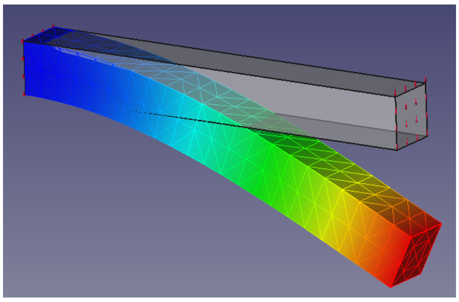
Institute of Mechanics and Fluid Dynamics
Chair of Applied Mechanics – Dynamics

Announcement: Master Thesis

FEM Simulation of a Cantilever Beam with Coupled Oscillation Modes

Vibrating mechanical structures can exhibit so-called internal resonances or mode coupling if two natural frequencies ω_i and ω_j are equal ($\omega_i = \omega_j$) or integer multiples of each other ($\omega_i = n\omega_j$ with $n \in \mathbb{N}$). In this case, even small non-linearities in the system (e. g. non-linear material properties or geometric non-linearities) lead to coupling of the associated oscillation modes, i. e. the oscillation of one mode also excites the coupled mode. This effect is used, for example, in micro-electro-mechanical systems (MEMS) to realize sensors in which one coupled mode is excited, but the measurement is based on the oscillation of the coupled so-called detection mode. One example of such sensors are MEMS gyroscopes, which are used as angular rate sensors to measure orientation or changes in orientation in many electronic devices such as smartphones.

As an academic example of a mechanical system with such coupled vibration modes, a cantilever beam with corresponding dimensions is to be investigated as a finite element model (FEM). For this purpose, the finite element toolbox *Ferrite.jl* in the software *Julia* is to be used. In contrast to commercial products such as *Abaqus* or *Ansys*, the equations of motion of the FEM model can be accessed in *Ferrite.jl* in order to use them in future work to optimize the system structure.



The aim of this work is to implement a FEM model of the cantilever beam, determine the natural angular frequencies and simulate the coupled modes. The results shall be validated with analytical results as well as with solutions from *Abaqus*.

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