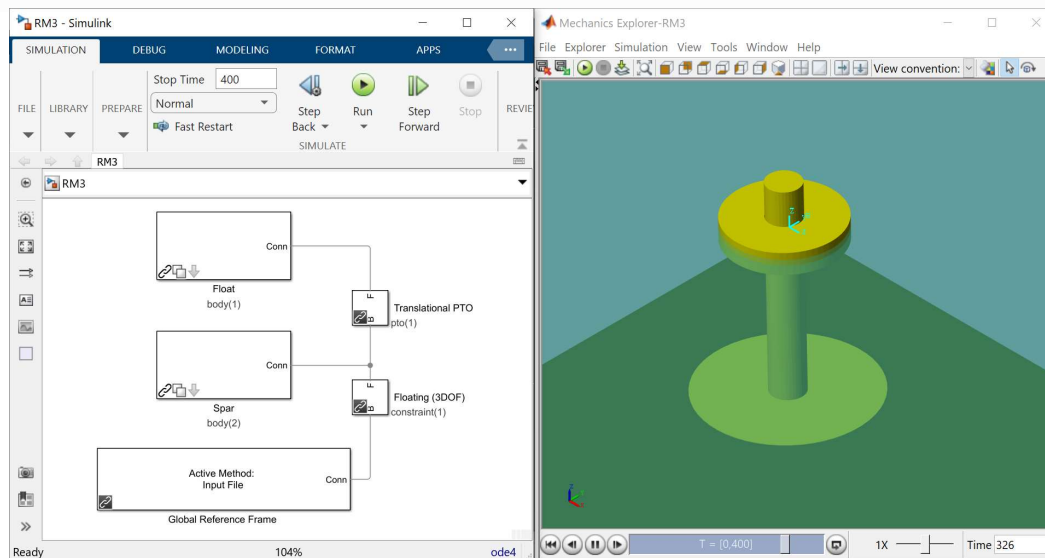
- Input file must be named: ***wecSimInputFile.m***
 - Input file must be located in the case directory:
\$WEC-Sim/tutorials/RM3
 - Input file template provided in:
\$WEC-Sim/tutorials/RM3
 - Complete input file located in:
\$WEC-Sim/examples/RM3
- **Update the following:**

```
simu.simMechanicsFile = 'RM3.slx';  
waves = waveClass('regular');  
waves.period = 8;  
waves.height = 2.5;  
body(1) = bodyClass('hydroData/rm3.h5');  
body(2) = bodyClass('hydroData/rm3.h5');  
pto(1).stiffness = 0;  
pto(1).damping = 1200000;
```

RM3 Tutorial: Step 4. Run WEC-Sim

Run wecSim.m

To execute the WEC-Sim code for the RM3 tutorial, type `wecSim` into the MATLAB Command Window. Below is a figure showing the final RM3 Simulink model and the WEC-Sim GUI during the simulation. For more information on using WEC-Sim to model the RM3 device, refer to [A1].



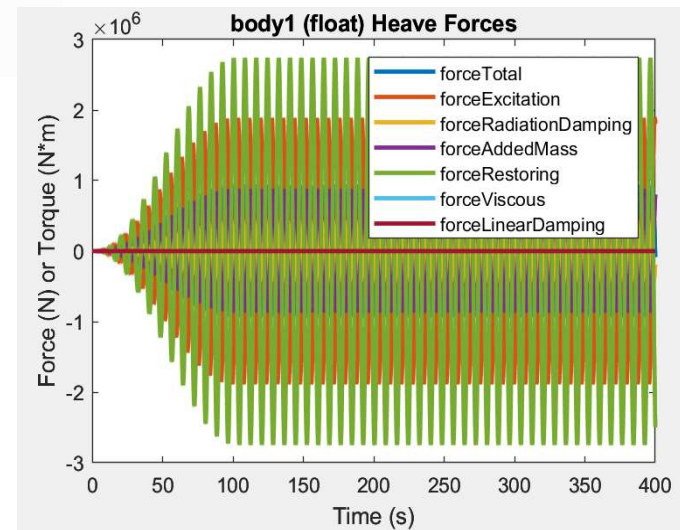
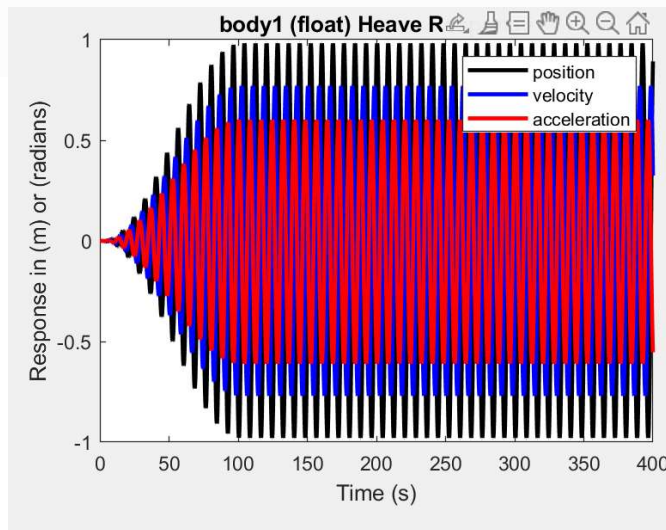
- Must execute WEC-Sim from the case directory:
\$WEC-Sim/tutorials/rm3
- Type into Command Window:
wecSim.m
- Mechanics Explorer should open up with RM3 simulation

<https://wec-sim.github.io/WEC-Sim/master/user/tutorials.html#two-body-point-absorber-rm3>

RM3 Tutorial: Step 5. Post-Processing

Post-processing

The RM3 tutorial includes a `userDefinedFunctions.m` which plots RM3 forces and responses. This file can be modified by users for post-processing. Additionally, once the WEC-Sim run is complete, the WEC-Sim results are saved to the `output` variable in the MATLAB workspace.



<https://wec-sim.github.io/WEC-Sim/master/user/tutorials.html#two-body-point-absorber-rm3>

Thank you

For more information please visit the WEC-Sim website:

<http://wec-sim.github.io/WEC-Sim>

If you have questions on this presentation please reach out to any of the WEC-Sim Developers on GitHub:

<https://github.com/WEC-Sim/WEC-Sim>



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