



## EXERCISE SHEET 4

### Exercise 6: MatMorembs

MatMorembs<sup>1</sup> (Model Order Reduction of Elastic Multibody Systems) is a Matlab software package which is developed at the ITM and used as a preprocessor to reduce flexible bodies. We will use it to reduce the arm of the governor with several reduction techniques, c.f. figure 1. You will have to consult the online help<sup>2</sup>, esp. *Examples* and *Functions Reference* → *Model Reduction*, in order to work at this exercise.

- (a) You can download an encoded version of MatMorembs from ILIAS. Extract it into a directory of your choice. Copy the file `exercise06.m` into a subdirectory named `scripts`. Also extract the FE model into a subdirectory named `model`.
- (b) From now on, you will only edit the file `exercise06.m`, which imports the FE data from Ansys, defines proportional damping and defines the input/output for the system (all degrees of freedom of the nodes 3, 14, 160, 164). Start this script and see if the FE model is correctly imported by looking at the variable `sysdata.constr_model` which should contain all the system matrices and by visualizing the arm with `plotSysdata`<sup>3</sup>.
- (c) Compare the following reduction methods:

(i) Modal reduction

(ii) Craig-Bampton reduction: Check that the input dofs are actually the right interface nodes with

```
sysdata.nodes.marker = [3,14,160,164];  
plotSysdata(sysdata, 'nodenumbers', 'marker');
```

(iii) Krylov reduction with shifts at 100 Hz, 200 Hz and 600 Hz and moment matching up to order 2. Comment on the size of the Krylov reduction with the help of the algorithm.

Details on the comparison:

- You can only compare apples with apples if the same reduction size is chosen for all three reduction methods.
- Visualize the relative error  $\epsilon_F^{\text{rel}}(f)$  for 500 frequencies  $f \in [1 \text{ Hz}, 10000 \text{ Hz}]$  using exercise 4.
- Use as much MatMorembs functions as you can.
- You can use the eigensolutions which are saved in the Ansys files.

### Notes

- The homework is due on Sunday night January 14th, 2024 at 11:59 p.m.
- All files can be found on ILIAS.

<sup>1</sup>More information: <https://www.itm.uni-stuttgart.de/en/software/morembs/>

<sup>2</sup>[http://info.itm.uni-stuttgart.de/research/model\\_reduction/MatMorembsDocumentation/html/](http://info.itm.uni-stuttgart.de/research/model_reduction/MatMorembsDocumentation/html/)

<sup>3</sup>There can be some problems with this command under Windows. You can skip it in that case.

- Only upload the modified file `exercise06.m`, not the model or MatMorembs code.

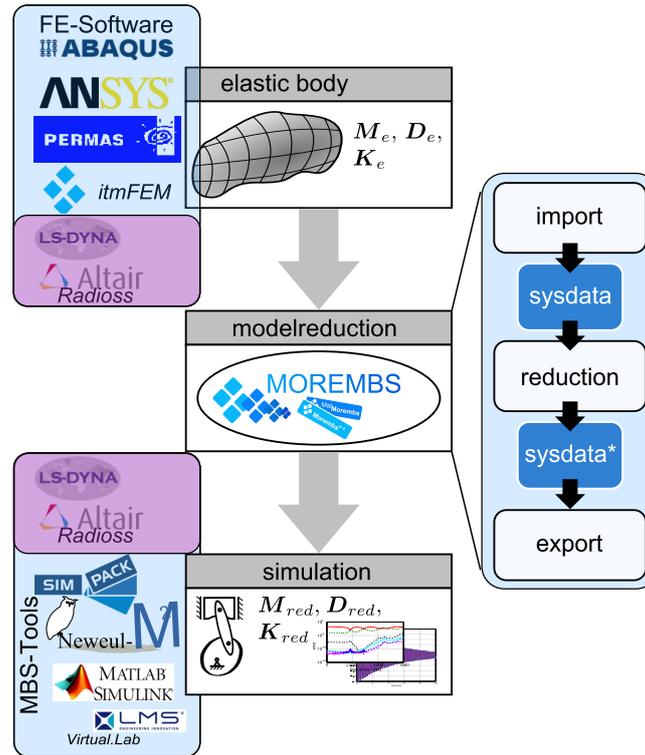


Figure 1: Workflow of MatMorembs